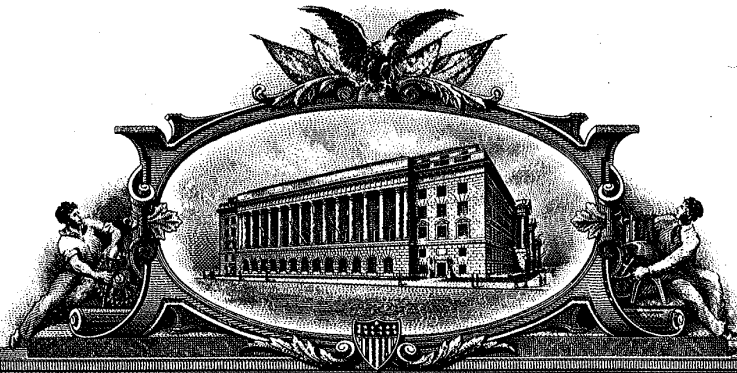


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APPLICATION NUMBER: 09/458,919

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Certifying Officer

PART (1) OF (2) PART(S)

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U.S. UTILITY Patent Application

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CLASS 502	SUBCLASS 11+	ART UNIT 1751	EXAMINER
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APPLICATION NO. 09/458919	CONT/PRIOR YES	CLASS 502 501	SUBCLASS 5	ART UNIT 1754 1755	EXAMINER KOSLOW
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APPLICANTS
DMITRI BRODKIN
CARLINO PANZERA
PAUL PANZERA

TITLE
PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

CPA

PTO-2040
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ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)					
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
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7-3-02 Formal Drawings **(1 sheet)** set **8-16-01**

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APPLICANTS DMITRI BRODKIN, WEST ORANGE, NJ ; CARLINO PANZERA, BELLE MEAD, NJ ; PAUL PANZERA, MT. HOLLY, NJ ;					
** CONTINUING DATA ***** THIS APPLN CLAIMS BENEFIT OF 60/153,916 09/14/1999 AND CLAIMS BENEFIT OF 60/122,558 03/02/1999 AND CLAIMS BENEFIT OF 60/111,872 12/11/1998					
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IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY ** ** 01/13/2000					
Foreign Priority claimed <input type="checkbox"/> yes <input checked="" type="checkbox"/> no 35 USC 119 (a-d) conditions <input type="checkbox"/> yes <input checked="" type="checkbox"/> no <input type="checkbox"/> Met after met <u>Allowance</u> Verified and Acknowledged <u>Examiner's Signature</u> Initials		STATE OR COUNTRY NJ	SHEETS DRAWING 1	TOTAL CLAIMS 77	INDEPENDENT CLAIMS 18
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TITLE PRESSABLE LITHIUM DISILICATE GLASS CERAMICS					
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Sir:

Transmitted herewith for filing is the patent application of :

INVENTOR(S): Dmitri Brodtkin, Carlino Panzera, Paul Panzera

FOR: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

Enclosed are:

☒ 34 pages of specification, including claims and abstract.

☐ 1 sheet(s) of drawing(s).

☐ Declaration and Power of Attorney.

☐ Information Disclosure Statement.

☐ An associate power of attorney.

☐ An assignment of the invention.

☐ A certified copy of a _____ application.

☒ A verified statement to establish small entity under 37 CFR 1.9 and 37 CFR 1.27.

The filing fee has been calculated as shown below:

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INDEP. CLAIMS (3)	18	15	x 39	\$585	x 78	
MULTIPLE DEPENDENT CLAIMS	0	0	+130	\$ 0	+260	
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09456919-121099

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Please file this application and conduct all future correspondence with Applicants' attorney identified below.

Respectfully Submitted,

Ann M. Knab
Applicants' Attorneys

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PRESSABLE LITHIUM DISILICATE GLASS CERAMICS5 **CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims priority to U.S. Provisional Application No. 60/153,916, filed September 14, 1999, U.S. Provisional Application No. 60/122,558, filed March 2, 1999, and U.S. Provisional Application No. 60/111,872, filed December 11, 1998, all which are incorporated herein by reference.

10

FIELD OF INVENTION

This invention relates generally to glass-ceramics comprising lithium disilicate and more specifically to glass-ceramics for use in the manufacture of dental restorations and methods of manufacture thereof.

15

BACKGROUND OF THE INVENTION

The use of lithium disilicate glass ceramics for use in dental restorations has been suggested in the prior art. U.S. Patent No. 4,189,325 to Barret et al. is directed to a glass-ceramic comprising lithium disilicate for use in dental restorations. The glass ceramic requires the presence of Nb₂O₅ and Pt as nucleation agents. Barrett et al. introduced dental restorations made from castable lithium disilicate glass-ceramics in the Li₂O-CaO-Al₂O₃-SiO₂ system nucleated by Pt and Nb₂O₅. According to Barret et al., dental restorations are made by casting a melt into an investment mold, and devitrifying thereafter.

20

U.S. Patent No. 4,515,634 to Wu et al. is directed to a castable glass-ceramic composition wherein the glass is melted and cast into a shape and is crystallized after it has been shaped. Therefore, the crystallization process is performed by the technician making the restoration, not the manufacturer of the dental material. Wu set al. suggests one way to improve properties of castable lithium disilicate dental restorations within the same Li₂O-

25

CaO-Al₂O₃-SiO₂ system as described by Barrett et al. is by utilization of P₂O₅ as a nucleating agent. Both Barrett et al. and Wu et al. describe castable compositions having CaO as an essential ingredient believed to improve chemical durability of the resulting glass-ceramics. Chemical durability is one of the major issues that the Wu and Barrett inventions fail to address. For example, total alkali leaching rates for materials presented in Wu's examples were four to five times higher than those for commercial dental porcelain.

Castable dental ceramics as described in Barret et al. and Wu et al. employ melting glass ingots supplied by a manufacturer and casting dental articles into a refractory investment mold. Following the casting process, the cast articles are devitrified (crystallized) by the required heat-treatment steps. This process is very similar to casting metals whereby a heat-treatment step follows the casting process to increase hardness and strength.

U.S. Patent Nos. 5,507,981 and 5,702,514 to Petticrew teach lithium disilicate compositions for use in dental restorations, but the method described therein implies forming glass into the shape of a dental restoration at temperatures much higher than the melting temperature of lithium disilicate and heat-treating the dental restoration after forming to convert the glass into a glass-ceramic.

German Patent Application No. DE19647739 to Schweiger et al. is directed to lithium disilicate compositions for use in dental restorations. The glass-ceramic bodies or blanks used to press dental restorations are defined as "sinterable glass ceramics" which are produced from the starting amorphous glass powder by simultaneous sintering and powder crystallizing, which process is also known as surface crystallization. The glass must be in powder form to be crystallized. Additionally, the lithium disilicate compositions therein require the presence of La₂O₃, MgO and ZnO.

Many of the lithium disilicate compositions in the prior art require casting of the glass into the desired shape and crystallizing thereafter. The glass must be formed into the finally desired shape and thereafter heat treated to crystallize into a lithium disilicate phase. This may result in structural and other problems, since the microstructure is not formed by the dental materials manufacturer, but by the technician fabricating the dental restoration.

3²

Overprocessing by a technician may change the microstructure of the material to something not preferred or desired by the dental materials manufacturer. Moreover, some of the prior art compositions require the forming of the glass ceramics by surface crystallization, limiting the forming and compositional possibilities of the material.

5 It is desirable to provide a lithium disilicate glass-ceramic which is pressable after the lithium disilicate is formed. It is beneficial to provide a lithium disilicate glass ceramic for use in the fabrication of dental restorations wherein crystallization is carried out by the dental materials manufacturer in the most controlled manner. It is beneficial to provide translucent lithium disilicate glass ceramics having high strength and good pressability.

10 SUMMARY OF THE INVENTION

This invention is directed to lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) based glass-ceramics comprising silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide in addition to other components listed below. The glass-ceramics are useful in the fabrication of
15 single and multi-unit dental restorations including but not limited to orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders, and connectors made by heat pressing into refractory investment molds produced using lost wax techniques. The glass-ceramics have good pressability, i.e., the ability to be
20 formed into dental articles by heat pressing, also known as hot pressing, or injection molding, using commercially available equipment.

In accordance with one embodiment directed to the process of making the glass-ceramics, the compositions herein are melted at about 1200° to about 1600°C and preferably in the range of about 1300° to about 1400°C for a period of time, preferably for about 4 hours
25 and thereafter quenched (e.g., water quenched or roller quenched) or cast into steel molds, or alternately, cooled to the crystallization temperature.

The resulting glass is heat-treated to form a glass-ceramic via a one or two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100°C . This

crystallization heat treatment may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450°C to about 700°C and preferably in the range of about 500°C to about 650°C for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the
5 range of about 800°C to about 1000°C and preferably in the range of about 830°C to about 930°C for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645°C and a subsequent four hour soak at about 850°C.

The resulting glass ceramics are then pulverized into powder and used to form pressable pellets and/or blanks of desired shapes, sizes and structures. Additives may be
10 mixed with the powder prior to forming into pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200°C, and more preferably in the range of about 850° to about 950°C, and most preferably at less than about 930°C, under vacuum and with the application of pressure of
15 between about 2 to about 8 bar (0.2 to 0.8 MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Features of the present invention are disclosed in the accompanying drawing, wherein:

Figure 1 is perspective view of a plunger system in a pressing furnace for use in the fabrication of dental restorations in accordance with the invention.

25 DESCRIPTION OF THE INVENTION

As will be appreciated, the present invention provides glass-ceramic compositions comprising a glassy matrix and lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$). The glass-ceramics are useful for the fabrication of dental restorations. The compositions of the lithium disilicate glass-

5 4

ceramics comprise inter alia, silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide in the ranges given in Table 1 below. The glass-ceramic compositions of the invention have a combination of properties useful for dental restorations. The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat pressing, also
5 known as hot pressing, or injection molding, using commercially available equipment.

Pressable ceramics employ some form of hot-pressing or injection-molding of the glass-ceramic materials, which are typically in the form of pellets. The pellets contain one or more crystalline phases and their morphology as well as volume fraction are not significantly altered in the course of pressing. One reason for this is that the pressing temperature is
10 typically lower than the melting temperature of the crystalline phases. This is a major advantage because microstructure is formed in the controlled conditions by the manufacturer of the glass-ceramic materials, e.g., pellets. Following pressing, the resulting dental article does not require crystallization heat-treatment.

The glass-ceramic pellets can be formed by a number of processes: (1) Glass can be
15 cast into the shape of pellet. Pellets are taken from the mold and crystallized. These pellets can not be shaded by the addition of pigments. (2) Glass can be crystallized in bulk and subsequently milled into powder. Pigments and other additives can be added to the powder. The powder is formed into a pellet and partially or fully sintered. Pigments, if added, create color centers that impart a certain color to a translucent body of the dental article pressed
20 from the pellet. The mechanism of crystallization in the two processes described above is volume crystallization.

Alternatively, surface crystallization may be utilized to crystallize a portion of the glass into one or more crystal phases. This involves milling glass into powder. Pigments and other additives can be added to the powder. This glass powder (amorphous, not crystalline)
25 is formed into a pellet. The glass pellet is sintered and crystallized in the same firing cycle. Not all glass-ceramic materials can be crystallized and sintered simultaneously. Only certain materials and compositions prone to surface crystallization can be processed this way. The glass-ceramics processed from glass powder via simultaneous sintering and crystallization are

6. 5

sometimes called "sintered" glass-ceramics. Another term that can be used is "sinterable" glass-ceramics.

The compositions herein are prepared by mixing, in the desired proportions, the oxides and/or compounds that decompose to form the oxides, followed by fusing the ingredients to obtain the compositions in Table 1. Convenient raw material include lithium carbonate, silica, alumina, carbonates of K, Na, Ca, ammonium phosphate, tricalcium aluminate, aluminum phosphate or aluminum metaphosphate and if necessary, Ta₂O₅, CeO₂, Tb₄O₇, titanium dioxide, and zirconium dioxide.

10

Table 1

Oxide, wt%	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
SiO ₂	about 62 to about 85	about 64 to about 70	about 62-85	about 64-70	about 64 to about 70	about 62 to about 76
B ₂ O ₃	about 0 to about 4.9	about 0 - about 2.7	about 0-4.9	about 0-2.7	about 0.5 - about 3.0	about 0 - about 5
Al ₂ O ₃	about 1.5 to about 10	about 1.5 to about 6.0	about 5.1-10	about 5.2-9.0	about 1.5 to about 6.0	about 1.5 to about 10
F	about 0 to about 1.5	about 0 to about 1.5	about 0 to about 1.5	about 0 to about 1.5	about 0 to about 1.5	about 0 to about 1.5
ZnO	about 0 to about 5	about 0 to about 2	about 0-5	about 0-2	-----	about 0 to about 5
CaO	about 0 to about 7	about 0 to about 0.9	about 0-7	about 0-0.9	about 0 to about 0.9	about 0 to about 7
MgO	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	-----	about 0 to about 2
BaO	about 0 to about 7	about 0 to about 7	about 0 to about 7	about 0 to about 7	about 0 to about 7	about 0 to about 7
SrO	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Cs ₂ O	about 0 to about 5	about 0 to about 5	about 0 to about 5	about 0 to about 5	about 0 to about 5	about 0 to about 5
Li ₂ O	about 8 to about 19	about 10 to about 15	about 8-19	about 10-15	about 10 to about 15	about 8 to about 19
K ₂ O	about 2.5 to about 7	about 2.5 to about 5	about 0-7	about 0-5	about 2.2 to about 5	about 0 to about 7
Na ₂ O	about 0 to about 5	about 0 to about 3	about 0-5	about 0-3	about 0.5 to about 3	about 0 to about 5
TiO ₂	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2
ZrO ₂	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3
P ₂ O ₅	about 0.5 to about 12	about 2 to about 7	about 0.5-12	about 2-7	about 2 to about 7	about 0.3 to about 7.0
SnO ₂	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Sb ₂ O ₃	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Y ₂ O ₃	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3	about 0 to about 3
CeO ₂	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Eu ₂ O ₃	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Tb ₄ O ₇	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1	about 0 to about 1
Nb ₂ O ₅	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2
Ta ₂ O ₅	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0 to about 2	about 0.5 to about 8.0

The compositions in Table 1 are melted at about 1200° to about 1600°C and preferably in the range of about 1300° to about 1400°C for a period of time, preferably for about 4 hours and thereafter quenched (e.g., water quenched or roller quenched), cast into steel molds, or alternately, cooled to the crystallization temperature. If the melt is cooled to the crystallization temperature, it may remain in the same furnace.

The resulting glass is heat-treated to form glass-ceramics using a one or a two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100°C. This crystallization heat-treatment may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450°C to about 700°C and preferably in the range of about 500°C to about 650°C for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the range of about 800°C to about 1000°C and preferably in the range of about 830°C to about 930°C for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645°C and a subsequent four hour soak at about 850°C.

The glass ceramics comprise lithium disilicate. The resulting glass ceramics are then pulverized into powder sieved to -200 mesh to provide powder with average particle sizes of about 30 to about 40 microns. Pigments, fluorescing agents, opacifying agents, and the like may be added to the powder in a wide range in an amount between about 0 and about 6 wt% and preferably in the amount of between about 0 and about 5 wt% and most preferably in the amount of about 0% to about 3 wt%. Moreover, reinforcing agents may be added to the powder in an amount of from about 0 to about 30 vol % and more preferably in an amount of from about 0 to about 20 vol %. The reinforcing agents may include fibers, whiskers, and particulate fillers and may be fabricated of any known material, preferably a glass or ceramic material.

The powders may be used to form and fuse pressable pellets and/or blanks of desired shapes, sizes and structures. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200°C, and more

preferably in the range of about 850° to about 950°C, and most preferably at less than about 930°C, under vacuum and with the application of pressure of between about 2 to about 8 bar (0.2 - 0.8 MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry using commercially available milling equipment such as the Maho HGF 500 5 Axis CNC Milling Machine available from Fraunhofer Institut Produktionstechnologie, Germany.

In an alternative method herein, the compositions in Table 1 are melted at about 1200° to about 1600°C and preferably in the range of about 1300° to about 1400°C for a period of time, preferably for about 4 hours and thereafter water quenched or cast into steel molds.

The quenched glass is comminuted to a powder. Pigments, fluorescing agents, opacifying agents, and the like may be added to the powder in a wide range in an amount between about 0 and about 6 wt% and preferably in the amount of between about 0 and about 5 wt% and most preferably in the amount of about 0% to about 3 wt%. Moreover, reinforcing agents may be added to the powder in an amount of from about 0 to about 30 vol % and more preferably in an amount of from about 0 to about 20 vol %. The reinforcing agents may include fibers, whiskers, and particulate fillers and may be fabricated of any known material, preferably a ceramic material.

The powder is compacted into a pellet or starting blank. The blank is thereafter simultaneously sintered and crystallized. Heat treatment may be one or more cycles in the temperature range of about 400° to about 1100°C. The crystallization may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450°C to about 700°C and preferably in the range of about 500°C to about 650°C for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the range of about 800°C to about 1000°C and preferably in the range of about 830°C to about 930°C for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645°C and a subsequent

four hour soak at about 850°C.

The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200°C, and more preferably in the range of about 850° to about 950°C, and most preferably at less than about 930°C, under vacuum and with the application of pressure of about between about 2 to about 8 bar (0.2 - 0.8 MPa) and preferably no greater than 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry.

To achieve the required combination of properties, namely sufficient strength, formability below 950°C, by heat-pressing using commercially available dental presses such as the Autopress® Plus available from Jeneric/Pentron, Wallingford, CT, translucency and chemical durability, the optimal chemical combinations and crystallization treatment of the present invention are necessary. The best properties are obtained when the lithium metasilicate (Li_2SiO_3) and silica phases are nearly absent, the volume fraction of Li_3PO_4 is less than about 5% and the volume fraction of lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) is between about 35% and about 60%. High aspect ratio morphology of the lithium disilicate phase is important and is believed to enhance mechanical properties, i.e., strength and fracture toughness of the glass-ceramic.

Li_2O and SiO_2 are instrumental in crystallizing the required amount of the lithium disilicate phase in the compositions of the present invention. Additionally, BaO and Cs_2O stabilize the residual glass and boost the refractive index of the residual glass to match that of lithium disilicate. Al_2O_3 and to a lesser extent, B_2O_3 , if less than 3%, yield chemically durable glass-ceramics that exhibit a sufficiently low solubility. Alkali (Na, K, Cs) and alkaline earth metal (Ca, Ba) oxides are required to lower processing temperatures of the glass-ceramic. However some of them affect chemical durability more than others. With respect to the following group of alkali metals and alkaline earth metals of potassium, calcium, sodium, and barium; potassium is associated with the smallest decrease in chemical durability of lithium containing glasses, with calcium being next, and sodium and barium affecting chemical durability the most. However, the best combination of properties is

achieved when those oxides are used in combination to achieve the so-called "mixed alkali effect." F lowers the viscosity of the glass-matrix and enhances formability at temperatures below about 950°C. Y_2O_3 in combination with Ce_2O_3 , Eu_2O_3 and Tb_4O_7 modify the refractive index as well as impart fluorescence. Nb_2O_5 and Ta_2O_5 modify the refractive index as well as aid nucleation and chemical durability of the resulting glass ceramics.

The following Table 2 illustrates examples of the compositions of the invention.

Table 2

Oxide, wt%	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15
SiO_2	68.8	70.0	70.1	65.4	70.7	70.9	68.1	69.5	72	69.0	68.8	68	67.2	68.9	72
B_2O_3	1.2	1.0	-----	-----	-----	-----	-----	1.3	2.9	-----	1.3	1.0	1.2	0.9	2.0
Al_2O_3	4.8	4.9	5.2	8.1	5.3	5.3	4.7	4.8	5.1	6.0	4.8	5	4.7	4.7	4.5
F	-----	-----	-----	1.4	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
ZnO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
CaO	0.9	0.5	2.2	-----	-----	-----	2.0	2.0	-----	-----	1.0	1	1	0.5	0
MgO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BaO	2.8	1.4	-----	3.8	5.4	5.4	-----	-----	2.0	2.7	2.8	2.7	2.7	1.4	2.0
SrO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cs_2O	-----	-----	-----	4.1	4.9	4.9	-----	-----	-----	-----	-----	-----	-----	-----	-----
Li_2O	14.4	14.7	14.7	13.4	11.0	10.8	14.3	14.6	13.0	15.3	14.4	15	14.1	14.3	13.0
K_2O	2.5	2.5	4.6	1.7	-----	-----	4.4	4.5	2.0	2.1	2.2	2.2	2.2	2.0	2.0
Na_2O	1.4	1.4	-----	-----	-----	-----	-----	-----	-----	-----	1.5	1.4	1.4	1.3	-----
TiO_2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
ZrO_2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
P_2O_5	3.3	3.6	3.4	2.7	2.7	2.7	3.3	3.4	3.0	4.0	3.3	3.5	3.2	3.5	3.0
SnO_2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sb_2O_3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Y_2O_3	-----	-----	-----	-----	-----	-----	-----	-----	0.5	0.8	-----	-----	-----	-----	0.5
CeO_2	-----	-----	-----	-----	-----	-----	0.4	-----	0.5	-----	-----	0.4	0.4	0.3	0.6
Eu_2O_3	-----	-----	-----	-----	-----	-----	-----	-----	0.5	-----	-----	-----	-----	-----	0.6
Tb_4O_7	-----	-----	-----	-----	-----	-----	0.8	-----	-----	-----	-----	0.9	-----	0.3	-----
Nb_2O_5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Ta ₂ O ₅	----	----	----	----	----	----	2.0	----	----	----	----	1.9	2.0	1.8	----
Three-Point Flexural Strength per ISO 6872, MPa										430±70	420±60		440±60		400±50
As-pressed Opacity (relative opacity units)										50	42		25		34
CTE (25°C-500°C), 10 ⁻⁶ °C ⁻¹		10.4								8.7	10.1-10.6		10.5	10.0	9.9

The following examples illustrate the invention.

Examples

Glass-ceramic compositions of the present invention were utilized to make glass-ceramic pellets. These pellets were used to make rectangular bars and rods for measuring the flexural strength by heat-pressing these pellets into the cavity of the refractory investment mold. The process was the same as that used to make dental restorations. The three-point flexure strength was greater or equal to 300 MPa. This strength is sufficient for multi-unit restorations such as anterior bridges. The compositions have a significant amount of glass phase, i.e., approximately 50% glass phase which enhances the pressability thereof.

Moreover, the closeness of refractive indices of the matrix glass (~1.5) and that of the crystallized phase - lithium disilicate - (~1.55) allows for the possibility of translucent glass-ceramics. Specifically in the present invention, the refractive index of the glass matrix is increased to match that of the lithium disilicate phase by adding small amounts of heavy ions such as, but not limited to, Sr, Y, Nb, Cs, Ba, Ta, Ce, Eu and Tb.

The following examples in Table 3 illustrate the effect of different additions on translucency, strength and reactivity with investment of the resulting glass ceramics. The composition of Example 11 (Table 2) was selected as a control composition for the purposes of this study. This composition was modified by adding 0.13 mole% of CeO₂, or 0.06 mole% of Tb₄O₇, or 0.26 mole% of Ta₂O₅, or La₂O₃, or Y₂O₃; and combinations of the latter with CeO₂. Opacity was measured on the pressed disk using an optical densitometer. Reactivity

with investment was evaluated qualitatively by visual inspection of disks and copings prior to and after sand-blasting of the reaction layer. Surfaces of the disks were inspected for pittings under low-magnification (8x) stereomicroscope. Compositions comprising combinations of Ta₂O₅, and CeO₂ were found to have the best combination of high translucency (low opacity) and low reactivity with the investment.

Table 3

Oxide, wt%	Ex. 11*	Ex. 16	Ex. 17	Ex. 18	Ex. 19	Ex. 20	Ex. 21	Ex. 22	Ex. 13*	Ex. 23
SiO ₂	68.8	68.12	68.5	68.2	67.5	67.8	67.9	68.0	67.2	67.5
B ₂ O ₃	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Al ₂ O ₃	4.8	4.7	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
CaO	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
BaO	2.8	2.7	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Li ₂ O	14.4	14.3	14.3	14.3	14.1	14.2	14.2	14.2	14.1	14.1
K ₂ O	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Na ₂ O	1.5	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4
P ₂ O ₅	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3
Y ₂ O ₃	-----	1.04	-----	-----	-----	-----	1.04	-----	-----	-----
CeO ₂	-----	-----	0.39	-----	-----	-----	0.39	0.39	0.39	0.39
Tb ₄ O ₇	-----	-----	-----	0.85	-----	-----	-----	0.85	-----	-----
Ta ₂ O ₅	-----	-----	-----	-----	2.02	-----	-----	-----	2.01	-----
La ₂ O ₃	-----	-----	-----	-----	-----	1.5	-----	-----	-----	1.49
3-pt Flexure Strength per ISO 6872, MPa	420±60								440±60	
As-Pressed Rod 3-pt Flexure Strength, MPa	370±40								370±30	
As-pressed Opacity (relative opacity units)	42	35	39	37	27	25	31	32	25	24
Reactivity with investment material	-----	Medium	Lower	Higher	Medium	Higher	Lower	Medium	Lower	The Highest

*Correspond to compositions in Table 2.

10 Pellets of the compositions of Examples 2, 11, 13 and 14 were used to press a variety of dental articles in the AutoPress® dental press (Jeneric/Pentron, Wallingford, CT) at pressing cycles carried out under vacuum and involving heating from 700°C to 920°C and holding the temperature for 20 minutes prior to initiation of the pressing cycle. Pressure of 0.5 MPa was applied for 7 minutes through a mold-plunger assembly schematically shown in Figure 1. The plunger assembly used to press the pellets into dental restorations may be the system set forth in copending commonly assigned application Serial No. 09/431,659, filed

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with investment was evaluated qualitatively by visual inspection of disks and copings prior to and after sand-blasting of the reaction layer. Surfaces of the disks were inspected for pittings under low-magnification (8x) stereomicroscope. Compositions comprising combinations of Ta₂O₅, and CeO₂ were found to have the best combination of high translucency (low opacity) and low reactivity with the investment.

Table 3

Oxide, wt%	Ex. 11*	Ex. 16	Ex. 17	Ex. 18	Ex. 19	Ex. 20	Ex. 21	Ex. 22	Ex. 13*	Ex. 23
SiO ₂	68.8	68.12	68.5	68.2	67.5	67.8	67.9	68.0	67.2	67.5
B ₂ O ₃	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Al ₂ O ₃	4.8	4.7	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
CaO	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
BaO	2.8	2.7	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Li ₂ O	14.4	14.3	14.3	14.3	14.1	14.2	14.2	14.2	14.1	14.1
K ₂ O	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Na ₂ O	1.5	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4
P ₂ O ₅	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3
Y ₂ O ₃	-----	1.04	-----	-----	-----	-----	1.04	-----	-----	-----
CeO ₂	-----	-----	0.39	-----	-----	-----	0.39	0.39	0.39	0.39
Tb ₄ O ₇	-----	-----	-----	0.85	-----	-----	-----	0.85	-----	-----
Ta ₂ O ₅	-----	-----	-----	-----	2.02	-----	-----	-----	2.01	-----
La ₂ O ₃	-----	-----	-----	-----	-----	1.5	-----	-----	-----	1.49
3-pt Flexure Strength per ISO 6872, MPa	420±60								440±60	
As-Pressed Rod 3-pt Flexure Strength, MPa	370±40								370±30	
As-pressed Opacity (relative opacity units)	42	35	39	37	27	25	31	32	25	24
Reactivity with investment material	-----	Medium	Lower	Higher	Medium	Higher	Lower	Medium	Lower	The Highest

*Correspond to compositions in Table 2.

Pellets of the compositions of Examples 2, 11, 13 and 14 were used to press a variety of dental articles in the AutoPress® dental press (Jeneric/Pentron, Wallingford, CT) at pressing cycles carried out under vacuum and involving heating from 700°C to 920°C and holding the temperature for 20 minutes prior to initiation of the pressing cycle. Pressure of 0.5 MPa was applied for 7 minutes through a mold-plunger assembly schematically shown in Figure 1. The plunger assembly used to press the pellets into dental restorations may be the system set forth in copending commonly assigned application Serial No. 09/431,659, filed

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November 1, 1999, which is hereby incorporated by reference. Disks of compositions of examples 11 and 13 were pressed as described above and chemical solubility was measured according to ISO 6872 and found to be significantly lower than the acceptable limit of 100 ug/cm².

5 The glass-ceramics of the present invention have the capability to be pressed into a single or multi-unit dental restorations at temperatures below about 950°C using already existing, commercially available equipment such as the Autopress[®] available from Jeneric/Pentron, Wallingford, CT. Pressability or ability to flow and be pressed into complex shapes of dental restorations at these temperatures is achieved due to the presence of a
10 sufficient amount of the residual glass in the resulting glass-ceramic, in the range of about 15%-60% by volume. The glass-ceramics of the present invention have the capability to be shaded by admixing pigments to the glass-ceramic powder by methods commonly used for dental porcelains.

As will be appreciated, the present invention provides a simple and effective method
15 for producing lithium disilicate glass-ceramic compositions and dental restorations therefrom. While various descriptions of the present invention are described above, it should be understood that the various features can be used singly or in any combination thereof. Therefore, this invention is not to be limited to only the specifically preferred embodiments depicted herein.

20 Further, it should be understood that variations and modifications within the spirit and scope of the invention may occur to those skilled in the art to which the invention pertains. Accordingly, all expedient modifications readily attainable by one versed in the art from the disclosure set forth herein that are within the scope and spirit of the present invention are to be included as further embodiments of the present invention. The scope of the present
25 invention is accordingly defined as set forth in the appended claims.

CLAIMS

What Is Claimed Is:

1. A glass-ceramic composition comprising in weight percent:

about 62 to about 85% SiO_2 ;
about 1.5 to about 10% Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 2.5 to about 7% K_2O ; and
about 0.5 to about 12 % P_2O_5 .

2. The glass-ceramic composition of claim 1 whereby the glass-ceramic is pressable.

3. The glass-ceramic composition of claim 1 further comprising in weight percent:

up to about 4.9% B_2O_3 ;
up to about 1.5% F;
up to about 5% ZnO ;
up to about 7% CaO ;
up to about 2% MgO ;
up to about 7% BaO ;
up to about 1% SrO ;
up to about 5% Cs_2O ;
up to about 5% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;

up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

34. A dental restoration comprising the glass-ceramic of claim 1.

1730 15. A method of making a lithium disilicate dental restoration comprising:
melting a starting glass composition at temperatures within the range of about 1200 to about 1600°C;

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100°C to convert the glass into a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

1831 16. A method of making a lithium disilicate dental product comprising:
melting a starting glass composition at temperatures within the range of about 1200 to about 1600°C;

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100°C to convert the glass into a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank; and
sintering the blank.

19 20 7. The method of claim 6 wherein the blank is manufactured to a desired
shape and structure.

21 22 8. The method of claim 6 wherein the blank is sintered to full density.

23 24 9. The method of claim 6 wherein crystallization of lithium disilicate is
effected in the glass after the quenching step.

25 26 10. The method of claim 6 wherein the powder is sieved to the required
mesh size prior to the compacting step.

27 28 11. The method of claim 6 further including adding additives to the
powder prior to the compacting step.

29 30 12. The method of claim 11 wherein the additives comprise pigments,
fluorescing agents, opacifying agents.

31 32 13. The method of claim 12 wherein the additives comprise reinforcing
agents.

33 34 14. The method of claim 13 wherein the reinforcing agents comprise one
of fibers, whiskers, particles and mixtures thereof.

35 36 15. The method of claim 13 wherein the reinforcing agents are fabricated
of ceramic material.

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27 ~~40~~ 16. The method of claim ~~6~~ ³¹¹⁸ wherein the sintering of the starting blank comprises heating to a temperature in the range of about 800° to about 1000°C.

5 28 ~~41~~ 17. The method of claim ~~6~~ ³¹¹⁸ wherein the sintering of the starting blank comprises heating to a temperature in the range of about 850° to about 950°C.

10 29 ~~42~~ 18. The method of claim ~~6~~ ³¹¹⁸ wherein the sintered starting blank is subjected to viscous deformation at a temperature in the range of from about 850° to about 950°C under vacuum and at a pressure not exceeding about 6 bar to obtained the desired shape.

15 30 ~~43~~ 19. The method of claim ~~6~~ ³¹¹⁸ wherein the sintered blank is machined to a dental restoration of desired shape.

31 ~~44~~ 20. The method of claim ~~6~~ ³¹¹⁸ wherein the dental product is a dental core and is provided with one or more coatings.

20 32 ~~45~~ 21. The method of claim ~~20~~ ⁴⁴³¹ wherein the one or more coatings is selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof.

25 33 ~~46~~ 22. The method of claim ~~20~~ ⁴⁴³¹ wherein the one or more coatings has a firing temperature in the range of about 700° to about 900°C and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6} / ^\circ\text{C}$ of the dental product (measured at the same temperature range).

34 ~~47~~ 23. The dental restoration of claim ~~4~~ ⁵⁷ formed into a component selected

from orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders, and connector.

5 24. A blank for the manufacture of a dental restoration comprising the glass ceramic of claim 1.

25. The method of claim 24 wherein the glass-ceramic comprises in weight percent:

about 62 to about 85% SiO_2 ;
about 1.5 to about 10% Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 2.5 to about 7% K_2O ; and
about 0.5 to about 12 % P_2O_5 .

26. The method of claim 25 wherein the glass-ceramic further comprises in weight percent:

up to about 4.9% B_2O_3 ;
up to about 1.5% F;
up to about 5% ZnO ;
up to about 7% CaO ;
up to about 2% MgO ;
up to about 7% BaO ;
up to about 1% SrO ;
up to about 5% Cs_2O ;
up to about 5% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;

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up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₂O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

27. A method of making a lithium disilicate dental product comprising:
melting a starting glass comprising a composition at temperatures within the
range of about 1200 to about 1600°C;
cooling the glass melt to the crystallization temperature to form a glass-
ceramic;
quenching the glass-ceramic;
comminuting the glass ceramic to a powder;
compacting the powder to a starting blank; and
sintering the blank.

28. The method of claim 27 wherein the sintering imparts sufficient
strength for further handling of the blank.

29. The method of claim 27 wherein the powder is sieved to the required
mesh size prior to the compacting step.

30. The method of claim 27 further including adding additives to the
powder prior to the compacting step.

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39 30/31. The method of claim 30 wherein the additives comprise pigments, fluorescing agents, opacifying agents.

5 40 32. The method of claim 30 wherein the additives comprise reinforcing agents.

41 33. The method of claim 32 wherein the reinforcing agents comprise one of fibers, whiskers, particles and mixtures thereof.

10 42 34. The method of claim 32 wherein the reinforcing agents are fabricated of ceramic material.

15 43 35. The method of claim 37 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 800 to about 1000°C.

44 36. The method of claim 27 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 850 to about 950°C.

20 45 37. The method of claim 27 wherein the sintered starting blank is subjected to viscous deformation at a temperature in the range of from about 850 to about 950°C under vacuum and at a pressure not exceeding about 7 bar to obtained the desired shape.

25 46 38. The method of claim 27 wherein the sintered blank is machined to a dental restoration of desired shape.

47 39. The method of claim 27 wherein the dental product is a core and is

provided with one or more coatings.

41. The method of claim 39 wherein the one or more coatings is selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof.

41. The method of claim 39 wherein the one or more coatings has a firing temperature in the range of about 700 to about 900°C and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6} / ^\circ\text{C}$ of the dental product (measured at the same temperature range).

42. The method of claim 39 wherein the glass-ceramic comprises in weight percent:

- about 62 to about 85% SiO_2 ;
- about 1.5 to about 10% Al_2O_3 ;
- about 8 to about 19% Li_2O ;
- about 2.5 to about 7% K_2O ; and
- about 0.5 to about 12 % P_2O_5 .

43. A glass-ceramic composition comprising in weight percent:

- about 64 to about 70% SiO_2 ;
- about 1.5 to about 6 Al_2O_3 ;
- about 10 to about 15% Li_2O ;
- about 2.5 to about 5% K_2O ; and
- about 2 to about 7 % P_2O_5 .

44. The glass-ceramic composition of claim 43 whereby the glass-ceramic is pressable.

45. The glass-ceramic composition of claim 43 further comprising in weight percent:

up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 2.7% B₂O₃;
up to about 2% ZnO;
up to about 0.9% CaO;
up to about 2% MgO;
up to about 3% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

46. A dental restoration comprising the glass-ceramic of claim 43.

47. A method of making a lithium disilicate dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 64 to about 70% SiO₂;
about 1.5 to about 6 Al₂O₃;

about 10 to about 15% Li_2O ;
about 2.5 to about 5% K_2O ; and
about 2 to about 7 % P_2O_5 ; at temperatures within the range of about 1200° to
about 1600°C ;

quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400° to about 1100°C to convert the glass into a
glass-ceramic;

comminuting the glass ceramic to a powder;
compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

48. A glass-ceramic composition comprising in weight percent:

about 62 to about 85% SiO_2 ;
about 5.1 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ; and
about 0.5 to about 12 % P_2O_5 .

49. The glass-ceramic composition of claim 48 whereby the glass-ceramic
is pressable.

50. The glass-ceramic composition of claim 48 further comprising in
weight percent:

up to about 7% K_2O ;
up to about 1.5% F ;
up to about 7% BaO ;
up to about 1% SrO ;

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up to about 5% Cs_2O ;
up to about 4.9% B_2O_3 ;
up to about 5% ZnO ;
up to about 7% CaO ;
up to about 2% MgO ;
up to about 5% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

51. A dental restoration comprising the glass-ceramic of claim 48.

52. A method of making a lithium disilicate dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 62 to about 85% SiO_2 ;
about 5.1 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ; and
about 0.5 to about 12 % P_2O_5 ; at temperatures within the range of about 1200°
to about 1600°C;
quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the

temperature range of from about 400° to about 1100°C to convert the glass into a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

53. A glass-ceramic composition comprising in weight percent:

about 64 to about 70% SiO₂;

about 5.2 to about 9 Al₂O₃;

about 10 to about 15% Li₂O; and

about 2 to about 7 % P₂O₅.

54. The glass-ceramic composition of claim 53 whereby the glass-ceramic is pressable.

55. The glass-ceramic composition of claim 53 further comprising in weight percent:

up to about 1.5% F;

up to about 7% BaO;

up to about 1% SrO;

up to about 5% Cs₂O;

up to about 5% K₂O;

up to about 2.7% B₂O₃;

up to about 2% ZnO;

up to about 0.9% CaO;

up to about 2% MgO;

up to about 3% Na₂O;

up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

53. A dental restoration comprising the glass-ceramic of claim 53.

53. A method of making a lithium disilicate dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 64 to about 70% SiO_2 ;
about 5.2 to about 9 Al_2O_3 ;
about 10 to about 15% Li_2O ; and
about 2 to about 7 % P_2O_5 ; at temperatures within the range of about 1200° to
about 1600°C;
quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400° to about 1100°C to convert the glass into a
glass-ceramic;

comminuting the glass ceramic to a powder;
compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

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5 13/1 58. A glass-ceramic composition comprising in weight percent:
about 64 to about 70% SiO₂;
5 about 1.5 to about 6 Al₂O₃;
about 10 to about 15% Li₂O;
about 2 to about 7 % P₂O₅;
about 2.2 to about 5% K₂O;
about 0.5 to about 3% Na₂O; and
10 about 0.5 to about 3% B₂O₃.

6 13/1 59. The glass-ceramic composition of claim 58 whereby the glass-ceramic
is pressable.

15 7 13/1 60. The glass-ceramic composition of claim 58 further comprising in
weight percent:

up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
20 up to about 5% Cs₂O;
up to about 0.9% CaO;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
25 up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;

28

up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

5

~~62~~ ~~48~~

A dental restoration comprising the glass-ceramic of claim 58.

~~135~~

~~546~~ ~~42~~

10

A method of making a lithium disilicate dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 64 to about 70% SiO_2 ;
about 1.5 to about 6 Al_2O_3 ;
about 10 to about 15% Li_2O ;
about 2 to about 7 % P_2O_5 ;
about 2.2 to about 5% K_2O ;
about 0.5 to about 3% Na_2O ; and
about 0.5 to about 3% B_2O_3 ; at temperatures within the range of about 1200°
to about 1600°C;

15

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400° to about 1100°C to convert the glass into a
glass-ceramic;

20

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

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~~546~~ ~~42~~

63. A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO_2 ;

about 1.5 to about 10 Al_2O_3 ;

29

about 8 to about 19% Li_2O ;
about .3 to about 7% P_2O_5 ; and
about .5 to about 8% Ta_2O_5 .

5 64. The glass-ceramic composition of claim 63 whereby the glass-ceramic
is pressable.

 65. The glass-ceramic composition of claim 63 further comprising in
weight percent:

10 up to about 5% B_2O_3 .
 up to about 5% Na_2O ;
 up to about 7% K_2O ;
 up to about 1.5% F ;
 up to about 5% ZnO ;
15 up to about 2% MgO ;
 up to about 7% BaO ;
 up to about 1% SrO ;
 up to about 5% Cs_2O ;
 up to about 7% CaO ;
20 up to about 2% TiO_2 ;
 up to about 3% ZrO_2 ;
 up to about 1% SnO_2 ;
 up to about 1% Sb_2O_3 ;
 up to about 3% Y_2O_3 ;
25 up to about 1% CeO_2 ;
 up to about 1% Eu_2O_3 ;
 up to about 1% Tb_4O_7 ; and
 up to about 2% Nb_2O_5 .

00458910 121000
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66. A dental restoration comprising the glass-ceramic of claim 63.

67. A method of making a dental restoration comprising:

melting a starting glass composition comprising in weight percent

about 62 to about 76% SiO_2 ;

about 1.5 to about 10 Al_2O_3 ;

about 8 to about 19% Li_2O ;

about .3 to about 7% P_2O_5 ; and

about .5 to about 8% Ta_2O_5 ; at temperatures within the range of about 1200°

to about 1600°C;

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the

temperature range of from about 400° to about 1100°C to convert the glass into a

glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

68. A glass-ceramic composition comprising in weight percent:

about 68.8% SiO_2 ;

about 1.3% B_2O_3 ;

about 4.8% Al_2O_3 ;

about 1.0% CaO ;

about 2.8% BaO ;

about 14.4% Li_2O ;

about 2.2 % K_2O ;

about 1.5% Na₂O; and

about 3.3% P₂O₅.

5 ~~69.~~ The glass-ceramic of claim 68 having a flexural strength of equal to or greater than about 420 MPa.

13 ~~70.~~ The glass-ceramic composition of claim 68 whereby the glass-ceramic is pressable.

10 ~~71.~~ A dental restoration comprising the glass-ceramic of claim 68.

15 ~~72.~~ A method of making a dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 68.8% SiO₂;
about 1.3% B₂O₃;
about 4.8% Al₂O₃;
about 1.0% CaO;
about 2.8% BaO;
about 14.4% Li₂O;
20 about 2.2 % K₂O;
about 1.5% Na₂O; and
about 3.3% P₂O₅; at temperatures within the range of about 1200° to about
1600°C;
quenching the glass melt;
25 subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400° to about 1100°C to convert the glass into a
glass-ceramic;
comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

14 24 73. A glass-ceramic composition comprising in weight percent:

about 67.2% SiO_2 ;
about 1.2% B_2O_3 ;
about 4.7% Al_2O_3 ;
about 1.0% CaO ;
about 2.7% BaO ;
about 14.1% Li_2O ;
about 2.2 % K_2O ;
about 1.4% Na_2O ;
about 3.2% P_2O_5 ;
about 0.4% CeO_2 ; and
about 2% Ta_2O_5 .

16 24 74. The glass-ceramic of claim 73 having a flexural strength of equal to or greater than about 440 MPa.

16 24 75. The glass-ceramic composition of claim 73 whereby the glass-ceramic is pressable.

16 24 76. A dental restoration comprising the glass-ceramic of claim 73.

16 24 77. A method of making a dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 68.8% SiO_2 ;

about 1.3% B_2O_3 ;
about 4.8% Al_2O_3 ;
about 1.0% CaO ;
about 2.8% BaO ;
5 about 14.4% Li_2O ;
about 2.2 % K_2O ;
about 1.5% Na_2O ; and
about 3.3% P_2O_5 ; at temperatures within the range of about 1200° to about
10 1600°C;
quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400 to about 1100°C to convert the glass into a
glass-ceramic;
15 comminuting the glass ceramic to a powder;
compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

Abstract

This invention is directed to lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) based glass-ceramics comprising silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide. The glass-ceramics are useful in the fabrication of single and multi-unit dental restorations (e.g. anterior bridges) made by heat pressing into refractory investment molds produced using lost wax techniques. The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat-pressing using commercially available equipment. In accordance with one embodiment directed to the process of making the glass-ceramics, the compositions herein are melted at about 1200° to about 1600°C , thereafter quenched (e.g., water quenched or roller quenched) or cast into steel molds, or alternately, cooled to the crystallization temperature. The resulting glass is heat-treated to form a glass-ceramic via a one or two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100°C . The resulting glass ceramics are then pulverized into powder and used to form pressable pellets and/or blanks of desired shapes, sizes and structures which are later pressed into dental restorations.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN

Docket Number (Optional)
JPP-1222NP

Applicant, Patentee, or Identifier: Dmitri Brodtkin, Carlino Panzera, Paul Panzera

Application or Patent No.: _____

Filed or Issued: _____

Title: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

I hereby state that I am

- ☐ the owner of the small business concern identified below:
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN Jeneric/Pentron Incorporated

ADDRESS OF SMALL BUSINESS CONCERN 53 North Plains Industrial Road
Wallingford, CT 06492

I hereby state that the above identified small business concern qualifies as a small business concern as defined in 13 CFR Part 121 for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby state that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate statements as to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

- Each person, concern, or organization having any rights in the invention is listed below:
☐ no such person, concern, or organization exists.
☐ each such person, concern, or organization is listed below.

Separate statements are required from each named person, concern or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

NAME OF PERSON SIGNING Ann M. Knab

TITLE OF PERSON IF OTHER THAN OWNER Assistant General Counsel

53 North Plains Industrial Road
 ADDRESS OF PERSON SIGNING Wallingford, CT 06492

SIGNATURE  DATE 12/10/99

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PRINT OF DRAWINGS
AS ORIGINALLY FILED

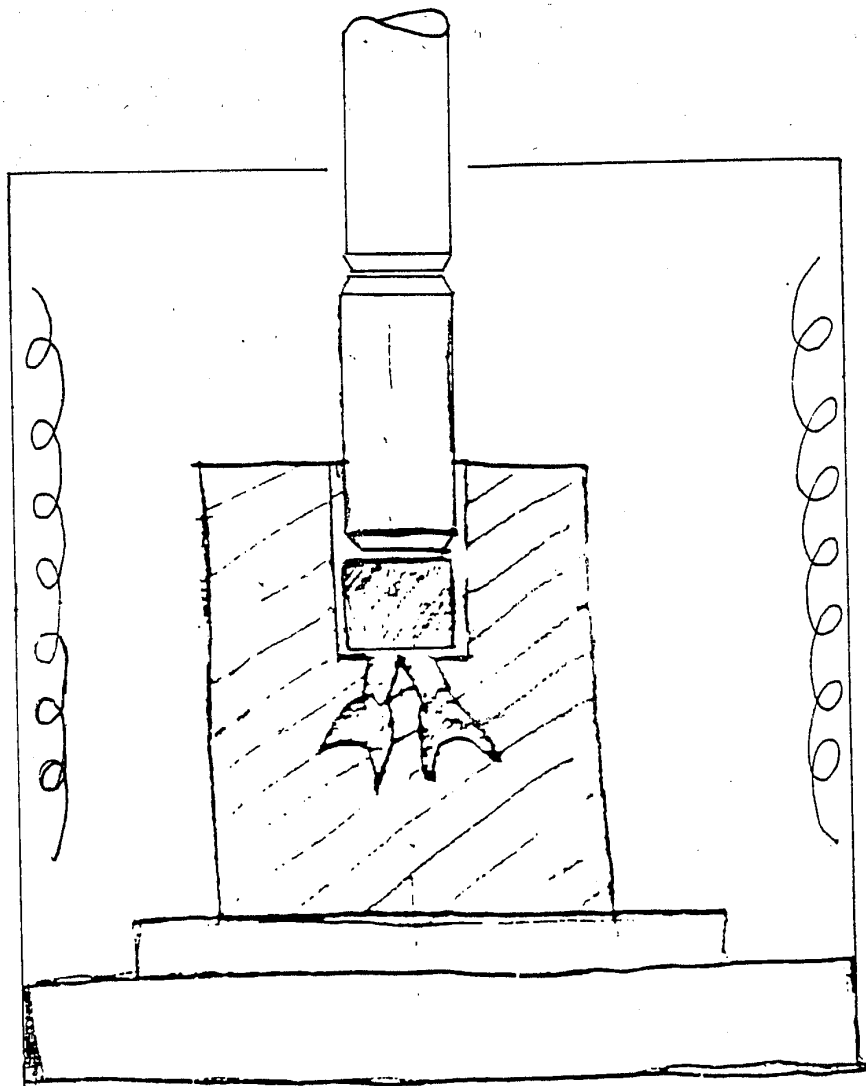


FIGURE 1

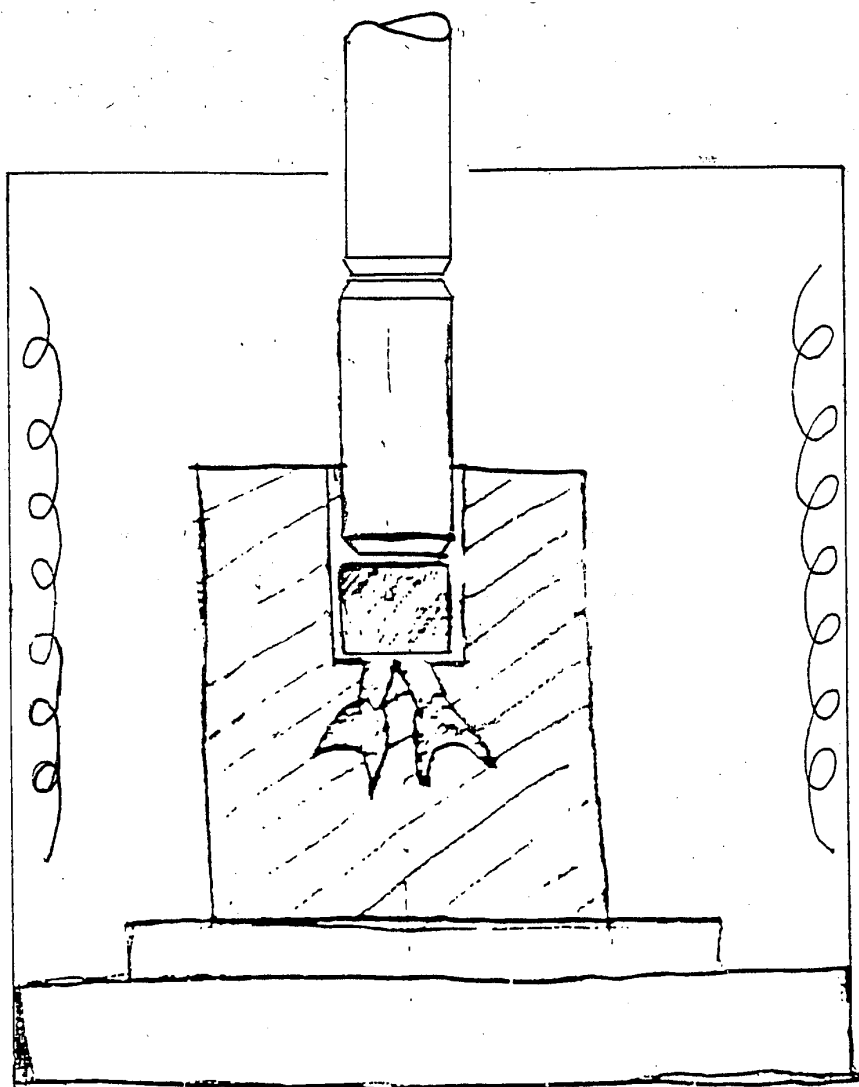


FIGURE 1

JPP-1222NP

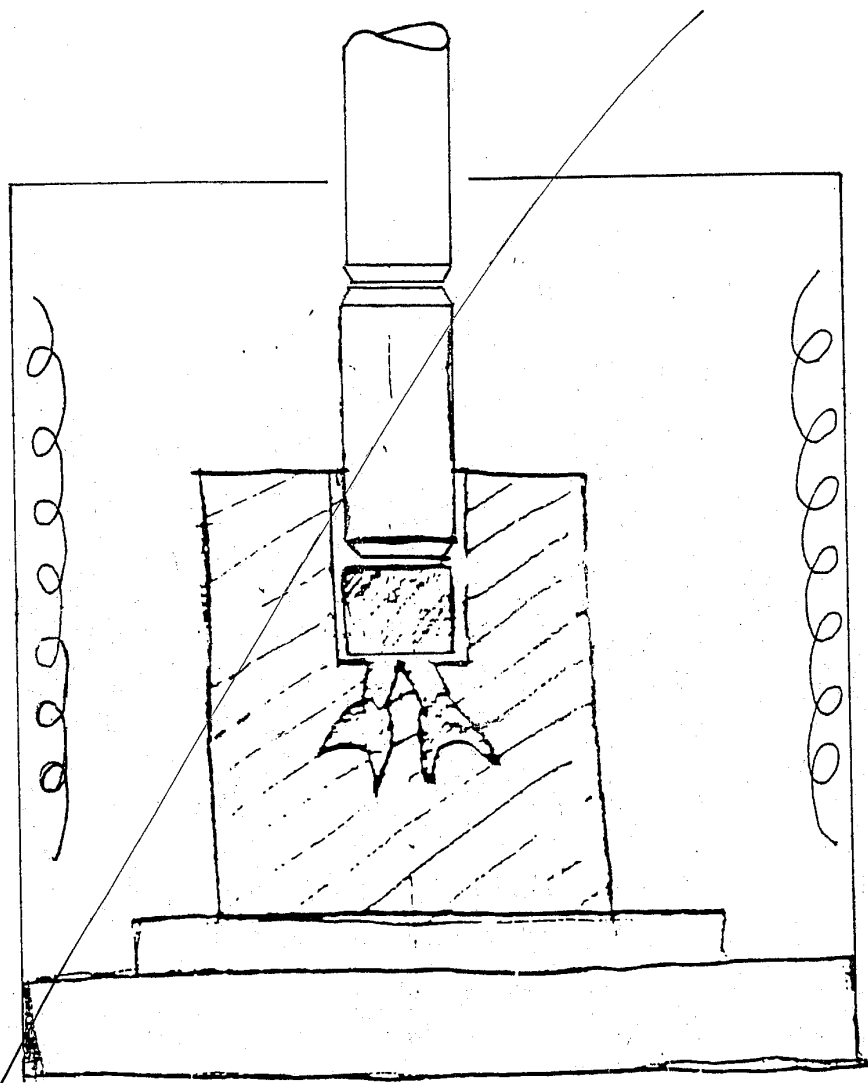


FIGURE 1



ANN M KNAB
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD CT 06492

DATE MAILED:

01/19/00

An Application Number and Filing Date have been assigned to this application. The items indicated below, however, are missing. Applicant is given **TWO MONTHS FROM THE DATE OF THIS NOTICE** within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a). **If any of items 1 or 3 through 5 are indicated as missing, the SURCHARGE set forth in 37 CFR 1.16(e) of ☒ \$65.00 for a small entity in compliance with 37 CFR 1.27, or ☐ \$130.00 for a non-small entity, must also be timely submitted in reply to this NOTICE to avoid abandonment.**

If all required items on this form are filed within the period set above, the total amount owed by applicant as a ☒ small entity (statement filed) ☐ non-small entity is \$ 12,000.

- ☐ 1. The statutory basic filing fee is:
- ☐ missing.
- ☐ insufficient.

Applicant must submit \$_____ to complete the basic filing fee and/or file a small entity statement claiming such status (37 CFR 1.27).

- ☐ 2. The following additional claims fees are due:

\$ _____ for _____ total claims over 20.

\$ _____ for _____ independent claims over 3.

\$_____ for multiple dependent claim surcharge.

Applicant must either submit the additional claim fees or cancel additional claims for which fees are due.

- ☒ 3. The oath or declaration:

- ☐ is missing or unsigned.

- ☐ does not cover the newly submitted items.

An oath or declaration in compliance with 37 CFR 1. 63, including residence information and identifying the application by the above Application Number and Filing Date is required.

- ☐ 4. The signature(s) to the oath or declaration is/are by a person other than inventor or person qualified under 37 CFR 1.42, 1.43 or 1.47.

A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

- ☐ 5. The signature of the following joint inventor(s) is missing from the oath or declaration:

An oath or declaration in compliance with 37 CFR 1.63 listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.

- ☐ 6. A \$50.00 processing fee is required since your check was returned without payment (37 CFR 1.21(m)).

- ☐ 7. Your filing receipt was mailed in error because your check was returned without payment.

- ☐ 8. The application was filed in a language other than English.

Applicant must file a verified English translation of the application, the \$130.00 set forth in 37 CFR 1.17(k), unless previously submitted, and a statement that the translation is accurate (37 CFR 1.52(d)).

- ☐ 9. OTHER:

Direct the reply and any questions about this notice to "Attention: Box Missing Parts."

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202



02-15-00

SECTOR #
#3

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No.: JPP-1222NP
Group Art Unit: 1754

Applicant : Dmitri Brodtkin, Carlino Panzera, Paul Panzera
Serial No. : 09/458,919
Filed : 12/10/99
Title : PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231
Attention: BOX MISSING PARTS

Sir:

* In response to the Notice to File Missing Parts of
Application Filing Date Granted, mailed January 19, 2000, submitted
herewith are the following:

1. Declaration/Power of Attorney
2. Recordation Form Cover Sheet (in duplicate)
3. Assignment
4. Notice to File Missing Parts of Application,
Filing Date Granted.
5. Return Date Stamped Post Card

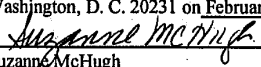
The Patent Office is authorized to charge my Deposit Account No. 50-0718 the
total of \$65.00 for the Declaration/Power of Attorney along with any additional fees
necessary for the advancement of the application. Two copies of this sheet are enclosed
for that purpose.

Respectfully submitted,


Amy M. Knab

Attorney for Applicant
Registration No. 33,331
Telephone: 203-265-7397, Ext. 508

Certificate of Mailing

I hereby certify that this correspondence is
being deposited with the United States Postal
Service with sufficient postage as Express Mail
in an envelope with Label No. EK217582243US
Addressed to: Commissioner of Patents and Trademarks
Washington, D. C. 20231 on February 14, 2000

Suzanne McHugh
Date: February 14, 2000

Jeneric/Pentron Incorporated
53 North Plains Industrial Road
Wallingford, Connecticut 06492
Date: February 14, 2000



#3

DECLARATION AND POWER OF ATTORNEY

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my/our name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled PRESSABLE LITHIUM DISILICATE GLASS CERAMICS the specification of which

(check one)

_____ is attached hereto.

X was filed on December 10, 1999 as
Application Serial No. 09/458,919
and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a).

I hereby claim foreign priority benefits under title 35, United States Code 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s).

			Priority Claimed
			Yes No
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	
			Yes No
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	
			Yes No
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

_____ (Application Serial No.)	_____ (Filing Date)	_____ (Status) (patented, pending, abandoned)
-----------------------------------	------------------------	---

<u>(Application Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status)</u> (patented, pending, abandoned)
---------------------------------	----------------------	---

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional applications(s) listed below:

<u>PROVISIONAL APPLICATION NUMBER</u>	<u>FILING DATE</u>
<u>60/153,916</u>	<u>09/14/99</u>
<u>60/122,558</u>	<u>03/02/99</u>
<u>60/111,872</u>	<u>12/11/98</u>

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Ann M. Knab

Registration No. 33,331

Send Correspondence to:
JENERIC/PENTRON INCORPORATED
53 North Plains Industrial Road
Wallingford, Connecticut 06492

Direct Telephone Calls To:
Ann M. Knab
(203) 265-7397, Extension 508

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole

or first inventor: Dmitri Brodkin

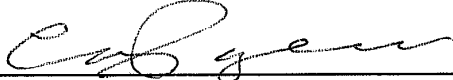
Inventor's signature: *Dmitri Brodkin* 2/8/00
Date

Residence: 75 Herbert Terrace, West Orange, New Jersey
07052

Citizenship: Russia

Post Office Address: 75 Herbert Terrace, West Orange, New Jersey 07052

Full name of second
joint inventor, if
any: Carlino Panzera

Inventor's signature:  Feb 8, 2000
Date

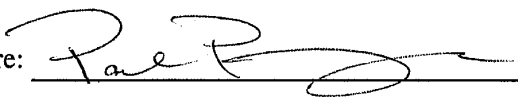
Residence: 7 Huntsman Lane, Belle Mead, New Jersey 08502

Citizenship: U.S.A.

Post Office Address: 7 Huntsman Lane, Belle Mead, New Jersey 08502

Full name of third

joint inventor, if
any: Paul Panzera

Inventor's signature:  2/8/00
Date

Residence: 1 Middleton Drive, Mt. Holly, New Jersey 08060

Citizenship: U.S.A.

Post Office Address: 1 Middleton Drive, Mt. Holly, New Jersey 08060



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

173

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO./FILE
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09/458,919 12/10/99 BROOKIN

0242/0119

ANN M KNAB
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD CT 06492



D JFP-1222NP

NOT ASSIGNED

1754

DATE MAILED:

01/19/00

NOTICE TO FILE MISSING PARTS OF APPLICATION Filing Date Granted

An Application Number and Filing Date have been assigned to this application. The items indicated below, however, are missing. Applicant is given TWO MONTHS FROM THE DATE OF THIS NOTICE within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a). If any of items 1 or 3 through 5 are indicated as missing, the SURCHARGE set forth in 37 CFR 1.16(e) of ☐ \$65.00 for a small entity in compliance with 37 CFR 1.27, or ☐ \$130.00 for a non-small entity, must also be timely submitted in reply to this NOTICE to avoid abandonment.

If all required items on this form are filed within the period set above, the total amount owed by applicant as a ☒ small entity (statement filed) ☐ non-small entity is \$ 65.00.

- ☐ 1. The statutory basic filing fee is:
- ☐ missing.
 - ☐ insufficient.
- Applicant must submit \$ _____ to complete the basic filing fee and/or file a small entity statement claiming such status (37 CFR 1.27).
- ☐ 2. The following additional claims fees are due:
- \$ _____ for _____ total claims over 20.
 - \$ _____ for _____ independent claims over 3.
 - \$ _____ for multiple dependent claim surcharge.
- Applicant must either submit the additional claim fees or cancel additional claims for which fees are due.
- ☒ 3. The oath or declaration:
- ☐ is missing or unsigned.
 - ☒ does not cover the newly submitted items.
- An oath or declaration in compliance with 37 CFR 1.63, including residence information and identifying the application by the above Application Number and Filing Date is required.
- ☐ 4. The signature(s) to the oath or declaration is/are by a person other than inventor or person qualified under 37 CFR 1.42, 1.43 or 1.47.
- A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- ☐ 5. The signature of the following joint inventor(s) is missing from the oath or declaration:

An oath or declaration in compliance with 37 CFR 1.63 listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.

- ☐ 6. A \$50.00 processing fee is required since your check was returned without payment (37 CFR 1.21(m)).
- ☐ 7. Your filing receipt was mailed in error because your check was returned without payment.
- ☐ 8. The application was filed in a language other than English.
- Applicant must file a verified English translation of the application, the \$130.00 set forth in 37 CFR 1.17(k), unless previously submitted, and a statement that the translation is accurate (37 CFR 1.52(d)).
- ☐ 9. OTHER:

Direct the reply and any questions about this notice to "Attention: Box Missing Parts."

A copy of this notice MUST be returned with the reply.

L. Lyser

Customer Service Center
Initial Patent Examination Division (703) 308-1202

FORM PTO-1533 (REV. 9/98)

PART 2 - COPY TO BE RETURNED WITH RESPONSE

GC Corporation, et al.
Exhibit 1006, p.53

U.S. GPO 1992-450-8875

02/17/2000 MARSH 00000005 07/0005 09458919 65.00 CH 01 C:205



**UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

125

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
-----------------	-------------	----------------------	---------------------

09/458,919 12/10/99 BRODKIN

D JPP-1222NP

EXAMINER

IM62/0131

ANN M KNAB
JENERIC PENTRON INCORPORATED
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD CT 06492

KOSLOW, C

ART UNIT

PAPER NUMBER

1755

DATE MAILED:

01/31/01

4

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/458,919

Applicant(s)

BRODKIN ET AL.

Examiner

C. Melissa Koslow

Art Unit

1755

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-77 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 5-7, 10-15, 18, 19, 25, 26, 47, 52 and 57-62 is/are allowed.
- 6) ☒ Claim(s) 1-4, 8, 16, 17, 20-24, 27, 28, 35, 36, 39-41, 43-46, 48-51, 53-55, 68, 69, 72-74 and 77 is/are rejected.
- 7) ☒ Claim(s) 9, 56, 63-67, 70, 71, 75 and 76 is/are objected to.
- 8) ☐ Claims ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. & 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____
- 18) ☐ Interview Summary (PTO-413) Paper No(s). ____
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other:

The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

The disclosure is objected to because of the following informalities: In table 1, in the Range 1 column, "toabout" should be "to about". The meaning of "about 0" in table 1 is unclear. If the lower limit of the amount is zero, then "about" should be deleted. If the lower limit is greater than zero, then the table should state "greater than 0" instead of "about 0". Appropriate correction is required.

Claims 9 and 28 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claims.

Claim 9 depends from claim 6. The third step in claim 6 is a heat treatment step which converts the glass to a glass-ceramic. This step occurs after the quenching step. One of ordinary skill in the art would know that the lithium disilicate of claim 6 refers to a lithium disilicate glass-ceramic containing lithium disilicate crystals, from the teachings in the specification and the cited prior art which teaches lithium disilicate dental products. Therefore, it is clear to one of ordinary skill in the art that the heat treatment step which converts the glass to a glass-ceramic in

claim 6 produces lithium disilicate crystals. Thus, the heat treatment step in claim 6 effects crystallization of lithium disilicate. Accordingly, claim 9 does not further limit claim 6. Claim 28 does not further limit claim 27 since the listed function of sintering is an inherent function of sintering.

Claims 3, 63 and 67 objected to because of the following informalities: "Na₂O" in claim 3 should be "Na₂O". The leading zeros in claims 63 and 67 are missing. Appropriate correction is required.

Claims 8, 16, 17, 20-22, 27-42, 68, 69, 72-74 and 77 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention.

The subject of these claims is not taught by the specification. Page 5, line 18 teaches the pellet is partially or fully sintered. The specification is silent as to the density of the sintered blank or pellet. An article can be fully sintered and not have full or 100% density. Thus, the specification does not support claim 8. The specification is silent as to the sintering temperatures of the pellets or blanks. The specification does not teach the lithium disilicate dental product is a core and that the core has one of more coatings. Page 3, lines 22-26 and page 7, lines 1-5 both teach producing a lithium disilicate blank or pellet by melting the starting glass at temperatures in the range of about 1200-1600°C and quenching the melt to form a glass or cooling the glass melt to the crystallizing temperature to form a glass-ceramic. The specification does not teach quenching the formed glass-ceramic of the second cooling process. The specification never states the sintering step imparts sufficient strength for further handling of the blank.

Example 11 in table 2 provides the basis for the glass composition of claims 68, 69 and 72. Example 13 in table 2 provides the basis for the glass composition of claims 73, 74 and 77. The compositional values in these examples in table 2 are exact values. Thus, the taught values do not support the claimed compositions where the values are modified by the term "about". It is suggested to delete "about" from the values in claims 68, 72, 73 and 77. The taught flexural strengths are 420 ± 60 MPa and 440 ± 60 MPa. Thus, the examples teach the flexural strengths in the ranges of 360-280 MPa and 380-500 MPa. These ranges do not support the claimed ranges of 440 MPa and greater and 420 MPa and greater. The claimed flexural ranges should be limited to the taught ranges.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-3 and 48-50 are rejected under 35 U.S.C. 102(b) as being anticipated by Goto et al.

Art Unit: 1755

This reference teaches a lithium disilicate glass-ceramic. Examples 1, 3, 6, 8 and the comparison example teach compositions which fall within the claimed ranges. The presence of PbO is not excluded due to the use of applicants' use of "comprising". Since the composition falls within the claimed composition, the taught glasses must inherently be pressable, absent any showing to the contrary. The claimed glass-ceramic reads upon that taught.

Claims 1-3, 43-45, 48-50 and 53-55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goto et al.

This reference teaches a lithium disilicate glass-ceramic comprising 65-83 wt% silica, 8-13 wt% Li_2O , 0-7 wt% K_2O , 0-7 wt% alumina, 1-4 wt% P_2O_5 , 0.5-5.5 wt% MgO , 0-5 wt% ZnO , 0-5 wt% PbO , 0.5-5.5 wt% $\text{MgO} + \text{PbO} + \text{ZnO}$ and 0-2 wt% As_2O_3 and/or Sb_2O_3 . Column 4, lines 13-18 teach the presence of alumina is desirable to improve the chemical durability of the glass-ceramic. Therefore, one of ordinary skill in the art would have it obvious to include alumina in the taught glass-ceramic. The taught glass-ceramic composition overlaps the claimed glass-ceramic compositions. Product claims with numerical ranges which overlap prior art ranges were held to have been obvious under 35 USC 103. *In re Wertheim* 191 USPQ 90 (CCPA 1976); *In re Malagari* 182 USPQ 549 (CCPA 1974); *In re Fields* 134 USPQ 242 (CCPA 1962); *In re Nehrenberg* 126 USPQ 383 (CCPA 1960). Since the composition overlaps the claimed composition, the taught glasses must inherently be pressable, absent any showing to the contrary, when it has a composition within the overlapping compositions. The reference suggests the claimed glass-ceramics.

Claims 48-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Petticrew.

This reference teaches lithium disilicate glass-ceramic dental restorations produced from pressable lithium disilicate glass-ceramic. The taught glass-ceramic compositions are taught in column 9 and in table II. The taught glass-ceramic comprises 75-85 wt% silica, 2-5.0 wt% alumina, 8-12 wt% Li_2O , 1.5-5 wt% P_2O_5 , 0-2 wt% of Na_2O , 0-2 wt% K_2O , 0-2 titania, 0-3 wt% zirconia and 0-5 wt% coloring agents. The taught glass-ceramic composition overlaps the claimed glass-ceramic compositions. The value 5.0 falls within the range of "about 5.1". Product claims with numerical ranges which overlap prior art ranges were held to have been obvious under 35 USC 103. *In re Wertheim* 191 USPQ 90 (CCPA 1976); *In re Malagari* 182 USPQ 549 (CCPA 1974); *In re Fields* 134 USPQ 242 (CCPA 1962); *In re Nehrenberg* 126 USPQ 383 (CCPA 1960). The reference suggests the claimed glass-ceramics.

Claims 1, 2, 4, 23, 24, 43, 44 and 46 are rejected under 35 U.S.C. 102(e) as being anticipated by Schweiger et al.

This reference teaches lithium disilicate glass-ceramic dental restorations, such as inlays, onlays and the other products taught in column 8, lines 55-60. Examples 1 and 14 teach glass compositions which fall within the claimed ranges. The reference teaches and the examples show the taught glass-ceramics are pressable. The claimed glass-ceramics read upon those taught.

Claims 1-4, 23, 24, 43-46, 58-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schweiger et al.

This reference teaches lithium disilicate glass-ceramic dental restorations, such as inlays, onlays and the other products taught in column 8, lines 55-60. The taught glass-ceramic is composed of 57-80 wt% silica, 0-5.0 wt% alumina, 0.1-6 wt% La_2O_3 , 0.1-7 wt% $\text{Al}_2\text{O}_3 + \text{La}_2\text{O}_3$, 11-19 wt% Li_2O , 0-5 wt% MgO , 0-8 wt% ZnO , 0.5-13.5 wt% K_2O , 0.5-11 wt% P_2O_5 , 0-8 wt%

Art Unit: 1755

colorant and 0-6 wt% of at least one of B_2O_3 , F, Na_2O , zirconia, BaO and SrO. The taught glass-ceramic composition overlaps the claimed glass-ceramic compositions. The value 5.0 falls within the range of "about 5.1". Column 7, lines 17-30 and column 8, lines 12-15 teach the presence of alumina is desirable to improve the chemical durability of the glass-ceramic and that it improves the pressability of the glass-ceramic. Therefore, one of ordinary skill in the art would have it obvious to include alumina in the taught glass-ceramic. Product claims with numerical ranges which overlap prior art ranges were held to have been obvious under 35 USC 103. *In re Wertheim* 191 USPQ 90 (CCPA 1976); *In re Malagari* 182 USPQ 549 (CCPA 1974); *In re Fields* 134 USPQ 242 (CCPA 1962); *In re Nehrenberg* 126 USPQ 383 (CCPA 1960). The reference teaches the glass-ceramic is pressable. The reference teaches producing glass-ceramic blanks of this glass-ceramic (col. 4, lines 65-67). The reference suggests the claimed glass-ceramics.

Claims 5-7, 10-15, 18, 19, 25, 26, 47, 52 and 57-62 are allowable over the cited art of record.

Claims 56, 64-66, 70, 71, 75 and 76 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 63 and 67 would be allowable if rewritten or amended to overcome the objection, set forth in this Office action.

Claims 16, 17, 68, 69, 72-74 and 77 would be allowable if rewritten or amended to overcome the rejections under 35 U.S.C. 112, set forth in this Office action.

The claimed process is not taught or suggested by the cited art of record. There is no suggestion or teaching in the art to form a sintered blank from lithium disilicate glass-ceramic particles. The cited art of record all form sintered glass blanks or form blanks from the crystallized quenched glass and then utilize these blanks to form dental products by machining or by injection molding. The claimed glass-ceramic compositions of claims 58, 63, 68 and 73 are not taught or suggested by the cited art of record. The cited art of record does not teach or suggest a dental restoration composed of the glass-ceramic of claim 53. There is no teaching or suggestion in the art to use the glass-ceramic of Goto et al to form a dental restoration.

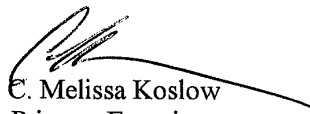
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Melissa Koslow whose telephone number is (703) 308-3817. The examiner can normally be reached on Monday-Thursday from 7:30 AM to 4:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Bell, can be reached at (703) 308-3823.

The fax number for Amendments filed under 37 CFR 1.116 or After Final communications is (703) 872-9311. The fax number for all other official communications is (703) 872-9310.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0661 or (703) 308-0662.

cmk
January 29, 2001


C. Melissa Koslow
Primary Examiner
Tech. Center 1700

Notice of References Cited	Application/Control No. 09/458,919		Applicant(s)/Patent Under Reexamination BRODKIN ET AL.	
	Examiner C. Melissa Koslow		Art Unit 1755	Page 1 of 1

U.S. PATENT DOCUMENTS

*	A	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS	DOCUMENT SOURCE **	
							APS	OTHER
<input type="checkbox"/>	A	5,968,856	Oct. 1999	Schweiger et al	106	35	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	B	5,507,981	Apr. 1996	Petticrew	264	16	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	C	5,391,522	Feb. 1995	Goto et al	501	4	<input type="checkbox"/>	<input type="checkbox"/>
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FOREIGN PATENT DOCUMENTS

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<input type="checkbox"/>	O							<input type="checkbox"/>	<input type="checkbox"/>
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<input type="checkbox"/>	T							<input type="checkbox"/>	<input type="checkbox"/>

NON-PATENT DOCUMENTS

*	A	DOCUMENT (Including Author, Title Date, Source, and Pertinent Pages)	DOCUMENT SOURCE **	
			APS	OTHER
<input type="checkbox"/>	U		<input type="checkbox"/>	<input type="checkbox"/>
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<input type="checkbox"/>	W		<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	X		<input type="checkbox"/>	<input type="checkbox"/>

*A copy of this reference is not being furnished with this Office action. (See Manual of Patent Examining Procedure, Section 707.05(a).)

**APS encompasses any electronic search i.e. text, image, and Commercial Databases.

U.S. Patent and Trademark Office

PTO-892 (Rev. 03-98)

Notice of References Cited

Part of Paper No. 4

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT
(Under 37 CFR 1.97(b) or 1.97(c))

Docket No.
JPP-1222NP

In Re Application Of: **DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA**

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5/10/01

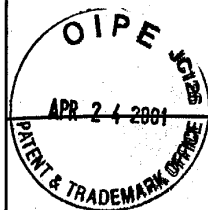
Serial No.
09/458,919

Filing Date
12/10/99

Examiner
KOSLOW, C.

Group Art Unit
1755

Title: **PRESSABLE LITHIUM DISILICATE GLASS CERAMICS**



Address to:
Assistant Commissioner for Patents
Washington, D.C. 20231

37 CFR 1.97(b)

1. ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application; within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or before the mailing date of a first Office Action on the merits, whichever event occurs last.

37 CFR 1.97(c)

2. ☒ The Information Disclosure Statement submitted herewith is being filed after three months of the filing of a national application, or the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or after the mailing date of a first Office Action on the merits, whichever occurred last but before the mailing date of either:

1. a Final Action under 37 CFR 1.113, or
2. a Notice of Allowance under 37 CFR 1.311,

whichever occurs first.

Also submitted herewith is:

- ☐ a certification as specified in 37 CFR 1.97(e);

OR

- ☒ the fee set forth in 37 CFR 1.17(p) for submission of an Information Disclosure Statement under 37 CFR 1.97(c).

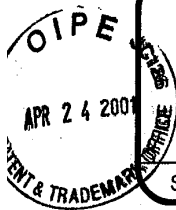
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PTO/SB/08A (08-00)
 App. for use through 10/31/2002. OMB 0651-0031
 Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 1 of 3

Complete if Known

Application Number 09/458,919
 Filing Date 12/10/99
 First Named Inventor BRQDKIN
 Group Art Unit 1755
 Examiner Name KOSLOW, C.
 Attorney Docket Number JPP-1222NP

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code ² (if known)			
		2,920,971		STOOKEY	01-12-1960	
		3,006,775		CHEN	10-31-1961	
		3,157,522		STOOKEY	11-17-1964	
		3,238,085		HAYAMI	03-01-1966	
		3,460,987		MCMILLAN	08-12-1969	
		3,650,817		MOTOYUKI	03-21-1972	
		3,804,608		HEDLEY	08-16-1974	4/1974
		3,809,543		GASKELL	05-07-1974	
		3,816,704		BOROM	06-11-1974	
		3,907,577		KIEFER	09-23-1975	
		3,931,438		BEALL	01-06-1976	
		3,977,857		MATTOX	08-31-1976	
		4,189,325		BARRETT	02-19-1980	
		4,414,282		MCCOLLISTER	11-08-1983	
		4,480,044		MCALINN	10-30-1984	
		4,515,634		WU	05-07-1985	
		4,672,152		SHINOHARA	06-09-1987	
		5,219,799		BEALL	06-15-1993	
		5,466,285		KAMIYA	11-14-1995	
		5,702,514		PETTICREW	12-30-1997	

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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁸
		Office ³	Number ⁴	Kind Code ⁵ (if known)				
			UK 924,996		MCMILLAN	05-01-1963		
			UK 943,599		MCMILLAN	12-04-1963		
			UK 1312700		DAVIES	04-04-1973		
			UK 1467459		DAVIES	03-16-1977		
			JP 01145348		NAOMI	07-06-1989		
			EP 0 536 572 A1		CROOKER	09-17-1992		
			JP 62072547		TOSHIMICHI	03-04-1987		
			EP 0781731 A1		TOMOYUKI	07-02-1997		
			JP 10188260		MASAHIRO	07-21-1998		
			JP 50094016		SOJIRO	07-26-1975		

Examiner
Signature

[Signature]

Date
Considered

5/31/01

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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Application Number	09/458,919
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Filing Date	12/10/99
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Filing Date	12/10/99
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First Named Inventor	BRODKIN
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Group Art Unit	1755
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Examiner Name	KOSLOW, C
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Attorney Docket Number	JPP-1222NP
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Signature

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GC Corporation, et al.
Exhibit 1006, p.66

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(use as many sheets as necessary)

Sheet

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of

3

Application Number

09/458,919

Filing Date

12/10/99

First Named Inventor

BRODKIN

Group Art Unit

1755

Examiner Name

KOSLOW, C.

Attorney Docket Number

JPP-1222NP

OTHER PRIOR ART -- NON PATENT LITERATURE DOCUMENTS

[illegible]

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TC 1700

Examiner
Signature

Ch 2

Date _____

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5/31/01

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Unique citation designation number. ² Applicant is to place a check mark here if English language Translation is attached.

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(Under 37 CFR 1.97(b) or 1.97(c))

Docket No.
JPP-1222NP

In Re Application Of: **DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA**

Serial No.
09/458,919

Filing Date
12/10/99

Examiner
KOSLOW, C.

Group Art Unit
1755

Title: **PRESSABLE LITHIUM DISILICATE GLASS CERAMICS**



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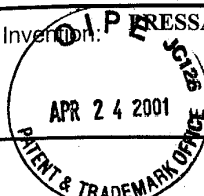
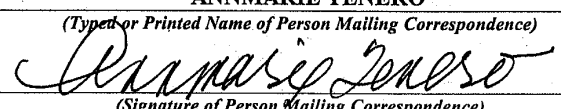
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Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C	Group Art Unit 1755
Invention: COMPRESSIBLE LITHIUM DISILICATE GLASS CERAMICS			
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Annmarie Tenero
Annmarie Tenero

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:)
Inventor: Brodtkin et al.)
Serial No.: 09/458,919) Group Art Unit: 1755
Filed: December 10, 1999)
Examiner: C. M. Koslow)
For: PRESSABLE LITHIUM)
DISILICATE GALSS CERAMICS)

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MAY 09 2001

TC 1700

AMENDMENT A

Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

Please enter the following amendments to the above-identified application in response to the Official Action mailed January 31, 2001.

In the specification:

Please amend Table 1 at page 6 as follows:

Table 1

Oxide, wt%	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
SiO ₂	about 62 to about 85	about 64 to about 70	about 62 to about 85	about 64 to about 70	about 64 to about 70	about 62 to about 76
B ₂ O ₃	0 to about 4.9	0 - about 2.7	0- about 4.9	0- about 2.7	about 0.5 - about 3.0	0 - about 5
Al ₂ O ₃	about 1.5 to about 10	about 1.5 to about 6.0	about 5.1- to about 10	about 5.2 to about 9.0	about 1.5 to about 6.0	about 1.5 to about 10

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F	0 to about 1.5	0 to about 1.5	about 0 to about 1.5	0 to about 1.5	0 to about 1.5	0 to about 1.5
ZnO	0 to about 5	0 to about 2	0 to about 5	0 to about 2	-----	0 to about 5
CaO	0 to about 7	0 to about 0.9	0 to about 7	0 to about 0.9	0 to about 0.9	0 to about 7
MgO	0 to about 2	0 to about 2	0 to about 2	about 0 to about 2	-----	0 to about 2
BaO	0 to about 7	0 to about 7	0 to about 7	about 0 to about 7	0 to about 7	0 to about 7
SrO	0 to about 1	0 to about 1	0 to about 1	about 0 to about 1	0 to about 1	0 to about 1
Cs ₂ O	0 to about 5	0 to about 5	0 to about 5	about 0 to about 5	0 to about 5	0 to about 5
Li ₂ O	about 8 to about 19	about 10 to about 15	about 8 to about 19	about 10 to about 15	about 10 to about 15	about 8 to about 19
K ₂ O	about 2.5 to about 7	about 2.5 to about 5	0 to about 7	0 to about 5	about 2.2 to about 5	0 to about 7
Na ₂ O	0 to about 5	0 to about 3	0 to about 5	0 to about 3	about 0.5 to about 3	0 to about 5
TiO ₂	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2
ZrO ₂	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3
P ₂ O ₅	0.5 to about 12	about 2 to about 7	about 0.5 to about 12	about 2 to about 7	about 2 to about 7	0.3 to about 7.0
SnO ₂	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Sb ₂ O ₃	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Y ₂ O ₃	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3
CeO ₂	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Eu ₂ O ₃	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Tb ₄ O ₇	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Nb ₂ O ₅	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2
Ta ₂ O ₅	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	about 0.5 to about 8.0

Please replace the paragraph beginning at page 7, line 25 and continuing to line 7 on page 8, with the following paragraph:

A2

The powders may be used to form and fuse (sinter) pressable pellets and/or blanks of desired shapes, sizes and structures. Sintering of the pellets or blanks is carried out at temperatures in the range of about 800° to about 1000°C, and preferably in the range of about 850° to about 950°C. Sintering imparts sufficient strength for handling of the pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The cores may be provided with one or more coatings. The coatings may be selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof. The coatings preferably have a firing temperature in the range of about 700° to about 900°C and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6}/^{\circ}\text{C}$ of the dental core (measured at the same temperature range). The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200°C, and more preferably in the range of about 850° to about 950°C, and most preferably at less than about 930°C, under vacuum and with the application of pressure of between about 2 to about 8 bar (0.2 - 0.8

MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry using commercially available milling equipment such as the Maho HGF 500 5 Axis CNC Milling Machine available from Fraunhofer Institut Produktionstechnologie, Germany.

Please amend Table 2 at pages 10 and 11 as follows:

Table 2

Oxide, wt%	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15
SiO ₂	68.8	70.0	70.1	65.4	70.7	70.9	68.1	69.5	72	69.0	about 68.8	65	about 67.2	68.9	72
B ₂ O ₃	1.2	1.0	-----	-----	-----	-----	-----	1.3	2.9	-----	about 1.3	1.0	about 1.2	0.9	2.0
Al ₂ O ₃	4.8	4.9	5.2	8.1	5.3	5.3	4.7	4.8	5.1	6.0	about 4.8	5	about 4.7	4.7	4.5
F	-----	-----	-----	1.4	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
ZnO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
CaO	0.9	0.5	2.2	-----	-----	-----	2.0	2.0	-----	-----	about 1.0	1	about 1	0.5	0
MgO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BaO	2.8	1.4	-----	3.8	5.4	5.4	-----	-----	2.0	2.7	about 2.8	2.7	about 2.7	1.4	2.0
SrO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ca ₂ O	-----	-----	-----	4.1	4.9	4.9	-----	-----	-----	-----	-----	-----	-----	-----	-----
Li ₂ O	14.4	14.7	14.7	13.4	11.0	10.8	14.3	14.6	13.0	15.3	about 14.4	15	about 14.1	14.3	13.0
K ₂ O	2.5	2.5	4.6	1.7	-----	-----	4.4	4.5	2.0	2.1	about 2.2	2.2	about 2.2	2.0	2.0
Na ₂ O	1.4	1.4	-----	-----	-----	-----	-----	-----	-----	-----	about 1.5	1.4	about 1.4	1.3	-----
TiO ₂	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
ZrO ₂	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
P ₂ O ₅	3.3	3.6	3.4	2.7	2.7	2.7	3.3	3.4	3.0	4.0	about 3.3	3.5	about 3.2	3.5	3.0

93 Cont

SnO ₂	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sb ₂ O ₃	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Y ₂ O ₃	-----	-----	-----	-----	-----	-----	-----	0.5	0.8	-----	-----	-----	-----	-----	0.5
CeO ₂	-----	-----	-----	-----	-----	-----	0.4	-----	0.5	-----	-----	0.4	about 0.4	0.3	0.6
Eu ₂ O ₃	-----	-----	-----	-----	-----	-----	-----	-----	0.5	-----	-----	-----	-----	-----	0.6
Tb ₄ O ₇	-----	-----	-----	-----	-----	-----	0.8	-----	-----	-----	-----	0.9	-----	0.3	-----
Nb ₂ O ₅	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ta ₂ O ₅	-----	-----	-----	-----	-----	-----	2.0	-----	-----	-----	-----	1.9	about 2.0	1.8	-----
Three- Point Flexural Strength per ISO 6872, MPa										430± 70	420± 60		440± 60		400± 50
As- pressed Opacity (relativeo pacity units)										50	42		25		34
CTE (25°C- 500°C), 10 ⁻⁶ °C ⁻¹		10.4								8.7	10.1- 10.6		10.5	10.0	9.9

In the claims:

Please cancel claims 3, 9, 28 and 48 through 51.

Please amend claims 1, 8, 27, 43, 53, 56, 63, 64, 65, 66, 67, 69 and 70 as follows:

1. (Amended) A glass-ceramic composition consisting essentially of in weight percent:

about 62 to about 85% SiO₂;
 about 1.5 to about 10% Al₂O₃;
 about 8 to about 19% Li₂O;
 about 2.5 to about 7% K₂O;
 about 0.5 to about 12% P₂O₅;
 up to about 4.9% B₂O₃;
 up to about 1.5% F;
 up to about 7% CaO;

Ad

up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅, and
up to about 2% Ta₂O₅.

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8. (Amended) The method of claim 7 wherein the blank is fully sintered.

~~36~~ ~~44~~ ~~36~~

29. (Amended) A method of making a lithium disilicate dental product comprising:

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melting a starting glass at temperatures within the range of about 1200 to about 1600°C;

quenching the glass;

cooling the quenched glass to the crystallization temperature to form a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank; and

sintering the blank.

A7

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43. (Amended) A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO₂;

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about 1.5 to about 6 Al_2O_3 ;
about 10 to about 15% Li_2O ;
about 2.5 to about 5% K_2O ;
about 2 to about 7 % P_2O_5
up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs_2O ;
up to about 2.7% B_2O_3 ;
up to about 0.9% CaO;
up to about 3% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

3 10
53. (Amended) A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO_2 ;
about 5.2 to about 9 Al_2O_3 ;
about 10 to about 15% Li_2O ;
about 2 to about 7 % P_2O_5 ;
up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;

up to about 5% Cs_2O ;
up to about 5% K_2O ;
up to about 2.7% B_2O_3 ;
up to about 0.9% CaO ;
up to about 3% Na_2O ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ;
up to about 2% Nb_2O_5 ; and
up to about 2% Ta_2O_5 .

A8
cont

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56. (Amended) A dental restoration comprising the glass-ceramic composition comprising :

about 64 to about 70% SiO_2 ;
about 5.2 to about 9 Al_2O_3 ;
about 10 to about 15% Li_2O ; and
about 2 to about 7 % P_2O_5 .

A9

61 16
60. (Amended) A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO_2 ;
about 1.5 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 0.3 to about 7% P_2O_5 ; and
about 0.5 to about 8% Ta_2O_5 .

A10

Q1864. (Amended) A glass-ceramic composition comprising:

about 62 to about 76% SiO_2 ;
about 1.5 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 0.3 to about 7% P_2O_5 ;
about 0.5 to about 8% Ta_2O_5 ; and
whereby the glass-ceramic is pressable.

Q1965. (Amended) A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO_2 ;
about 1.5 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ;
about .3 to about 7% P_2O_5 ;
about .5 to about 8% Ta_2O_5 ;
up to about 5% B_2O_3 ;
up to about 5% Na_2O ;
up to about 7% K_2O ;
up to about 1.5% F;
up to about 5% ZnO ;
up to about 2% MgO ;
up to about 7% BaO ;
up to about 1% SrO ;
up to about 5% Cs_2O ;
up to about 7% CaO ;
up to about 2% TiO_2 ;
up to about 3% ZrO_2 ;
up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ; and
up to about 2% Nb_2O_5 .

Q10
Cont
63 ~~28~~ 66. (Amended) A dental restoration comprising the glass-ceramic comprising:

about 62 to about 76% SiO_2 ;
about 1.5 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 0.3 to about 7% P_2O_5 ; and
about 0.5 to about 8% Ta_2O_5 .

64 ~~28~~ 67. (Amended) A method of making a dental restoration comprising:
melting a starting glass composition comprising in weight percent
about 62 to about 76% SiO_2 ;
about 1.5 to about 10 Al_2O_3 ;
about 8 to about 19% Li_2O ;
about 0.3 to about 7% P_2O_5 ; and
about 0.5 to about 8% Ta_2O_5 ; at temperatures within the range of about
1200° to about 1600°C;
quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the
temperature range of from about 400° to about 1100°C to convert the glass into a
glass-ceramic;
comminuting the glass ceramic to a powder;
compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

Q11
12 ~~28~~ 68. (Amended) The glass-ceramic of claim 68 having a flexural strength
in the range of 360 to 480 MPa.

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74. (Amended) The glass-ceramic of claim 73 having a flexural strength in the range of 380 to 500 MPa.

REMARKS

Claims 1, 8, 27, 43, 53, 56, 63, 64, 65, 66, 67, 69 and 70 have been amended to more particularly define and distinctly claim the instant invention. Claims 3, 9, 28 and 48 through 51 have been cancelled. Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned **VERSION WITH MARKINGS TO SHOW CHANGES MADE**. The specification has been amended to clarify any inconsistencies therein. No new matter has been added. In regard to the objections to the drawings, Applicants respectfully submit that the drawings will be amended upon receipt of the Notice of Allowance. The allowability of claims 5 – 7, 10 – 15, 18, 19, 25, 26, 47, 52 and 57 – 62 is hereby acknowledged. In view of the foregoing amendments and following remarks, reconsideration of the application is respectfully requested.

Table 1 was amended to remove the word "about" before the number 0. Moreover, the word "about" was inserted before those numbers from which it was inadvertently left out. Support for such additions is found in the originally filed claims. The subject matter in originally filed claims 16, 17, 20 – 22, 68, 72, 73 and 77 has been incorporated into the specification at pages 7 and 8, and in Table 2, examples 11 and 13. No new matter was added. "It must be kept in mind that an original claim is part of the disclosure and might adequately set forth subject matter which is completely absent from the specification." *Ex parte Gould*, 6 USPQ2d 1680, 1681 (bd. Pat. App. & Int'f 1987); See also *In re Benno*, 768 F.2d 1340, 1346, 226 USPQ 683, 686-687 (Fed. Cir. 1985); *Twin Disc, Inv. v. United States*, 10 Cl. Ct. 713, 231 USPQ 417, 435 (Cl. Ct. 1986). Accordingly, the originally filed claims 16, 17, 20 – 22, 68, 72, 73 and 77 provide support for the amendments to the specification.

Claims 1 – 3 and 48 – 50 were rejected under 35 U.S.C. 102(b) as being anticipated by Goto et al., U.S. Patent No. 5,391,522. The Examiner states that the presence of PbO is not excluded due to the use of applicants' use of "comprising"

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language. Claims 1 – 3, 43 – 45, 48 – 50 and 53 – 55 were rejected under 35 U.S.C. 103(a) as being unpatentable over Goto '522. The Examiner contends that the composition in Goto '522 overlaps with the claimed glass-ceramic compositions. The Examiner concludes that since the composition overlaps the claimed composition, the taught glasses must inherently be pressable. For the reasons set forth below, the rejections are respectfully traversed.

The claimed invention is now directed to a glass-ceramic composition consisting essentially of SiO_2 ; Al_2O_3 ; Li_2O ; K_2O ; and P_2O as main ingredients in the composition. The following components may also be present: B_2O_3 ; F; CaO; BaO; SrO; Cs_2O ; Na_2O ; TiO_2 ; ZrO_2 ; SnO_2 ; Sb_2O_3 ; Y_2O_3 ; CeO_2 ; Eu_2O_3 ; Tb_4O_7 ; Nb_2O_5 ; and Ta_2O_5 . There is mention of MgO, or ZnO in the claimed composition. Goto '522 requires the presence of MgO and ZnO in an amount of at least 0.5 %. The claimed invention is not anticipated or rendered obvious over Goto '522.

Claims 48 – 51 were rejected under 35 U.S.C. 103 as being unpatentable over Petticrew, U.S. Patent No. 5,507,981. Claims 48 – 51 were cancelled, therefore the rejection is hereby moot.

Claims 1, 2, 4, 23, 24, 43, 44 and 46 were rejected under 35 U.S.C. 102(e) as being anticipated by Schweiger et al., U.S. Patent No. 5,968,856. The Examiner states that the reference teaches lithium disilicate glass-ceramic dental restorations, and glass compositions which fall within the claimed ranges. Claims 1 – 4, 23, 24, 43 – 46, 58 – 51 were rejected under 35 U.S.C. 103(a) as being unpatentable over Schweiger '856. The Examiner contends that it would have been obvious for one of ordinary skill in the art to include alumina in the taught glass-ceramic. The Examiner concludes that the reference suggests the claimed glass-ceramics. For the reasons set forth below, the rejections are respectfully traversed.

As stated above, the claimed invention is now directed to a glass-ceramic composition consisting essentially of SiO_2 ; Al_2O_3 ; Li_2O ; K_2O ; and P_2O as main ingredients in the composition. The following components may also be present: B_2O_3 ; F; CaO; BaO; SrO; Cs_2O ; Na_2O ; TiO_2 ; ZrO_2 ; SnO_2 ; Sb_2O_3 ; Y_2O_3 ; CeO_2 ; Eu_2O_3 ; Tb_4O_7 ; Nb_2O_5 ; and Ta_2O_5 . Schweiger '856 requires the presence of La_2O_3 in an amount of at least 0.1 percent. As set forth in Schweiger '856, La_2O_3 and Al_2O_3 are required in the

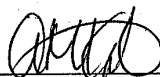
composition to provide a free-flowing glass ceramic that can be pressed in the plastic state. The claimed invention excludes the presence of La_2O_3 . Moreover, the present invention excludes the presence of MgO and ZnO which may be present in the Schweiger '856 composition. The claims are not anticipated or rendered obvious by the Schweiger '856 reference.

The allowability of claims 5 – 7, 10 – 15, 18, 19, 25, 26, 47, 52 and 57 – 62 is hereby acknowledged. Claims 56, 64, 65, 66, have been amended to include the limitations of the base claim and any intervening claim. Claims 63 and 67 have been rewritten to overcome the objections in the Office Action.

Accordingly, it is believed that claims 1 – 47 and 52 - 77 specify patentable subject matter and are now in condition for allowance. Applicants therefore respectfully request favorable reconsideration and allowance of this application. The Examiner is requested to telephone Applicants' attorney at the number listed below if it will advance the prosecution of this case. If necessary, the Examiner is authorized to charge further fees necessary to advance the prosecution in this case from Deposit Account No. 500718.

Respectfully submitted,

Date: April 23 2001


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Attorney Docket: JPP-1222NP

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the specification:

Table 1 has been amended as follows:

Oxide, wt%	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
SiO ₂	about 62 to about 85	about 64 to about 70	about 62- <u>to about</u> 85	about 64 <u>to about</u> - 70	about 64 to about 70	about 62 to about 76
B ₂ O ₃	<u>about 0 to about</u> 4.9	<u>about 0 - about</u> 2.7	<u>about 0- about</u> 4.9	<u>about 0- about</u> 2.7	about 0.5 - about 3.0	<u>about 0 - about</u> 5
Al ₂ O ₃	about 1.5 to about 10	about 1.5 to about 6.0	about 5.1- <u>to about</u> 10	about 5.2 <u>to about</u> -9.0	about 1.5 to about 6.0	about 1.5 to about 10
F	<u>about 0 to about</u> 1.5	<u>about 0 to about</u> 1.5	about 0 to about 1.5	<u>about 0 to about</u> 1.5	<u>about 0 to about</u> 1.5	<u>about 0 to about</u> 1.5
ZnO	<u>about 0 to about</u> 5	<u>about 0 to about</u> 2	<u>about 0- to about</u> 5	<u>about 0- to about</u> 2	-----	<u>about 0 to about</u> 5
CaO	<u>about 0 to about</u> 7	<u>about 0 to about</u> 0.9	<u>about 0- to about</u> 7	<u>about 0- to about</u> 0.9	<u>about 0 to about</u> 0.9	<u>about 0 to about</u> 7
MgO	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	-----	<u>about 0 to about</u> 2
BaO	<u>about 0 to about</u> 7	<u>about 0 to about</u> 7	<u>about 0 to about</u> 7	<u>about 0 to about</u> 7	<u>about 0 to about</u> 7	<u>about 0 to about</u> 7
SrO	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
CaO	<u>about 0 to about</u> 5	<u>about 0 to about</u> 5	<u>about 0 to about</u> 5	<u>about 0 to about</u> 5	<u>about 0 to about</u> 5	<u>about 0 to about</u> 5
Li ₂ O	about 8 to about 19	about 10 to about 15	about 8- <u>to about</u> 19	about 10- <u>to about</u> 15	about 10 to about 15	about 8 to about 19
K ₂ O	about 2.5 to about 7	about 2.5 to about 5	<u>about 0- to about</u> 7	<u>about 0- to about</u> 5	about 2.2 to about 5	<u>about 0 to about</u> 7
Na ₂ O	<u>about 0 to about</u> 5	<u>about 0 to about</u> 3	<u>about 0- to about</u> 5	<u>about 0- to about</u> 3	about 0.5 to about 3	<u>about 0 to about</u> 5
TiO ₂	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2
ZrO ₂	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3
P ₂ O ₅	<u>about 0.5 to about</u> 12	about 2 to about 7	about 0.5- <u>to about</u> 12	about 2- <u>to about</u> 7	about 2 to about 7	<u>about 0.3 to about</u> 7.0
SnO ₂	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
Sb ₂ O ₃	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
Y ₂ O ₃	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3	<u>about 0 to about</u> 3
CeO ₂	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
Eu ₂ O ₃	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
Tb ₄ O ₇	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1	<u>about 0 to about</u> 1
Nb ₂ O ₅	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2
Ta ₂ O ₅	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	<u>about 0 to about</u> 2	about 0.5 to about 8.0

Paragraph beginning at line 25 of page 7 and continuing to line 7 of page 8 has been amended as follows:

The powders may be used to form and fuse (sinter) pressable pellets and/or blanks of desired shapes, sizes and structures. Sintering of the pellets or blanks is carried out at temperatures in the range of about 800° to about 1000°C, and preferably in the range of about 850° to about 950°C. Sintering imparts sufficient strength for handling of the pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The cores may be provided with one or more coatings. The coatings may be selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof. The coatings

preferably have a firing temperature in the range of about 700° to about 900°C and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6}/^{\circ}\text{C}$ of the dental core (measured at the same temperature range). The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200°C, and more preferably in the range of about 850° to about 950°C, and most preferably at less than about 930°C, under vacuum and with the application of pressure of between about 2 to about 8 bar (0.2 - 0.8 MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry using commercially available milling equipment such as the Maho HGF 500 5 Axis CNC Milling Machine available from Fraunhofer Institut Produktionstechnologie, Germany.

Table 2 has been amended as follows:

Table 2

Oxide, wt%	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15
SiO ₂	68.8	70.0	70.1	65.4	70.7	70.9	68.1	69.5	72	69.0	<u>about</u> 68.8	65	<u>about</u> 67.2	68.9	72
B ₂ O ₃	1.2	1.0	-----	-----	-----	-----	-----	1.3	2.9	-----	<u>about</u> 1.3	1.0	<u>about</u> 1.2	0.9	2.0
Al ₂ O ₃	4.8	4.9	5.2	8.1	5.3	5.3	4.7	4.8	5.1	6.0	<u>about</u> 4.8	5	<u>about</u> 4.7	4.7	4.5
F	-----	-----	-----	1.4	0.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
ZnO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
CaO	0.9	0.5	2.2	-----	-----	-----	2.0	2.0	-----	-----	<u>about</u> 1.0	1	<u>about</u> 1	0.5	0
MgO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BaO	2.8	1.4	-----	3.8	5.4	5.4	-----	-----	2.0	2.7	<u>about</u> 2.8	2.7	<u>about</u> 2.7	1.4	2.0
SrO	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cs ₂ O	-----	-----	-----	4.1	4.9	4.9	-----	-----	-----	-----	-----	-----	-----	-----	-----
Li ₂ O	14.4	14.7	14.7	13.4	11.0	10.8	14.3	14.6	13.0	15.3	<u>about</u> 14.4	15	<u>about</u> 14.1	14.3	13.0

K ₂ O	2.5	2.5	4.6	1.7	----	----	4.4	4.5	2.0	2.1	about 2.2	2.2	about 2.2	2.0	2.0
Na ₂ O	1.4	1.4	----	----	----	----	----	----	----	----	about 1.5	1.4	about 1.4	1.3	----
TiO ₂	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
ZrO ₂	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
P ₂ O ₅	3.3	3.6	3.4	2.7	2.7	2.7	3.3	3.4	3.0	4.0	about 3.3	3.5	about 3.2	3.5	3.0
SnO ₂	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Sb ₂ O ₃	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Y ₂ O ₃	----	----	----	----	----	----	----	----	0.5	0.8	----	----	----	----	0.5
CeO ₂	----	----	----	----	----	----	0.4	----	0.5	----	----	0.4	about 0.4	0.3	0.6
Eu ₂ O ₃	----	----	----	----	----	----	----	----	0.5	----	----	----	----	----	0.6
Tb ₄ O ₇	----	----	----	----	----	----	0.8	----	----	----	----	0.9	----	0.3	----
Nb ₂ O ₅	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Ta ₂ O ₅	----	----	----	----	----	----	2.0	----	----	----	----	1.9	about 2.0	1.8	----
Three-Point Flexural Strength per ISO 6872, MPa										430± 70	420± 60		440± 60		400± 50
As-pressed Opacity (relative opacity units)										50	42		25		34
CTE (25°C- 500°C), 10 ⁻⁶ °C ⁻¹		10.4								8.7	10.1- 10.6		10.5	10.0	9.9

In the claims:

Claims 3, 9, 28 and 48 through 51 have been cancelled.

Claims 1, 8, 27, 43, 53, 56, 63, 64, 65, 66, 67, 69 and 70 have been amended as follows:

1. (Amended) A glass-ceramic composition ~~comprising~~ consisting essentially of in weight percent:

about 62 to about 85% SiO_2 ;

about 1.5 to about 10% Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 2.5 to about 7% K_2O ; ~~and~~

about 0.5 to about 12 % P_2O_5 ;

up to about 4.9% B_2O_3 ;

up to about 1.5% F;

up to about 7% CaO ;

up to about 7% BaO ;

up to about 1% SrO ;

up to about 5% Cs_2O ;

up to about 5% Na_2O ;

up to about 2% TiO_2 ;

up to about 3% ZrO_2 ;

up to about 1% SnO_2 ;

up to about 1% Sb_2O_3 ;

up to about 3% Y_2O_3 ;

up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;

up to about 1% Tb_4O_7 ;

up to about 2% Nb_2O_5 ; and

up to about 2% Ta_2O_5 .

8. (Amended) The method of claim 6 wherein the blank is fully sintered,
~~to full density.~~

27. (Amended) A method of making a lithium disilicate dental product
comprising:

melting a starting glass ~~comprising a composition~~ at temperatures within the range of about 1200 to about 1600°C;

quenching the glass;

cooling the quenched glass ~~melt~~ to the crystallization temperature to form a glass-ceramic;

~~quenching the glass-ceramic;~~

comminuting the glass-ceramic to a powder;

compacting the powder to a starting blank; and

sintering the blank.

43. (Amended) A glass-ceramic composition ~~comprising~~ consisting essentially of in weight percent:

about 64 to about 70% SiO₂;

about 1.5 to about 6 Al₂O₃;

about 10 to about 15% Li₂O;

about 2.5 to about 5% K₂O; and

about 2 to about 7 % P₂O₅;

up to about 1.5% F;

up to about 7% BaO;

up to about 1% SrO;

up to about 5% Cs₂O;

up to about 2.7% B₂O₃;

up to about 0.9% CaO;

up to about 3% Na₂O;

up to about 2% TiO₂;

up to about 3% ZrO₂;

up to about 1% SnO₂;

up to about 1% Sb₂O₃;

up to about 3% Y₂O₃;

up to about 1% CeO₂;

up to about 1% Eu₂O₃;

up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

53. A glass-ceramic composition ~~comprising~~consisting essentially of
in weight percent:

about 64 to about 70% SiO₂ ;
about 5.2 to about 9 Al₂O₃;
about 10 to about 15% Li₂O; and
about 2 to about 7 % P₂O₅;
up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% K₂O;
up to about 2.7% B₂O₃;
up to about 0.9% CaO;
up to about 3% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

56. A dental restoration comprising the glass-ceramic composition
comprising :of claim 53

about 64 to about 70% SiO₂;
about 5.2 to about 9 Al₂O₃;
about 10 to about 15% Li₂O; and
about 2 to about 7 % P₂O₅.

63. (Amended) A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅; and
about 0.5 to about 8% Ta₂O₅.

64. (Amended) A The glass-ceramic composition of claim 63 comprising:
about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅;
about 0.5 to about 8% Ta₂O₅; and
whereby the glass-ceramic is pressable.

65. (Amended) A The glass-ceramic composition of claim 63 further
comprising in weight percent:

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about .3 to about 7% P₂O₅;
about .5 to about 8% Ta₂O₅;
up to about 5% B₂O₃;
up to about 5% Na₂O;
up to about 7% K₂O;

up to about 1.5% F;
up to about 5% ZnO;
up to about 2% MgO;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 7% CaO;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇; and
up to about 2% Nb₂O₅.

66. (Amended) A dental restoration comprising the glass-ceramic of ~~claim 63~~ comprising:

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅; and
about 0.5 to about 8% Ta₂O₅.

67. (Amended) A method of making a dental restoration comprising:

melting a starting glass composition comprising in weight percent

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅; and

about 0.5 to about 8% Ta₂O₅; at temperatures within the range of about 1200° to about 1600°C;
quenching the glass melt;
subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100°C to convert the glass into a glass-ceramic;
comminuting the glass ceramic to a powder;
compacting the powder to a starting blank;
sintering the blank; and
pressing the blank into the dental restoration.

69. (Amended) The glass-ceramic of claim 68 having a flexural strength ~~of equal to or greater than about 420~~ in the range of 360 to 480 MPa.

74. (Amended) The glass-ceramic of claim 73 having a flexural strength ~~of equal to or greater than about 440~~ in the range of 380 to 500 MPa.



UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

T-P

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/458,919	12/10/99	BRUDKIN	D JPP-1222NP

IM22/0531

ANN M KNAE
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EXAMINER
KOSLOW, C

ART UNIT	PAPER NUMBER
1755	

7

DATE MAILED: 05/31/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Notice of Allowability

Application No.
09/458,919

Applicant(s)

Brodtkin et al

Examiner
Melissa Koslow

Art Unit
1755



--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance and Issue Fee Due or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment of 23 April 2001.
2. ☒ The allowed claim(s) is/are 1, 2, 4-8, 10-27, 29-47 and 52-77.
3. ☐ The drawings filed on _____ are acceptable as formal drawings.
4. ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
a) ☐ All b) ☐ Some* c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
- *Certified copies not received: _____

5. ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE FOR SUBMITTING NEW FORMAL DRAWINGS, OR A SUBSTITUTE OATH OR DECLARATION.** This three-month period for complying with the REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL is extendable under 37 CFR 1.136(a).

6. ☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.
7. ☒ Applicant MUST submit NEW FORMAL DRAWINGS
(a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
1) ☐ hereto or 2) ☐ to Paper No. _____.
(b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the examiner.
(c) ☐ including changes required by the attached Examiner's Amendment/Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

8. ☐ Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Any reply to this letter should include, in the upper right hand corner, the APPLICATION NUMBER (SERIES CODE/SERIAL NUMBER). If applicant has received a Notice of Allowance and Issue Fee Due, the ISSUE BATCH NUMBER and DATE of the NOTICE OF ALLOWANCE should also be included.

Attachment(s)

- | | |
|---|--|
| 1 <input type="checkbox"/> Notice of References Cited (PTO-892) | 2 <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3 <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 4 <input type="checkbox"/> Interview Summary (PTO-413), Paper No. _____ |
| 5 <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449), Paper No(s). <u>5</u> | 6 <input type="checkbox"/> Examiner's Amendment/Comment |
| 7 <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material | 8 <input type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| 9 <input type="checkbox"/> Other | |

MELISSA KOSLOW
PRIMARY EXAMINER
ART UNIT 1755



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

IM22/0531

ANN M KNAB
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WALLINGFORD CT 06492

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
09/458,919	12/10/99	020	KOSLOW, C	1755 05/31/01
First Named Applicant	BROOKIN,	35 USC 154(b) term ext. =	0 Days.	

TITLE OF INVENTION PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
0 JPP-1222NP	501-005.000	G99	UTILITY	YES	\$620.00	08/31/01

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

- If the status is changed, pay twice the amount of the FEE DUE shown above and notify the Patent and Trademark Office of the change in status, or
- If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

- Pay FEE DUE shown above, or
- File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

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III. All communications regarding this application must give application number and batch number. Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

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NOTICE OF ALLOWANCE AND ISSUE FEE DUE

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IM22/0604

ANN M KNAB
JENERIC PENTRON INCORPORATED
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD CT 06492

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
09/458,919	12/10/99	070	KOSLOW, C	1755 06/04/01
First Named Applicant	BRODKIN,		35 USC 154(b) term ext. = 0 Days.	
TITLE OF INVENTION	PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
0 JPP-1222NP	501-005.000	699	UTILITY	YES	\$620.00	09/04/01

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

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 - A. Pay FEE DUE shown above, or
 - B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.
- II. Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.
- III. All communications regarding this application must give application number and batch number.
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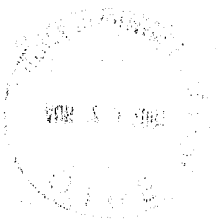
08-24-01

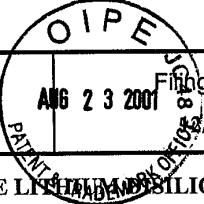
CA 1755 JK

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)		Docket No. JPP-1222NP CPA <i>ABP</i>	
Applicant(s): DMITRI BRODIE, CARLINO PANZERA, PAUL PANZERA			
Serial No. 09/458,919	Filing Date AUG 23 2001 <i>12/10/99</i>	Examiner KOSLOW, C	Group Art Unit 1755
Invention: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
RECEIVED AUG 28 2001			
I hereby certify that the following correspondence: <div style="border: 1px solid black; padding: 5px; text-align: right;">TC 1700</div> TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT'; POST CARD <i>(Identify type of correspondence)</i>			
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1C09-458919



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In Re Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA				
Serial No. 09/458,919	<div style="text-align: center;">  </div> Filing Date 8/23/10/99	Examiner KOSLOW, C.	Group Art Unit 1755	
Title: PRESSABLE LITHIUM-BOROSILICATE GLASS CERAMICS				
Address to: Assistant Commissioner for Patents Washington, D.C. 20231				
37 CFR 1.97(b)				
1. <input checked="" type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53(d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.				
37 CFR 1.97(c)				
2. <input type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), provided that the Information Disclosure Statement is filed before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:				
<div style="display: flex; justify-content: space-around;"> <div> <input type="checkbox"/> the statement specified in 37 CFR 1.97(e); </div> <div> OR </div> <div> <input type="checkbox"/> the fee set forth in 37 CFR 1.17(p). </div> </div>				

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EXPIRATION DATE AUG 23 2001

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Sheet

1

of

1

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Application Number	09/458,919
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Filing Date	12/10/99
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First Named Inventor	DMITRI BRODKIN
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Group Art Unit	1755
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Examiner Name	KOSLOW, C.
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Attorney Docket Number	JPP-1222NP CPA
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[illegible][illegible]

Examiner
Signature

Date _____

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10/24/01

¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet

of

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Application Number	09/458,919
Filing Date	12/10/99
First Named Inventor	DMITRI BRODKIN
Group Art Unit	1755
Examiner Name	KOSLOW, C.
Attorney Docket Number	JPP-1222NP CPA

OTHER PRIOR ART -- NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
Q		DILMORE, M.F., CLARK, D.E., HENCH, L.L., Corrosion Behavior of Lithia Disilicate Glass in Aqueous Solutions of Aluminum Compounds. Ceramic Bulletin, pg. 1111-1124. Vol. 58, No. 11 (1979).	
Q		FREIMAN, S.W., HENCH, L.L., Effect of Crystallization on the Mechanical Properties of Li2O-SiO2 Glass-Ceramics. Journal of the American Ceramic Society. pg. 86-90 Vol. 55, No.2.	
Q		HENCH, L.L., FREIMAN, S.W., KINSER, D.L., The early stages of crystallisation of a Li2O-2SiO2 glass. Physics and Chemistry of Glasses. pg. 58-63. Vol. 12, No. 2 April 1971.	
Q		MCCRACKEN, W.J., CLARK, D.E., HENCH, L.L., Aqueous Durability of Lithium Disilicate Glass-Ceramics. Ceramic Bulletin. pg. 1218-1223. Vol.61, No. 11 (1982).	
Q		MCCRACKEN, W.J., PERSON, W.B., HENCH, L.L., Polarized infrared reflection spectroscopy of single crystal lithia-silicates and quartz. Journal of Materials Science. pg. 3853-3864. 20, 1985.	
Q		OHUCHI, F., CLARK, D.E., HENCH, L.L., Effect of Crystallization on the Auger Electron Signal Decay in an Li2O 2SiO2 Glass and Glass-Ceramic. Journal of American Ceramic Society. pg. 500-503. Sept-Oct. 1979.	
Q		PALMER, R.A., LINDBERG, W.R., HENCH, L.L., Fatigue Properties of Li2O 2SiO2 Glass and Glass Ceramic. Journal of The American Ceramic Society - Discussions and Notes. pg. 319-320. Vol. 62, No.5-6. May-June 1979	

Examiner Signature

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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT
(Under 37 CFR 1.97(b) or 1.97(c))

Docket No.
JPP-1222NP CPA

In Re Application: **DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA**

Serial No. **AUG 23 2001**
09/458,919

Filing Date
12/10/99

Examiner
KOSLOW, C.

Group Art Unit
1755

PRESSABLE ALUMINUM DISILICATE GLASS CERAMICS

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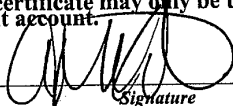
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TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))			Docket No. JPP-1222NP CPA
In Re Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA			
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755
Title: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
Address to: Assistant Commissioner for Patents Washington, D.C. 20231		RECEIVED AUG 20 2001 TC 1700	
<p style="text-align: center;">37 CFR 1.97(b)</p> <p>1. <input checked="" type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53(d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.</p> <p style="text-align: center;">37 CFR 1.97(c)</p> <p>2. <input type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), provided that the Information Disclosure Statement is filed before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:</p> <p style="margin-left: 40px;"><input type="checkbox"/> the statement specified in 37 CFR 1.97(e);</p> <p style="text-align: center;">OR</p> <p style="margin-left: 40px;"><input type="checkbox"/> the fee set forth in 37 CFR 1.17(p).</p>			

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Sheet	1	of	6
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Application Number	09/458,919
Filing Date	12/10/99
First Named Inventor	BRODKIN
Group Art Unit	1755
Examiner Name	C. KOSLOW
Attorney Docket Number	JPP-1222NP CPA

U.S. PATENT DOCUMENTS						
Examiner Initials*	Cite No.†	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code‡ (if known)			
Q		2,106,744		HOOD	02-01-1938	<div>RECEIVED</div> <div>AUG 20 2001</div> <div>TC 1700</div>
Q		2,515,940		STOOKEY	07-18-1950	
Q		2,628,160		STOOKEY	02-10-1953	
Q		2,684,911		STOOKEY	07-27-1954	
Q		2,779,136		STOOKEY	01-29-1957	
Q		2,971,853		STOOKEY	02-14-1961	
Q		3,013,362		CALKINS	12-19-1961	
Q		3,032,429		ARTHUR	05-01-1962	
Q		3,114,646		CURRIE	12-17-1963	
Q		3,130,061		MCMAHON	04-21-1964	
Q		3,170,805		MCMILLAN	02-23-1965	
Q		3,231,456		MCMILLAN	01-25-1966	
Q		3,236,610		MCMILLAN	02-22-1966	
Q		3,252,811		BEALL	05-24-1966	
Q		3,253,975		OLCOTT	05-31-1966	
Q		3,380,838		SACK	04-30-1968	
Q		3,397,076		LITTLE	08-13-1968	
Q		3,436,109		LOOSE	04-01-1969	
Q		3,458,330		TRYGGVE	07-29-1969	
Q		3,463,646		LITTLE	08-26-1969	

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20124101

¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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Application Number	09/458,919
Filing Date	12/10/99
First Named Inventor	BRODKIN
Group Art Unit	1755
Examiner Name	C. KOSLOW
Attorney Docket Number	JPP-1222NP

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Examiner Initials ¹	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code ² (if known)			
		3,511,681		HUEY	05-12-1970	
		3,499,787		INOUE	03-10-1970	
		3,537,868		KOSAKA	11-03-1970	
		3,561,984		EPPLER	02-09-1971	
		3,564,587		ELLIS	02-16-1971	
		3,600,204		BEALL	08-17-1971	
		3,647,489		MCMILLAN	03-07-1972	
		3,663,193		WILSON	05-16-1972	
		3,929,494		VERES	12-30-1975	
		3,939,295		ROBERTSON	02-17-1976	
		4,097,295		CHYUNG	06-27-1978	
		4,125,651		CAMPBELL	11-14-1978	
		4,186,021		CHYUNG	01-29-1980	
		4,196,004		BERRETZ	04-01-1980	
		4,222,760		CHYUNG	09-16-1980	
		4,289,538		ORSO	09-15-1981	
		4,340,645		O'CONOR	07-20-1982	
		4,391,914		BEALL	07-05-1983	
		4,431,451		MABIE	02-14-1984	
		4,473,653		RUDOI	09-25-1984	

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Date Considered	10/24/01
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¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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Sheet 3 of 6

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Application Number 09/458,919
Filing Date 12-10-99
First Named Inventor BRODKIN
Group Art Unit 1755
Examiner Name C. KOSLOW
Attorney Docket Number JPP-1222NP CPA

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U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code ² (if known)			
		4,515,634		WU	05-07-1985	
		5,176,961		CROOKER	01-05-1993	
		5,200,369		CLIFFORD	04-06-1993	
		5,232,878		KASUGA	08-03-1993	
		5,308,391		KOMMA	05-03-1994	
		5,308,803		CLIFFORD	05-03-1994	
		5,330,939		MARAZZI	07-19-1994	
		5,507,981		PETTICREW	04-16-1996	
		5,552,350		HORNOR	09-03-1996	
		5,567,217		GOTO	10-22-1996	
		5,580,363		GOTO	12-03-1996	
		5,849,649		POOLE	12-15-1998	
		5,872,069		ABE	02-16-1999	
		5,874,376		TAGUCHI	02-23-1999	
		5,895,719		FYLES	04-20-1999	
		5,897,885		PETTICREW	04-27-1999	
		5,968,856		SCHWEIGER	10-19-1999	
		5,997,977		ZOU	12-07-1999	
		6,121,175		DRESCHER	09-19-2000	
		3,450,546		STONG	06-17-1969	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Foreign Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Office ³	Number ⁴				
			JP 03271130	HISAKUNI	03-12-1991		
			JP 49-128011	ISHIZUKA	12-07-1974		
			JP 62072547	NETSUKAGAKU	03-04-1987		
			CA 696,415	MCMILLAN	10-20-1964		✓
			CA 799,407	MCMILLAN	11-19-1968		✓
			CA 1,120,960	BARRETT	03-30-1982		✓
			CA 2,213,390	SCHWEIGER	03-05-1998		✓
			EP 0 536 479 A1	BEALL	04-14-1993		✓
			EP 695 726 A1	FRANK	02-07-1996		✓
			EP 0 827 941 B1	SCHWEIGER	11-03-1999		✓

Examiner
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 Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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Application Number	09/458,919
Filing Date	12-10-99
First Named Inventor	BRODKIN
Group Art Unit	1755
Examiner Name	C. KOSLOW
Attorney Docket Number	JPP-1222NP

Sheet	4	of	6
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Sheet	4	of	6
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FOREIGN PATENT DOCUMENTS								
Examiner Initials ¹	Cite No. ¹	Foreign Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶	
		Office ³	Number ⁴					Kind Code ⁵ (if known)
C			EP 0916625A1		SCHWEIGER	05-19-1999		✓
C			DE 2313347		SCHULER	10-04-1973		✓
C			DE 2314721		BOROM	10-11-1973		✓
C			DE 2314722		BOROM	10-11-1973		✓
C			DE 2451121		BOROM	05-07-1975		✓
C			DE 3039930A1		DANIELSON	05-14-1981		✓
C			DE 4020893A1		KASUGA	01-03-1991		✓
C			DE 1421886		HAYAMI	04-22-1971		
C			UK 940706		SIMENS-SCHUCKERTWER	10-30-1963		✓
C			UK 955,437		KOGYOGIJUTSUIN	04-15-1964		

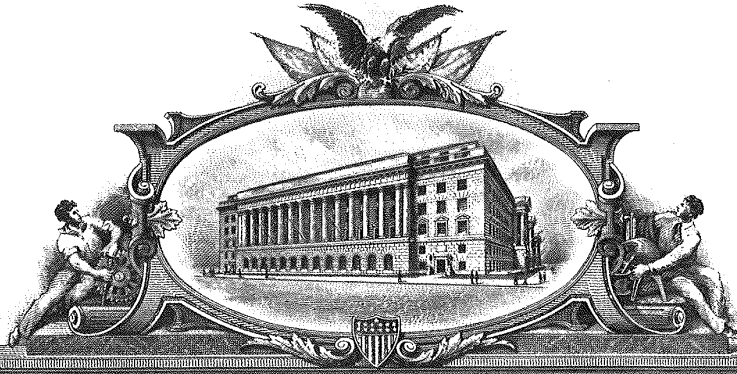
Examiner
Signature

Considered

¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U. S. Patent and Trademark Office, Washington, DC 20231. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.**

IW 7619300



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

February 21, 2017

THIS IS TO CERTIFY THAT ANNEXED IS A TRUE COPY FROM THE
RECORDS OF THIS OFFICE OF THE FILE WRAPPER AND CONTENTS
OF:

APPLICATION NUMBER: 09/458,919


FILING DATE: December 10, 1999

PATENT NUMBER: 6,455,451

ISSUE DATE: September 24, 2002

By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office




JOHN A BURSON
Certifying Officer

PART (7) OF (2) PART(S)

+

PTO/SB/08A (08-00)

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Collection of information unless it contains a valid OMB control number.

Complete if Known

Application Number	09/458,919
Filing Date	12-10-99
First Named Inventor	BRODKIN
Group Art Unit	1755
Examiner Name	C. KOSLOW
Attorney Docket Number	JPP-1222NP

(use as many sheets as necessary)

Sheet

5

Q

6

RECEIVED
AUG 20 2007
CPA
PC 1700
Pages, Columns, Lines

[illegible][illegible]

Examiner
Signature

Date	
Considered	

10/24/01

¹ Unique citation designation number. ² See attached Kinds of U.S. Patent Documents. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U. S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Express Mail Label No.

EK9047 JS

08-17-01

1755 CPA

**CONTINUED PROSECUTION APPLICATION (CPA)
REQUEST TRANSMITTAL (Small Entity)**

Submit an original, and a duplicate for fee processing.

(Only for Continuation or Divisional Applications Under 37 CFR 1.53(d))

Docket No.

JPP-1222NP CPA

☐ **DUPLICATE** (Check box if applicable)

First Named Inventor

Examiner

Group/Art Unit

DMITRI BRODKIN

C. KOSLOW

1755

Address to:

Assistant Commissioner for Patents
Box CPA
Washington, D.C. 20231

This is a request for filing a ☒ continuation or ☐ divisional application under 37 CFR 1.53(d), (continued prosecution application (CPA)) of prior application number 09/458,919 filed on 12/10/99 and entitled:

PRESSABLE LITHIUM DISILICATE GLASS CERAMIC

1. ☐ Enter the unentered amendment previously filed on _____ under 37 CFR 1.116 in the prior nonprovisional application.
2. ☐ A preliminary amendment is enclosed.
3. ☐ This application is being filed by fewer than all the inventors named in the prior application, 37 CFR 1.53(d)(4).
- a. ☐ **DELETE** the following inventor(s) named in the prior nonprovisional application:

09/20/2001 07:13:23AM 00000130 100010

01 FC:031	375.00	00
02 FC:033	750.00	00
03 FC:002	375.00	00

- b. ☐ The inventor(s) to be deleted are set forth on a separate sheet attached hereto.
4. ☐ A new power of attorney or authorization of agent is enclosed.
5. ☒ Small Entity Status:
- a. ☐ A small entity statement is enclosed.
- b. ☒ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
6. ☐ The fee for this application is calculated as follows:

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	70	- 20 =	50	x \$9.00	\$450.00
Indep. Claims	20	- 3 =	17	x \$40.00	\$680.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$355.00
TOTAL FILING FEE					\$1,485.00

CONTINUED PROSECUTION APPLICATION (CPA) REQUEST TRANSMITTAL (Small Entity)
(Only for Continuation or Divisional Applications Under 37 CFR 1.53(d))

7. ☒ The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 50-0718

- ☐ fees required under 37 C.F.R. 1.16.
- ☐ fees required under 37 C.F.R. 1.17.
- ☐ fees required under 37 C.F.R. 1.18.

8. ☐ A check in the amount of _____ is enclosed.

9. ☒ An Information Disclosure Statement (IDS) is enclosed:

- a. ☒ PTO-1449
- b. ☒ Copies of IDS Citations

10. ☒ Also enclosed:

Transmittal of Formal Drawings and 1 Sheet of Formal Drawings; International Search Report, Post Card.

11. ☐ The prior application's correspondence address will carry over to this CPA UNLESS a new correspondence address is provided below:

CONTINUED PROSECUTION APPLICATION (CPA) REQUEST TRANSMITTAL (Small Entity)
(Only for Continuation or Divisional Applications Under 37 CFR 1.53(d))

NOTES

Submit an original, and a duplicate for fee processing.

RECEIVED
AUG 20 2001
TC 1700

FILING QUALIFICATIONS: The prior application must be a nonprovisional application that is either: (1) complete as defined by 37 C.F.R. 1.51(b), or (2) the national stage of an international application in compliance with 35 U.S.C. 371. A Notice will be placed on a patent issuing from a CPA, except for reissues and designs, to the effect that the patent issued on a CPA and is subject to the twenty-year patent term provisions of 35 USC 154(a)(2). Therefore, the prior application of a CPA may have been filed before, on or after June 8, 1995.

C-I-P NOT PERMITTED: A continuation-in-part application cannot be filed as a CPA under 37 C.F.R. 1.53(d), but must be filed under 37 C.F.R. 1.53(b).

EXPRESS ABANDONMENT OF PRIOR APPLICATION: The filing of this CPA is a request to expressly abandon the prior application as of the filing date of the request for a CPA. 37 C.F.R. 1.53(b) must be used to file a continuation, divisional or continuation-in-part of an application that is not to be abandoned.

ACCESS TO PRIOR APPLICATION: The filing of this CPA will be construed to include a waiver of confidentiality by the Applicant under 35 U.S.C. 122 to the extent that any member of the public who is entitled under the provisions of 37 C.F.R. 1.14 to access to, copies of, or information concerning, the prior application may be given similar access to, copies of, or similar information concerning, the other application or application in the file jacket.

35 U.S.C. 120 STATEMENT: In a CPA, no reference to the prior application is needed in the first sentence of the specification and none should be submitted. If a sentence referencing the prior application is submitted, it will not be entered. A request for a CPA is the specific reference required by 35 U.S.C. 120 and to every application assigned the application number identified in such request, 37 C.F.R. 1.78(a).

Dated: 8/16/01



Signature

ANN M. KNAB

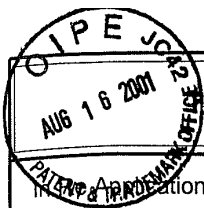
Typed or printed name

33,331

Registration Number (if applicable)

- ☐ Inventor(s)
☐ Assignee of complete interest
☒ Attorney or agent of record

cc:



TRANSMITTAL OF FORMAL DRAWINGS

Docket No.
JPP-1222NP CPA

Inventor(s) Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA

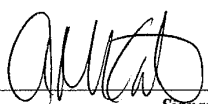
Serial No.	Filing Date	Batch No.	Examiner	Art Unit
09/458,919	12/10/99		C. KOSLOW	1755

Invention: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

RECEIVED
AUG 20 2001
TC 1700Address to:
Assistant Commissioner for Patents
Washington, D.C. 20231

Transmitted herewith are:

1 sheets of formal drawing(s) for this application.

Each sheet of drawing indicates the identifying indicia suggested in 37 CFR Section 1.84(c)
on the reverse side of the drawing.

ANN M. KNAB
REG NO. 33,331

Signature

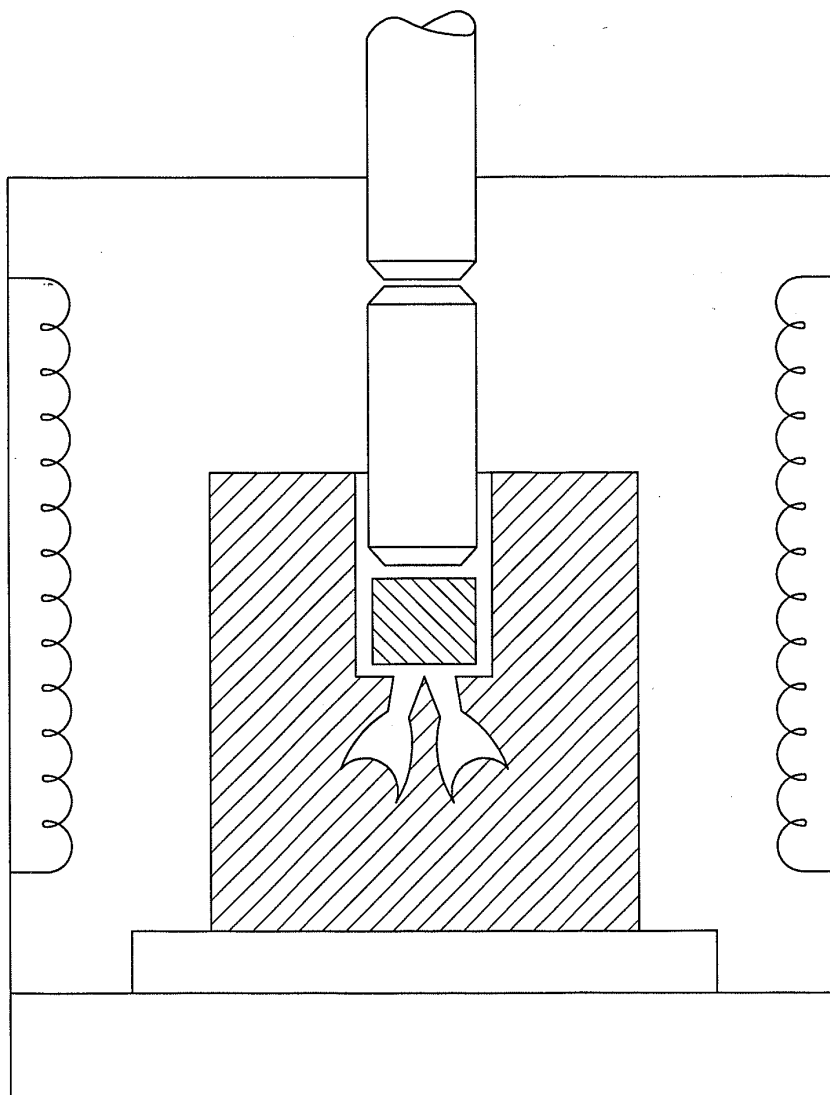
Dated: 8/16/01

I certify that this document and attached formal drawings
are being deposited on _____ with the
U.S. Postal Service as first class mail under 37 C.F.R. 1.8
and addressed to the Assistant Commissioner for Patents,
Washington, D.C. 20231.

Signature of Person Mailing Correspondence

Typed or Printed Name of Person Mailing Correspondence

P23B/REV01

*FIG. 1*



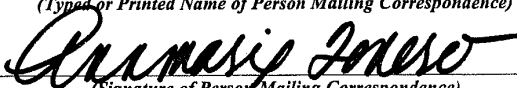
TC 1700

AUG 20 2001

RECEIVED

SERIAL NO.: 09/458,919
INVENTOR: DMITRI BRODKIN, CARLINO
PANZERA, PAUL PANZERA
DOCKET NO.: JPP-1222NP CPA
CONTACT PERSON: ANN KNAB, REG NO.
33,331

(203) 265-7397 x508

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)			Docket No.	
Applicant(s): DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA			JPP-1222NP	
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C	Group Art Unit 1755	
Invention: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS				
<div style="text-align: right;">RECEIVED AUG 20 2001 TC 1700</div> <p>I hereby certify that the following correspondence:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>CONTINUED PROSECUTION APPLICATION; TRANSMITTAL OF FORMAL DRAWINGS; TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT; INTERNATIONAL SEARCH REPORT ; POST CARD</p></div> <p style="text-align: center;"><i>(Identify type of correspondence)</i></p> <p>is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231 on</p> <p style="text-align: center;"><u>8/16/01</u> <i>(Date)</i></p> <div style="text-align: right; margin-top: 20px;"><p><u>ANNMARIE TENERO</u> <i>(Typed or Printed Name of Person Mailing Correspondence)</i></p><p><u></u> <i>(Signature of Person Mailing Correspondence)</i></p><p><u>EK904747464US</u> <i>("Express Mail" Mailing Label Number)</i></p></div>				
<p>Note: Each paper must have its own certificate of mailing.</p>				

P06A/REV02

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))			Docket No. JPP-1222NP CPA	
In Re Application DMITRIY BRODIN, CARLINO PANZERA, PAUL PANZERA				
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755	
PRESSABLE LITHIUM DISILICATE GLASS CERAMICS				
<div style="text-align: right; font-size: 1.2em; font-weight: bold; transform: rotate(-10deg);"> RECEIVED AUG 20 2007 TC 1700 </div> <div style="text-align: center; margin-top: 20px;"> Payment of Fee (Only complete if Applicant elects to pay the fee set forth in 37 CFR 1.17(p)) </div> <div style="margin-top: 10px;"> <input type="checkbox"/> A check in the amount of _____ is attached. <input type="checkbox"/> The Assistant Commissioner is hereby authorized to charge and credit Deposit Account No. _____ as described below. A duplicate copy of this sheet is enclosed. </div> <div style="margin-left: 40px; margin-top: 5px;"> <input type="checkbox"/> Charge the amount of _____ <input type="checkbox"/> Credit any overpayment. <input type="checkbox"/> Charge any additional fee required. </div> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="width: 45%;"> <p>Certificate of Transmission by Facsimile*</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> I certify that this document and authorization to charge deposit account is being facsimile transmitted to the United States Patent and Trademark Office (F </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> _____ (Date) </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> _____ Signature </div> <div style="border: 1px solid black; padding: 5px;"> _____ Typed or Printed Name of Person Signing Certificate </div> </div> <div style="width: 45%;"> <p>Certificate of Mailing by First Class Mail</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> I certify that this document and fee is being deposited with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231. </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> _____ Signature of Person Mailing Correspondence </div> <div style="border: 1px solid black; padding: 5px;"> _____ Typed or Printed Name of Person Mailing Certificate </div> </div> </div> <div style="margin-top: 20px;"> <p>*This certificate may only be used if paying by deposit account.</p> <div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="width: 40%;"> _____ Signature </div> <div style="width: 50%;"> Dated: 8/16/01 </div> </div> </div> <div style="margin-top: 10px;"> <p>ANN M. KNAB ATTORNEY REG. NO.: 33,331</p> </div>				
CC:				

P10A/REV02



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
-----------------	-------------	----------------------	---------------------

09/458,919 12/10/99 BRODKIN

D JFP-1222NP

EXAMINER

IM52/1025

ANN M KNAB
JENERIC PENTRON INCORPORATED
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD CT 06492

KOSLOW, C

ART UNIT

PAPER NUMBER

1755

DATE MAILED:

10/25/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/458,919

Applicant(s)

BRODKIN ET AL.

Examiner

C. Melissa Koslow

Art Unit

1755

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 August 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-8,10-27,29-47 and 52-77 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 4-8,10-23,25-27,29-44,46,47,52-54,56-64 and 66-77 is/are allowed.
- 6) ☒ Claim(s) 1,2 and 24 is/are rejected.
- 7) ☒ Claim(s) 45,55 and 65 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 August 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 9,10. 6) ☐ Other: _____

The request filed on 16 August 2001 for a Continued Prosecution Application (CPA) under 37 CFR 1.53(d) based on parent Application No. 09/458,919 is acceptable and a CPA has been established. An action on the CPA follows.

The references cited on the Information Disclosure Statements of 16 August 2001 and 23 August 2001 having a line drawn through them have already been considered and were cited by either the Examiner on form PTO-892 or by applicants in an earlier Information Disclosure Statement.

The non-English references cited in the Information Disclosure Statements of 16 August 2001 and 23 August 2001 have been considered with respect to the provided English abstracts, English translations and English equivalent references.

Claim 45 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim.

The subject matter in this claim is found in claim 43 from which claim 45 depends.

Claim 55 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim.

The subject matter in this claim is found in claim 53 from which claim 55 depends.

Claim 65 is objected to because of the following informalities: The leading zeros are missing from the amount of phosphorus oxide and tantalum oxide. Appropriate correction is required.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2 and 24 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by GB 1,312,700; EP 536,479; DE 2,451,121; US 3,816,704 or Borom et al.

All of these references teach glass-ceramic compositions. Borom et al and Example 1 in the translation of DE 2,451,121 teach a glass-ceramic, in the shape of a rod or cane, comprising 71.8 wt% silica, 5.1 or 4.8 wt% alumina, 12.6 wt% lithia, 4.8 or 5.1 wt% potassium oxide and 2.5 wt% phosphorous pentaoxide. Rods or canes are known shapes for blanks. This composition falls within the claimed composition. Since the taught composition falls within that claimed, one of ordinary skill in the art would expect it to inherently be pressable, absent any showing to the contrary. GB 1,312,700 teaches a glass-ceramic preform or blank comprising 73 wt% silica, 5.1 wt% alumina, 13.5 wt% lithia, 5.5 wt% potassium oxide, 2.7 wt% phosphorous pentaoxide and 0.2 wt% zirconia. This composition falls within the claimed composition. Since the taught composition falls within that claimed, one of ordinary skill in the art would expect it to inherently be pressable, absent any showing to the contrary. US 3,816,704 teaches, in examples II-IV and VI, glass-ceramic rods composed of 71.1-73.41 wt% silica, 3.9-5.1 wt% alumina, 12.6-15.6 wt% lithia, 4.66-6.2 wt% potassium oxide and 1.65-3.2 wt% phosphorous pentaoxide. Example II also contains 3.2 wt% boron oxide. Rods or canes are known shapes for blanks. This composition falls within the claimed composition. Since the taught composition falls within that claimed, one of ordinary skill in the art would expect it to inherently be pressable, absent any

showing to the contrary. EP 536,479 teaches, in examples 3, a glass-ceramic slab or blank comprising 74.2 wt% silica, 3.54 wt% alumina, 15.4 wt% lithia, 3.25 wt% potassium oxide and 23.37 wt% phosphorous pentaoxide. This composition falls within the claimed composition. Since the taught composition falls within that claimed, one of ordinary skill in the art would expect it to inherently be pressable, absent any showing to the contrary. The claimed glass-ceramic reads upon that taught.

Claims 1 and 2 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by JP 1145,348.

The abstract for this reference teaches it is addressed to glass-ceramic compositions in terms of weight percentage. The table on page 288 teaches specific glass-ceramic compositions. Composition 1 teaches a glass-ceramic consisting of 74.2 wt% silica, 4.3 wt% alumina, 12.3 wt% lithia, 4.5 wt% potassium oxide, 2.5 wt% phosphorous pentaoxide, 1 wt% boron oxide, 0.1 wt% fluorine and 0.3 wt% antimony trioxide. This composition falls within the claimed composition. Since the taught composition falls within that claimed, one of ordinary skill in the art would expect it to inherently be pressable, absent any showing to the contrary. The claimed glass-ceramic reads upon that taught.

Claims 4-8, 10-23, 25-27, 29-44, 46, 47, 52-54, 56-64 and 66-77 are allowable over the cited art of record.

Claim 65 would be allowable if rewritten or amended to overcome the objection set forth in this Office action.

The claimed glass-ceramic composition, methods and dental restoration are not taught or suggested by the cited art of record.

Application/Control Number: 09/458,919

Page 5

Art Unit: 1755

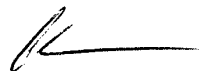
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Melissa Koslow whose telephone number is (703) 308-3817. The examiner can normally be reached on Monday-Thursday from 7:30 AM to 4:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Bell, can be reached at (703) 308-3823.

The fax number for Amendments filed under 37 CFR 1.116 or After Final communications is (703) 872-9311. The fax number for all other official communications is (703) 872-9310.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0661 or (703) 308-0662.

cmk
October 25, 2001



C. Melissa Koslow
Primary Examiner
Tech. Center 1700

Notice of References Cited	Application/Control No. 09/458,919	Applicant(s)/Patent Under Reexamination BRODKIN ET AL.	
	Examiner C. Melissa Koslow	Art Unit 1755	Page 1 of 1

U.S. PATENT DOCUMENTS

* * *		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification	
*	A	US-3,816,704	06-1974	Borom et al	219	462
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

* * *		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification	
*	N	DE 2,451,121	05-1974	Germany	Borom et al	--	--
*	O	EP 536,479	04-1993	Europe	Beall et al	--	--
*	P	GB 1,312,700	04-1973	UK	Davies et al	--	--
*	Q	JP 1-145,348	06-1989	Japan	Toshiba Glass KK	--	--
	R						
	S						
	T						

NON-PATENT DOCUMENTS

* * *		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
*	U	Borom et al, "Strength and Microstructure in Lithium Disilicate Glass-Ceramics", Jour. Amer. Chem. Soc., Vol. 58, pp. 385-91, 1975.
	V	
	W	
	X	


*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) (Small Entity)			Docket No. JPP-1222NP CPA	
In Re Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA				
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755	
Invention: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS				
<p style="text-align: center;"><u>TO THE ASSISTANT COMMISSIONER FOR PATENTS:</u></p> <p>This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a response to the Office Action of <u>10/25/01</u> in the above-identified application. <small>Date</small></p> <p>The requested extension is as follows (check time period desired):</p> <p> <input checked="" type="checkbox"/> One month <input type="checkbox"/> Two months <input type="checkbox"/> Three months <input type="checkbox"/> Four months <input type="checkbox"/> Five months </p> <p> from: <u>1/25/02</u> until: <u>2/25/02</u> <small>Date</small> <small>Date</small> </p> <p>A verified statement of small entity status as a small entity under 37 CFR 1.27:</p> <p> <input type="checkbox"/> is enclosed. <input checked="" type="checkbox"/> has already been filed in this application. </p> <p>The fee for the extension of time is \$55 and is to be paid as follows:</p> <p> <input type="checkbox"/> A check in the amount of the fee is enclosed. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account No. 50-0718 A duplicate copy of this sheet is enclosed. </p> <p> <input checked="" type="checkbox"/> If an additional extension of time is required, please consider this a petition therefor and charge any additional fees which may be required to Deposit Account No. 50-0718 A duplicate copy of this sheet is enclosed. </p> <p style="text-align: right;">Dated: 1/31/02</p> <p>_____ <small>Signature</small></p> <p>ANN M. KNAB, ESQ. REG. NO. 33,331</p>				
<div style="float: right; transform: rotate(-45deg); border: 1px solid black; padding: 5px; font-weight: bold;"> RECEIVED FEB 11 2002 TC 1700 </div>				
<div style="border: 1px solid black; padding: 5px;"> I certify that this document and fee is being deposited on _____ with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231. </div>				
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02/01/2002 CNGUYEN 00000084 500718 09458919
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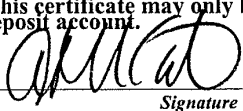
TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))			Docket No. JPP-1222NP CPA
In Re Application: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA			
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755
PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
Payment of Fee (Only complete if Applicant elects to pay the fee set forth in 37 CFR 1.17(p))			
<input type="checkbox"/> A check in the amount of _____ is attached.			
<input checked="" type="checkbox"/> The Assistant Commissioner is hereby authorized to charge and credit Deposit Account No. 50-0718 as described below. A duplicate copy of this sheet is enclosed.			
<input checked="" type="checkbox"/> Charge the amount of \$240.00			
<input checked="" type="checkbox"/> Credit any overpayment.			
<input checked="" type="checkbox"/> Charge any additional fee required.			
Certificate of Transmission by Facsimile*		Certificate of Mailing by First Class Mail	
I certify that this document and authorization to charge deposit account is being facsimile transmitted to the United States Patent and Trademark Office (F		I certify that this document and fee is being deposited with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.	
_____ (Date)		_____	
_____ Signature		_____ Signature of Person Mailing Correspondence	
_____ Typed or Printed Name of Person Signing Certificate		_____ Typed or Printed Name of Person Mailing Certificate	
<p>*This certificate may only be used if paying by deposit account.</p> <div style="display: flex; justify-content: space-between;"> <div style="text-align: center;">  _____ Signature </div> <div> Dated: 1/31/02 </div> </div> <p>ANN M. KNAB ATTORNEY REG. NO.: 33,331</p>			

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TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))		Docket No. JPP-1222NP CPA	
In Re Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA			
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755
Title: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
Address to: Assistant Commissioner for Patents Washington, D.C. 20231			
37 CFR 1.97(b)			
1. <input type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53(d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.			
37 CFR 1.97(c)			
2. <input checked="" type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), provided that the Information Disclosure Statement is filed before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:			
<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> the statement specified in 37 CFR 1.97(e); </div> <div> OR </div> <div> <input checked="" type="checkbox"/> the fee set forth in 37 CFR 1.17(p). </div> </div>			

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TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))			Docket No. JPP-1222NP CPA	
In Re Application: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA				
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755	
PRESSABLE LITHIUM DISILICATE GLASS CERAMICS				
Payment of Fee (Only complete if Applicant elects to pay the fee set forth in 37 CFR 1.17(p))				
<input type="checkbox"/> A check in the amount of _____ is attached. <input checked="" type="checkbox"/> The Assistant Commissioner is hereby authorized to charge and credit Deposit Account No. 50-0718 as described below. A duplicate copy of this sheet is enclosed.				
<input checked="" type="checkbox"/> Charge the amount of \$240.00 <input checked="" type="checkbox"/> Credit any overpayment. <input checked="" type="checkbox"/> Charge any additional fee required.				
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I certify that this document and authorization to charge deposit account is being facsimile transmitted to the United States Patent and Trademark Office (F)		I certify that this document and fee is being deposited with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.		
_____ (Date)		_____		
_____ Signature		_____ Signature of Person Mailing Correspondence		
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 _____ Signature		Dated: 1/31/02		
ANN M. KNAB ATTORNEY REG. NO.: 33,331				
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Date: January 31, 2002

Annmarie Tenero
Annmarie Tenero

PATENT

16/B
2/15/02
P

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:)
)
Inventor: Brodtkin et al.)
Serial No.: 09/458,919) Group Art Unit: 1755
Filed: December 10, 1999)
) Examiner: C. M. Koslow
For: PRESSABLE LITHIUM)
DISILICATE GLASS CERAMICS)

AMENDMENT B

Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

Please enter the following amendments to the above-identified application in response to the Official Action mailed October 25, 2001.

In the claims:

Please cancel claims 1, 2, 45 and 55.

Please amend claims 4, 24 and 65 as follows:

57 (amended). A dental restoration comprising a glass-ceramic consisting essentially of:

about 62 to about 85% SiO₂;
about 1.5 to about 10% Al₂O₃;
about 8 to about 19% Li₂O;
about 2.5 to about 7% K₂O;
about 0.5 to about 12 % P₂O₅;
up to about 4.9% B₂O₃;
up to about 1.5% F;
up to about 7% CaO;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

B₂

~~57~~ 57 (amended). A blank for machining the dental restoration of claim 4.

~~4065~~ (twice amended) A glass-ceramic composition comprising in weight percent:

B₃

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅;

B⁶
Cont

about 0.5 to about 8% Ta₂O₅;
up to about 5% B₂O₃;
up to about 5% Na₂O;
up to about 7% K₂O;
up to about 1.5% F;
up to about 5% ZnO;
up to about 2% MgO;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 7% CaO;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇; and
up to about 2% Nb₂O₅.

REMARKS

Claims 4, 24 and 65 have been amended to more particularly define and distinctly claim the instant invention. Claims 1, 2, 45 and 55 have been cancelled. Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned **VERSION WITH MARKINGS TO SHOW CHANGES MADE**. The allowability of claims 4 – 8, 10 – 23, 25 – 27, 29 – 44, 46, 47, 52 – 54, 56 – 64 and 66 – 77 is hereby acknowledged. In view of the foregoing amendments and following remarks, reconsideration of the application is respectfully requested.

Claims 45, 55 and 65 were objected to. Claims 45 and 55 have been cancelled and claim 65 has been amended to overcome the informalities therein.

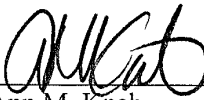
Claims 1, 2 and 24 were rejected under 35 U.S.C. 102 (b) as being clearly anticipated by GB 1,312,700; EP 536,479; DE 2,451,121 and US 3,816,704 to Borom et al. Claims 1 and 2 were rejected under 35 U.S.C. 102 (b) as being clearly anticipated by JP 1,145,348.

In response thereto, claims 1 and 2 have been cancelled. Claim 24 has been amended to depend from claim 4 and to include the word machining. "Blank" is the term of art used to describe the block of material used in computer assisted design/computer assisted milling (cad/cam) operations. Support for this amendment is found on page 4 at lines 16 and 17 of the application. None of the references show or suggest a blank or block of glass-ceramic material for machining into a dental restoration. Rods or canes are not shapes of material used in machines for milling or machining into a desired shape. U.S. Patent Nos. 5,030,392, 6,174,168 and 6,190,171 are cited to show use of the term "blank" as a block of material used for machining into a desired shape. See claim 7 of U.S. Patent 5,030,392; see col. 2, line 1 and line 10 – 11 of U.S. Patent No. 6,174,168; and col. 4, lines 50 – 65. The claim is not anticipated or obvious over the cited references.

Accordingly, it is believed that claims 4 – 8, 10 – 27, 29 – 44, 46, 47, 52 – 54, 56 – 77 is hereby acknowledged specify patentable subject matter and are now in condition for allowance. Applicants therefore respectfully request favorable reconsideration and allowance of this application. The Examiner is requested to telephone Applicants' attorney at the number listed below if it will advance the prosecution of this case. If necessary, the Examiner is authorized to charge further fees necessary to advance the prosecution in this case from Deposit Account No. 500718.

Respectfully submitted,

Date: January 31, 2002


Ann M. Khab
Attorney for Applicants
Registration No. 33,331

Jeneric/Pentron Inc.
53 North Plains Industrial Road
Wallingford, CT 06492
Telephone (203) 265-7397 x508

Attorney Docket: JPP-1222NP

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the claims:

Claims 1, 2, 45 and 55 were cancelled.

Claims 4, 24 and 65 were amended.

1. ~~(amended)~~ A glass ceramic composition consisting essentially of in weight percent:

about 62 to about 85% SiO_2 ;

about 1.5 to about 10% Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 2.5 to about 7% K_2O ;

about 0.5 to about 12 % P_2O_5 ;

up to about 4.9% B_2O_3 ;

up to about 1.5% F;

up to about 7% CaO ;

up to about 7% BaO ;

up to about 1% SrO ;

up to about 5% Cs_2O ;

up to about 5% Na_2O ;

up to about 2% TiO_2 ;

up to about 3% ZrO_2 ;

up to about 1% SnO_2 ;

up to about 1% Sb_2O_3 ;

up to about 3% Y_2O_3 ;

up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;

up to about 1% Tb_4O_7 ;

up to about 2% Nb_2O_5 ; and

up to about 2% Ta_2O_5 .

2. ~~—~~ The glass ceramic of claim 1 whereby the glass ceramic is pressable.

4 (amended). A dental restoration comprising ~~the~~ a glass-ceramic of ~~claim 1~~ consisting essentially of:

about 62 to about 85% SiO₂;
about 1.5 to about 10% Al₂O₃;
about 8 to about 19% Li₂O;
about 2.5 to about 7% K₂O;
about 0.5 to about 12 % P₂O₅;
up to about 4.9% B₂O₃;
up to about 1.5% F;
up to about 7% CaO;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

24 (amended). A blank for ~~the manufacture of a~~ machining the dental restoration ~~comprising the composition of claim 1~~ of claim 4.

45 (amended). The glass-ceramic composition of claim 43 ~~further comprising in weight percent:~~

up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 2.7% B₂O₃;
up to about 2% ZnO;
up to about 0.9% CaO;
up to about 2% MgO;
up to about 3% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

55. —The glass-ceramic composition of claim 53 further comprising in weight percent:

up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% K₂O;
up to about 2.7% B₂O₃;
up to about 2% ZnO;
up to about 0.9% CaO;
up to about 2% MgO;

~~up to about 3% Na₂O;~~
~~up to about 2% TiO₂;~~
~~up to about 3% ZrO₂;~~
~~up to about 1% SnO₂;~~
~~up to about 1% Sb₂O₃;~~
~~up to about 3% Y₂O₃;~~
~~up to about 1% CeO₂;~~
~~up to about 1% Eu₂O₃;~~
~~up to about 1% Tb₄O₇;~~
~~up to about 2% Nb₂O₅; and~~
~~up to about 2% Ta₂O₅.~~

65. (twice amended) A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO₂;
about 1.5 to about 10 Al₂O₃;
about 8 to about 19% Li₂O;
about 0.3 to about 7% P₂O₅;
about 0.5 to about 8% Ta₂O₅;
up to about 5% B₂O₃;
up to about 5% Na₂O;
up to about 7% K₂O;
up to about 1.5% F;
up to about 5% ZnO;
up to about 2% MgO;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 7% CaO;
up to about 2% TiO₂;
up to about 3% ZrO₂;

up to about 1% SnO_2 ;
up to about 1% Sb_2O_3 ;
up to about 3% Y_2O_3 ;
up to about 1% CeO_2 ;
up to about 1% Eu_2O_3 ;
up to about 1% Tb_4O_7 ; and
up to about 2% Nb_2O_5 .



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NOTICE OF ALLOWANCE AND FEE(S) DUE

7590

03/13/2002

ANN M KNAB
JENERIC PENTRON INCORPORATED
53 NORTH PLAINS INDUSTRIAL ROAD
WALLINGFORD, CT 06492

EXAMINER

KOSLOW, CAROL M

ART UNIT

CLASS-SUBCLASS

1755

501-005000

17

DATE MAILED: 03/13/2002

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/458,919	12/10/1999	DMITRI BRODKIN	JPP-1222NP	9478

TITLE OF INVENTION: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

TOTAL CLAIMS	APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
66	nonprovisional	YES	\$640	\$0	\$640	06/13/2002

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above. If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

B. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status.
See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

AMENDMENT TRANSMITTAL LETTER (Small Entity)		Docket No. JPP-1222NP CPA
Applicant(s): DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA		
Serial No. 09/458,919	Filing Date JAN 31 2002 12/10/99	Examiner KOSLOW, C.
		Group Art Unit 1755

Invention: **PRESSABLE LITHIUM DISILICATE GLASS CERAMICS**

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith is an amendment in the above-identified application.

- ☒ Small Entity status of this application has been established under 37 CFR 1.27 by a verified statement previously submitted.
- ☐ A verified statement to establish Small Entity status under 37 FR 1.27 is enclosed.

The fee has been calculated and is transmitted as shown below.

CLAIMS AS AMENDED

	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST # PREV. PAID FOR	NUMBER EXTRA CLAIMS PRESENT	RATE	ADDITIONAL FEE
TOTAL CLAIMS	66 -	70 =	0 x	\$9.00	\$0.00
INDEP. CLAIMS	16 -	20 =	0 x	\$42.00	\$0.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT					\$0.00

- ☒ No additional fee is required for amendment.
- ☐ Please charge Deposit Account No. **50-0718** in the amount of _____
A duplicate copy of this sheet is enclosed.
- ☐ A check in the amount of _____ to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. **50-0718**
A duplicate copy of this sheet is enclosed.
- ☒ Any additional filing fees required under 37 C.F.R. 1.16.
- ☒ Any patent application processing fees under 37 CFR 1.17.

ANN M. KNAB, ESQ.
REG. NO. 33,331

Dated: **1/31/02**

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Signature of Person Mailing Correspondence

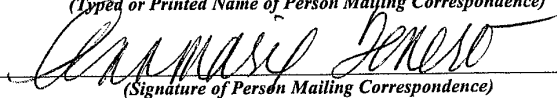
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P11SMALL/REV05

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))			Docket No. JPP-1222NP CPA
In Re Application Of: DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA			
Serial No. 09/458,919	Filing Date 12/10/99	Examiner KOSLOW, C.	Group Art Unit 1755
Title: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
Address to: Assistant Commissioner for Patents Washington, D.C. 20231			
<div style="text-align: center;"> 37 CFR 1.97(b) </div> <p>1. <input type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application other than a continued prosecution application under 37 CFR 1.53(d); within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; before the mailing of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a request for continued examination under 37 CFR 1.114.</p> <div style="text-align: center; margin-top: 20px;"> 37 CFR 1.97(c) </div> <p>2. <input checked="" type="checkbox"/> The Information Disclosure Statement submitted herewith is being filed after the period specified in 37 CFR 1.97(b), provided that the Information Disclosure Statement is filed before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application, and is accompanied by one of:</p> <div style="margin-left: 40px; margin-top: 10px;"> <input type="checkbox"/> the statement specified in 37 CFR 1.97(e); </div> <div style="text-align: center; margin-top: 10px;"> OR </div> <div style="margin-left: 40px; margin-top: 10px;"> <input checked="" type="checkbox"/> the fee set forth in 37 CFR 1.17(p). </div>			

02-05-02

17558

CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)		Docket No.	
Applicant(s): DMITRI BRODKIN, CARLINO PANZERA, PAUL PANZERA		JPP-1222NP CPA	
Serial No. 09/458,919	Filing Date JAN 31 2002	Examiner KOSLOW, C	Group Art Unit 1755
Invention: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS			
<p>I hereby certify that the following correspondence:</p> <div style="border: 1px solid black; padding: 5px;"><p>PETITION FOR EXTENSION OF TIME, AMENDMENT B, TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT; POST CARD</p></div> <p style="text-align: center;"><i>(Identify type of correspondence)</i></p> <p>is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: The Assistant Commissioner for Patents, Washington, D.C. 20231 on</p> <p style="text-align: center;"><u>1/31/02</u> (Date)</p> <div style="text-align: right; margin-top: 20px;"><p>ANNMARIE TENERO <i>(Typed or Printed Name of Person Mailing Correspondence)</i></p><p> <i>(Signature of Person Mailing Correspondence)</i></p><p>EK904747892US <i>("Express Mail" Mailing Label Number)</i></p></div>			

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AS-17

Notice of Allowability

Application No.	Applicant(s)	
09/458,919	BRODKIN ET AL.	
Examiner	Art Unit	
C. Melissa Koslow	1755	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

- 1. ☒ This communication is responsive to the amendment of 31 Jan. 2002.
- 2. ☒ The allowed claim(s) is/are 4-8, 10-27, 29-44, 46, 47, 52-54 and 56-77.
- 3. ☐ The drawings filed on _____ are accepted by the Examiner.
- 4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 - 1. ☐ Certified copies of the priority documents have been received.
 - 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 - 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
- * Certified copies not received: _____.
- 5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
 - (a) ☐ The translation of the foreign language provisional application has been received.
- 6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

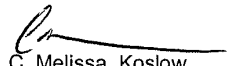
- 7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
- 8. ☐ CORRECTED DRAWINGS must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No. _____.
 - (b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.
 - (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the top margin (not the back) of each sheet. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

- 9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1 <input type="checkbox"/> Notice of References Cited (PTO-892) | 2 <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3 <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 4 <input type="checkbox"/> Interview Summary (PTO-413), Paper No. _____. |
| 5 <input checked="" type="checkbox"/> Information Disclosure Statements (PTO-1449), Paper No. <u>15.</u> | 6 <input type="checkbox"/> Examiner's Amendment/Comment |
| 7 <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material | 8 <input type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| | 9 <input type="checkbox"/> Other |


C. Melissa Koslow
Primary Examiner
Art Unit: 1755

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Complete and mail this form, together with applicable fee(s), to:

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(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/458,919	12/10/1999	DMITRI BRODKIN	JPP-1222NP	9478

TITLE OF INVENTION: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

TOTAL CLAIMS	APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
66	nonprovisional	YES	\$640	\$0	\$640	06/13/2002

EXAMINER	ART UNIT	CLASS-SUBCLASS
KOSLOW, CAROL M	1755	501-005000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). Use of PTO form(s) and Customer Number are recommended, but not required.

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47) attached.

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent)

☐ individual ☐ corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed:

- ☐ Issue Fee
☐ Publication Fee
☐ Advance Order - # of Copies _____

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☐ Payment by credit card. Form PTO-2038 is attached.
☐ The Commissioner is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

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(Authorized Signature) _____ (Date) _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/458,919	12/10/1999	DMITRI BRODKIN	JPP-1222NP	9478
7590	03/13/2002		EXAMINER	
ANN M KNAB JENERIC PENTRON INCORPORATED 53 NORTH PLAINS INDUSTRIAL ROAD WALLINGFORD, CT 06492			KOSLOW, CAROL M	
			ART UNIT	PAPER NUMBER
			1755	

DATE MAILED: 03/13/2002

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The patent term adjustment to date is 0 days. If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the term adjustment will be 0 days.

If a continued prosecution application (CPA) was filed in the above-identified application, the filing date that determines patent term adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system. (<http://pair.uspto.gov>)



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EXAMINER

KOSLOW, CAROL M

ART UNIT

CLASS-SUBCLASS

1755

501-005000

DATE MAILED: 03/13/2002

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/458,919	12/10/1999	DMITRI BRODKIN	JPP-1222NP	9478

TITLE OF INVENTION: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

TOTAL CLAIMS	APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
66	nonprovisional	YES	\$640	\$0	\$640	06/13/2002

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. **PROSECUTION ON THE MERITS IS CLOSED.** THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN **THREE MONTHS** FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. **THIS STATUTORY PERIOD CANNOT BE EXTENDED.** SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above. If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

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- B. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

If the SMALL ENTITY is shown as NO:

- A. Pay TOTAL FEE(S) DUE shown above, or
- B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.
 - ☒ Applicant claims SMALL ENTITY status.
See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

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Annmarie Tenero (Depositor's name)
Annmarie Tenero (Signature)
June 13, 2002 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/458,919	12/10/1999	DMITRI BRODKIN	JPP-1222NP	9478

TITLE OF INVENTION: PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

TOTAL CLAIMS	APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
66	nonprovisional	YES	\$640	\$0	\$640	06/13/2002

EXAMINER	ART UNIT	CLASS-SUBCLASS
KOSLOW, CAROL M	1755	501-005000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). Use of PTO form(s) and Customer Number are recommended, but not required.

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1 Ann M. Knab
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

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(A) NAME OF ASSIGNEE

Jeneric/Pentron, Inc.

(B) RESIDENCE: (CITY AND STATE OR COUNTRY)

Wallingford, Connecticut

Please check the appropriate assignee category or categories (will not be printed on the patent) ☐ individual ☒ corporation or other private group entity ☐ government

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(Authorized Signature)

(Date)

June 13, 2002

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01 FC:242
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US006455451B1

(12) **United States Patent**
Brodkin et al.

(10) **Patent No.:** **US 6,455,451 B1**
(45) **Date of Patent:** ***Sep. 24, 2002**

(54) **PRESSABLE LITHIUM DISILICATE GLASS CERAMICS**

(75) Inventors: **Dmitri Brodkin**, West Orange, NJ (US); **Carlino Panzera**, Belle Mead, NJ (US); **Paul Panzera**, Mt. Holly, NJ (US)

(73) Assignee: **Jeneric/Pentron, Inc.**, Wallingford, CT (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/458,919**

(22) Filed: **Dec. 10, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/153,916, filed on Sep. 14, 1999, provisional application No. 60/122,558, filed on Mar. 2, 1999, and provisional application No. 60/111,872, filed on Dec. 11, 1998.

(51) Int. Cl.⁷ **C03B 27/012**; C03B 32/00; A61C 13/00

(52) U.S. Cl. **501/5**; 106/35; 264/16; 264/19; 433/201.2; 433/202.1; 433/212.1

(58) Field of Search 264/16, 19; 106/35; 501/5; 433/201.1, 202.1, 212.1

(56) **References Cited**

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(List continued on next page.)

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(List continued on next page.)

OTHER PUBLICATIONS

Borom et al, "Strength and Microstructure in Lithium Disilicate Glass-Ceramics", Jour. Amer. Chem. Soc., vol. 58, pp. 385-391, 1975.*

(List continued on next page.)

Primary Examiner—C. Melissa Koslow

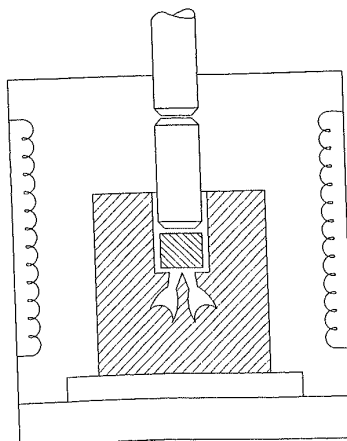
(74) Attorney, Agent, or Firm—Ann M. Knab

(57)

ABSTRACT

This invention is directed to lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) based glass-ceramics comprising silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide. The glass-ceramics are useful in the fabrication of single and multi-unit dental restorations (e.g. anterior bridges) made by heat pressing into refractory investment molds produced using lost wax techniques. The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat-pressing using commercially available equipment. In accordance with one embodiment directed to the process of making the glass-ceramics, the compositions herein are melted at about 1200° to about 1600° C., thereafter quenched (e.g., water quenched or roller quenched) or cast into steel molds, or alternately, cooled to the crystallization temperature. The resulting glass is heat-treated to form a glass-ceramic via a one or two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100° C. The resulting glass ceramics are then pulverized into powder and used to form pressable pellets and/or blanks of desired shapes, sizes and structures which are later pressed into dental restorations.

66 Claims, 1 Drawing Sheet



U.S. PATENT DOCUMENTS

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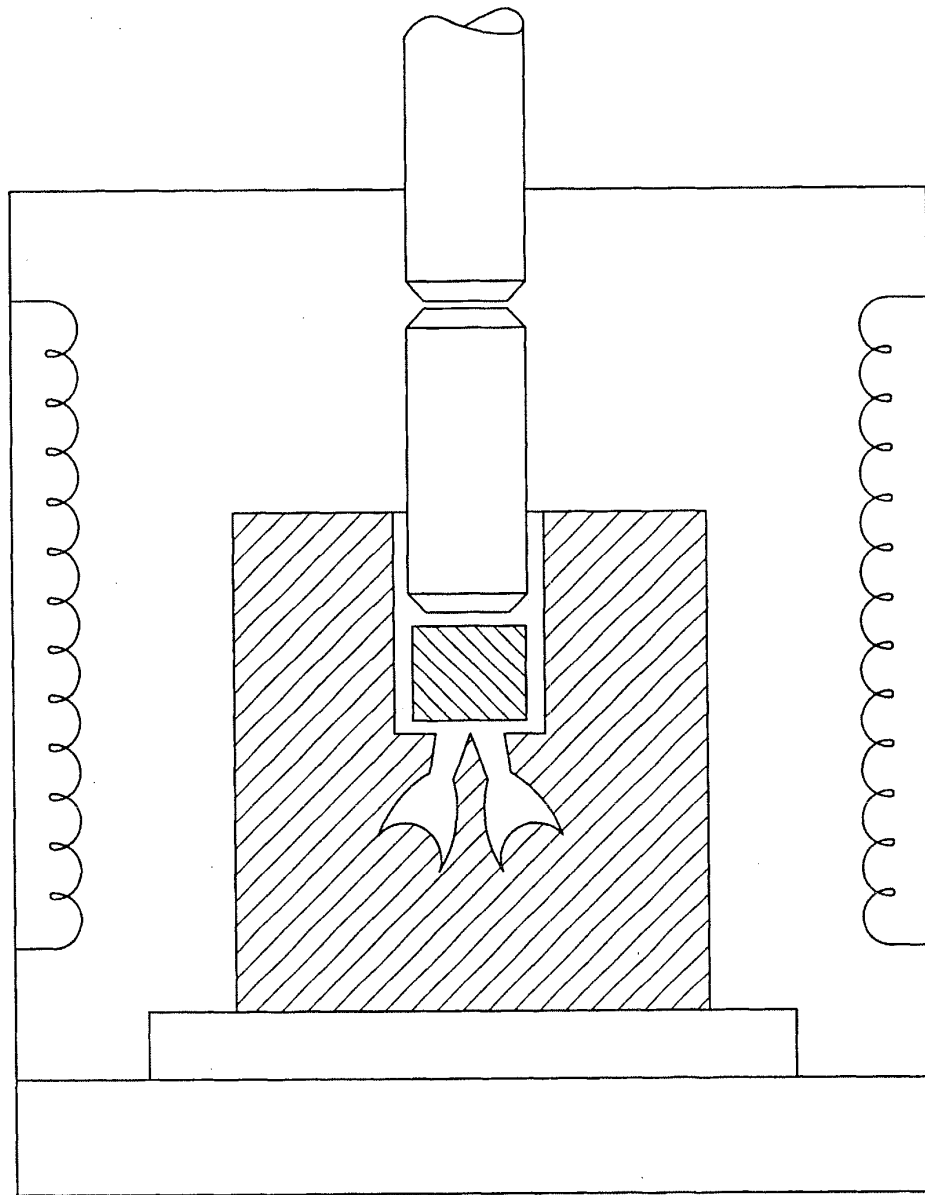


FIG. 1

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PRESSABLE LITHIUM DISILICATE GLASS CERAMICS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 60/153,916, filed Sep. 14, 1999, U.S. Provisional Application No. 60/122,558, filed Mar. 2, 1999, and U.S. Provisional Application No. 60/111,872, filed Dec. 11, 1998, all which are incorporated herein by reference.

FIELD OF INVENTION

This invention relates generally to glass-ceramics comprising lithium disilicate and more specifically to glass-ceramics for use in the manufacture of dental restorations and methods of manufacture thereof.

BACKGROUND OF THE INVENTION

The use of lithium disilicate glass ceramics for use in dental restorations has been suggested in the prior art. U.S. Pat. No. 4,189,325 to Barret et al. is directed to a glass-ceramic comprising lithium disilicate for use in dental restorations. The glass ceramic requires the presence of Nb_2O_5 and Pt as nucleation agents. Barrett et al. introduced dental restorations made from castable lithium disilicate glass-ceramics in the $\text{Li}_2\text{O}-\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$ system nucleated by Pt and Nb_2O_5 . According to Barret et al., dental restorations are made by casting a melt into an investment mold, and devitrifying thereafter.

U.S. Pat. No. 4,515,634 to Wu et al. is directed to a castable glass-ceramic composition wherein the glass is melted and cast into a shape and is crystallized after it has been shaped. Therefore, the crystallization process is performed by the technician making the restoration, not the manufacturer of the dental material. Wu et al. suggests one way to improve properties of castable lithium disilicate dental restorations within the same $\text{Li}_2\text{O}-\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$ system as described by Barrett et al. is by utilization of P_2O_5 as a nucleating agent. Both Barrett et al. and Wu et al. describe castable compositions having CaO as an essential ingredient believed to improve chemical durability of the resulting glass-ceramics. Chemical durability is one of the major issues that the Wu and Barrett inventions fail to address. For example, total alkali leaching rates for materials presented in Wu's examples were four to five times higher than those for commercial dental porcelain.

Castable dental ceramics as described in Barret et al. and Wu et al. employ melting glass ingots supplied by a manufacturer and casting dental articles into a refractory investment mold. Following the casting process, the cast articles are devitrified (crystallized) by the required heat-treatment steps. This process is very similar to casting metals whereby a heat-treatment step follows the casting process to increase hardness and strength.

U.S. Pat. Nos. 5,507,981 and 5,702,514 to Petticrew teach lithium disilicate compositions for use in dental restorations, but the method described therein implies forming glass into the shape of a dental restoration at temperatures much higher than the melting temperature of lithium disilicate and heat-treating the dental restoration after forming to convert the glass into a glass-ceramic.

German Patent Application No. DE19647739 to Schweiger et al. is directed to lithium disilicate compositions for use in dental restorations. The glass-ceramic bodies or blanks used to press dental restorations are defined as

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"sinterable glass ceramics" which are produced from the starting amorphous glass powder by simultaneous sintering and powder crystallizing, which process is also known as surface crystallization. The glass must be in powder form to be crystallized. Additionally, the lithium disilicate compositions therein require the presence of La_2O_3 , MgO and ZnO.

Many of the lithium disilicate compositions in the prior art require casting of the glass into the desired shape and crystallizing thereafter. The glass must be formed into the finally desired shape and thereafter heat treated to crystallize into a lithium disilicate phase. This may result in structural and other problems, since the microstructure is not formed by the dental materials manufacturer, but by the technician fabricating the dental restoration. Overprocessing by a technician may change the microstructure of the material to something not preferred or desired by the dental materials manufacturer. Moreover, some of the prior art compositions require the forming of the glass ceramics by surface crystallization, limiting the forming and compositional possibilities of the material.

It is desirable to provide a lithium disilicate glass-ceramic which is pressable after the lithium disilicate is formed. It is beneficial to provide a lithium disilicate glass ceramic for use in the fabrication of dental restorations wherein crystallization is carried out by the dental materials manufacturer in the most controlled manner. It is beneficial to provide translucent lithium disilicate glass ceramics having high strength and good pressability.

SUMMARY OF THE INVENTION

This invention is directed to lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) based glass-ceramics comprising silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide in addition to other components listed below. The glass-ceramics are useful in the fabrication of single and multi-unit dental restorations including but not limited to orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders, and connectors made by heat pressing into refractory investment molds produced using lost wax techniques. The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat pressing, also known as hot pressing, or injection molding, using commercially available equipment.

In accordance with one embodiment directed to the process of making the glass-ceramics, the compositions herein are melted at about 1200° to about 1600° C. and preferably in the range of about 1300° to about 1400° C. for a period of time, preferably for about 4 hours and thereafter quenched (e.g., water quenched or roller quenched) or cast into steel molds, or alternately, cooled to the crystallization temperature.

The resulting glass is heat-treated to form a glass-ceramic via a one or two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100° C. This crystallization heat treatment may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450° C. to about 700° C. and preferably in the range of about 500° C. to about 650° C. for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the range of about 800° C. to about 1000° C. and preferably in the range of about 830° C. to about 930° C.

C. for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645° C. and a subsequent four hour soak at about 850° C.

The resulting glass ceramics are then pulverized into powder and used to form pressable pellets and/or blanks of desired shapes, sizes and structures. Additives may be mixed with the powder prior to forming into pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200° C., and more preferably in the range of about 850° to about 950° C., and most preferably at less than about 930° C., under vacuum and with the application of pressure of between about 2 to about 8 bar (0.2 to 0.8 MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry.

BRIEF DESCRIPTION OF THE DRAWINGS

Features of the present invention are disclosed in the accompanying drawing, wherein:

FIG. 1 is perspective view of a plunger system in a pressing furnace for use in the fabrication of dental restorations in accordance with the invention.

DESCRIPTION OF THE INVENTION

As will be appreciated, the present invention provides glass-ceramic compositions comprising a glassy matrix and lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$). The glass-ceramics are useful for the fabrication of dental restorations. The compositions of the lithium disilicate glass-ceramics comprise inter alia, silica, lithium oxide, alumina, potassium oxide and phosphorus pentoxide in the ranges given in Table 1 below. The glass-ceramic compositions of the invention have a combination of properties useful for dental restorations. The glass-ceramics have good pressability, i.e., the ability to be formed into dental articles by heat pressing, also known as hot pressing, or injection molding, using commercially available equipment.

Pressable ceramics employ some form of hot-pressing or injection-molding of the glass-ceramic materials, which are typically in the form of pellets. The pellets contain one or

more crystalline phases and their morphology as well as volume fraction are not significantly altered in the course of pressing. One reason for this is that the pressing temperature is typically lower than the melting temperature of the crystalline phases. This is a major advantage because microstructure is formed in the controlled conditions by the manufacturer of the glass-ceramic materials, e.g., pellets. Following pressing, the resulting dental article does not require crystallization heat-treatment.

The glass-ceramic pellets can be formed by a number of processes: (1) Glass can be cast into the shape of pellet. Pellets are taken from the mold and crystallized. These pellets can not be shaded by the addition of pigments. (2) Glass can be crystallized in bulk and subsequently milled into powder. Pigments and other additives can be added to the powder. The powder is formed into a pellet and partially or fully sintered. Pigments, if added, create color centers that impart a certain color to a translucent body of the dental article pressed from the pellet. The mechanism of crystallization in the two processes described above is volume crystallization.

Alternatively, surface crystallization may be utilized to crystallize a portion of the glass into one or more crystal phases. This involves milling glass into powder. Pigments and other additives can be added to the powder. This glass powder (amorphous, not crystalline) is formed into a pellet. The glass pellet is sintered and crystallized in the same firing cycle. Not all glass-ceramic materials can be crystallized and sintered simultaneously. Only certain materials and compositions prone to surface crystallization can be processed this way. The glass-ceramics processed from glass powder via simultaneous sintering and crystallization are sometimes called "sintered" glass-ceramics. Another term that can be used is "sinterable" glass-ceramics.

The compositions herein are prepared by mixing, in the desired proportions, the oxides and/or compounds that decompose to form the oxides, followed by fusing the ingredients to obtain the compositions in Table 1. Convenient raw material include lithium carbonate, silica, alumina, carbonates of K, Na, Ca, ammonium phosphate, tricalcium aluminate, aluminum phosphate or aluminum metaphosphate and if necessary, Ta_2O_5 , CeO_2 , Tb_4O_7 , titanium dioxide, and zirconium dioxide.

TABLE 1

Oxide wt %	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
SiO_2	about 62 to about 85	about 64 to about 70	about 62 to about 85	about 64 to about 70	about 64 to about 70	about 62 to about 76
B_2O_3	0 to about 4.9	0 - about 2.7	0 - about 4.9	0 - about 27	about 0.5 - about 3.0	0 - about 5
Al_2O_3	about 1.5 to about 10	about 1.5 to about 6.0	about 5.1 - to about 10	about 5.2 to about 9.0	about 1.5 to about 6.0	about 1.5 to about 10
F	0 to about 1.5	0 to about 1.5	about 0 to about 1.5	0 to about 1.5	0 to about 1.5	0 to about 1.5
ZnO	0 to about 5	0 to about 2	0 to about 5	0 to about 2	—	0 to about 5
CaO	0 to about 7	0 to about 0.9	0 to about 7	0 to about 0.9	0 to about 0.9	0 to about 7
MgO	0 to about 2	0 to about 2	0 to about 2	about 0 to about 2	—	0 to about 2
BaO	0 to about 7	0 to about 7	0 to about 7	about 0 to about 7	0 to about 7	0 to about 7
SrO	0 to about 1	0 to about 1	0 to about 1	about 0 to about 1	0 to about 1	0 to about 1
Cs_2O	0 to about 5	0 to about 5	0 to about 5	about 0 to about 5	0 to about 5	0 to about 5
Li_2O	about 8 to about 19	about 10 to about 15	about 8 to about 19	about 10 to about 15	about 10 to about 15	about 5 to about 19
K_2O	about 2.5 to about 7	about 2.5 to about 7	0 to about 7	0 to about 5	about 2.2 to about 5	0 to about 7

TABLE 1-continued

Oxide wt %	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6
Na ₂ O	0 to about 5	0 to about 3	0 to about 5	0 to about 3	about 0.5 to about 3	0 to about 5
TiO ₂	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2
ZrO ₂	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3
P ₂ O ₅	0.5 to about 12	about 2 to about 7	about 0.5 to about 12	about 2 to about 7	about 2 to about 7	0.3 to about 7.0
SnO ₂	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Sb ₂ O ₃	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Y ₂ O ₃	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3	0 to about 3
CeO ₂	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Eu ₂ O ₃	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Tb ₄ O ₇	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1	0 to about 1
Nb ₂ O ₅	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2
Ta ₂ O ₅	0 to about 2	0 to about 2	0 to about 2	0 to about 2	0 to about 2	about 0.5 to about 8.0

The compositions in Table 1 are melted at about 1200° to about 1600° C. and preferably in the range of about 1300° to about 1400° C. for a period of time, preferably for about 4 hours and thereafter quenched (e.g., water quenched or roller quenched), cast into steel molds, or alternately, cooled to the crystallization temperature. If the melt is cooled to the crystallization temperature, it may remain in the same furnace.

The resulting glass is heat-treated to form glass-ceramics using a one or a two step heat-treatment cycle preferably in the temperature range of about 400° to about 1100° C. This crystallization heat-treatment may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450° C. to about 700° C. and preferably in the range of about 500° C. to about 650° C. for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the range of about 800° C. to about 1000° C. and preferably in the range of about 830° C. to about 930° C. for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645° C. and a subsequent four hour soak at about 850° C.

The glass ceramics comprise lithium disilicate. The resulting glass ceramics are then pulverized into powder sieved to -200 mesh to provide powder with average particle sizes of about 30 to about 40 microns. Pigments, fluorescing agents, opacifying agents, and the like may be added to the powder in a wide range in an amount between about 0 and about 6 wt % and preferably in the amount of between about 0 and about 5 wt % and most preferably in the amount of about 0% to about 3 wt %. Moreover, reinforcing agents may be added to the powder in an amount of from about 0 to about 30 vol % and more preferably in an amount of from about 0 to about 20 vol %. The reinforcing agents may include fibers, whiskers, and particulate fillers and may be fabricated of any known material, preferably a glass or ceramic material.

The powders may be used to form and fuse (sinter) pressable pellets and/or blanks of desired shapes, sizes and structures. Sintering of the pellets or blanks is carried out at temperatures in the range of about 800° to about 1000° C., and preferably in the range of about 850° to about 950° C. Sintering imparts sufficient strength for handling of the pellets or blanks. These pellets and blanks may be used for pressing cores or other frameworks or shapes for dental restorations. The cores may be provided with one or more coatings. The coatings may be selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a

glaze, a composite and mixtures thereof. The coatings preferably have a firing temperature in the range of about 700° to about 900° C. and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6}/^{\circ}\text{C.}$ of the dental core (measured at the same temperature range). The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200° C., and more preferably in the range of about 850° to about 950° C., and most preferably at less than about 930° C., under vacuum and with the application of pressure of between about 2 to about 8 bar (0.2-0.8 MPa) and preferably no greater than about 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry using commercially available milling equipment such as the Maho HGF 500 5 Axis CNC Milling Machine available from Fraunhofer Institut Produktionstechnologie, Germany.

In an alternative method herein, the compositions in Table 1 are melted at about 1200° to about 1600° C. and preferably in the range of about 1300° to about 1400° C. for a period of time, preferably for about 4 hours and thereafter water quenched or cast into steel molds.

The quenched glass is comminuted to a powder. Pigments, fluorescing agents, opacifying agents, and the like may be added to the powder in a wide range in an amount between about 0 and about 6 wt % and preferably in the amount of between about 0 and about 5 wt % and most preferably in the amount of about 0% to about 3 wt %. Moreover, reinforcing agents may be added to the powder in an amount of from about 0 to about 30 vol % and more preferably in an amount of from about 0 to about 20 vol %. The reinforcing agents may include fibers, whiskers, and particulate fillers and may be fabricated of any known material, preferably a ceramic material.

The powder is compacted into a pellet or starting blank. The blank is thereafter simultaneously sintered and crystallized. Heat treatment may be one or more cycles in the temperature range of about 400° to about 1100° C. The crystallization may comprise a nucleation step and a crystal growth step. Depending on the composition, the first, nucleation step, may be carried out in the range of about 450° C. to about 700° C. and preferably in the range of about 500° C. to about 650° C. for about 0.5 to about 4 hours and the second, crystal growth step, may be carried out in the range of about 800° C. to about 1000° C. and preferably in the range of about 830° C. to about 930° C. for about 0.5 to about 48 hours. The most preferable heat treatment comprises about a one hour soak at about 645° C. and a subsequent four hour soak at about 850° C.

The blank or pellet may be subjected to viscous deformation at a temperature in the range of about 800° to about 1200° C., and more preferably in the range of about 850° to about 950° C., and most preferably at less than about 930° C., under vacuum and with the application of pressure of about between about 2 to about 8 bar (0.2–0.8 MPa) and preferably no greater than 6 bar (0.6 MPa) to obtain a dental restoration. Moreover, it is possible that the blanks may be machined to a dental restoration of desired geometry.

To achieve the required combination of properties, namely sufficient strength, formability below 950° C., by heat-pressing using commercially available dental presses such as the Autopress® Plus available from Jeneric/Pentron, Wallingford, Conn., translucency and chemical durability, the optimal chemical combinations and crystallization treatment of the present invention are necessary. The best properties are obtained when the lithium metasilicate (Li_2SiO_3) and silica phases are nearly absent, the volume fraction of Li_3PO_4 is less than about 5% and the volume fraction of lithium disilicate ($\text{Li}_2\text{Si}_2\text{O}_5$) is between about 35% and about 60%. High aspect ratio morphology of the lithium disilicate phase is important and is believed to enhance mechanical properties, i.e., strength and fracture toughness of the glass-ceramic.

Li_2O and SiO_2 are instrumental in crystallizing the required amount of the lithium disilicate phase in the com-

positions of the present invention. Additionally, BaO and Cs_2O stabilize the residual glass and boost the refractive index of the residual glass to match that of lithium disilicate. Al_2O_3 and to a lesser extent, B_2O_3 , if less than 3%, yield chemically durable glass-ceramics that exhibit a sufficiently low solubility. Alkali (Na, K, Cs) and alkaline earth metal (Ca, Ba) oxides are required to lower processing temperatures of the glass-ceramic. However some of them affect chemical durability more than others. With respect to the following group of alkali metals and alkaline earth metals of potassium, calcium, sodium, and barium; potassium is associated with the smallest decrease in chemical durability of lithium containing glasses, with calcium being next, and sodium and barium affecting chemical durability the most. However, the best combination of properties is achieved when those oxides are used in combination to achieve the so-called "mixed alkali effect." F lowers the viscosity of the glass-matrix and enhances formability at temperatures below about 950° C. Y_2O_3 in combination with Ce_2O_3 , Eu_2O_3 and Tb_4O_7 modify refractive index as well as impart fluorescence. Nb_2O_5 and Ta_2O_5 modify the refractive index as well as aid nucleation and chemical durability of the resulting glass ceramics.

The following Table 2 illustrates examples of the compositions of the invention.

TABLE 2

Oxide, wt %	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15
SiO_2	68.8	70.0	70.1	65.4	70.7	70.9	68.1	69.5	72	69.0	about 68.8	65	about 67.2	68.9	72
B_2O_3	1.2	1.0	—	—	—	—	—	1.3	2.9	—	about 1.3	1.0	about 1.2	0.9	2.0
Al_2O_3	48	4.9	5.2	8.1	5.3	5.3	4.7	4.8	5.1	6.0	about 4.8	5	about 4.7	4.7	4.5
F	—	—	—	1.4	0.2	—	—	—	—	—	—	—	—	—	—
ZnO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CaO	0.9	0.5	2.2	—	—	—	2.0	2.0	—	—	about 1.0	1	about 1	0.5	0
MgO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BaO	2.8	1.4	—	3.8	5.4	5.4	—	—	2.0	2.7	about 2.8	2.7	about 2.7	1.4	2.0
SrO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cs_2O	—	—	—	4.1	4.9	4.9	—	—	—	—	—	—	—	—	—
Li_2O	14.4	14.7	14.7	13.4	11.0	10.8	14.3	14.6	13.0	15.3	about 14.4	15	about 14.1	14.3	13.0
K_2O	2.5	2.5	4.6	1.7	—	—	4.4	4.5	2.0	2.1	about 2.2	2.2	about 2.2	2.0	2.0
Na_2O	1.4	1.4	—	—	—	—	—	—	—	—	about 1.5	1.4	about 1.4	1.3	—
TiO_2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ZrO_2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P_2O_5	3.3	3.6	3.4	2.7	2.7	2.7	3.3	3.4	3.0	4.0	about 3.3	3.5	about 3.2	3.5	3.0
SnO_2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sb_2O_3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Y_2O_3	—	—	—	—	—	—	—	—	0.5	0.8	—	—	—	—	0.5
CeO_2	—	—	—	—	—	—	0.4	—	0.5	—	—	0.4	about 0.4	0.3	0.6
Eu_2O_3	—	—	—	—	—	—	—	—	0.5	—	—	—	—	—	0.6
Tb_4O_7	—	—	—	—	—	—	0.8	—	—	—	—	0.9	—	0.3	—
Nb_2O_5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ta_2O_5	—	—	—	—	—	—	2.0	—	—	—	—	1.9	about 2.0	1.8	—
Three-Point Flexural Strength per ISO 6872, MPa											430 ± 70	420 ± 60	440 ± 60	400 ± 50	

TABLE 2-continued

Oxide, wt %	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13	Ex. 14	Ex. 15
As-pressed Opacity (relative opacity units)										50	42		25		34
CTE (25° C.— 500° C.), 10 ⁻⁶ ° C. ⁻¹		10.4								8.7	10.1– 10.6		10.5	10.0	9.9

The following examples illustrate the invention.

EXAMPLES

Glass-ceramic compositions of the present invention were utilized to make glass-ceramic pellets. These pellets were used to make rectangular bars and rods for measuring the flexural strength by heat-pressing these pellets into the cavity of the refractory investment mold. The process was the same as that used to make dental restorations. The three-point flexure strength was greater or equal to 30° MPa. This strength is sufficient for multi-unit restorations such as anterior bridges. The compositions have a significant amount of glass phase, i.e., approximately 50% glass phase which enhances the pressability thereof.

Moreover, the closeness of refractive indices of the matrix glass (~1.5) and that of the crystallized phase—lithium disilicate—(~1.55) allows for the possibility of translucent glass-ceramics. Specifically in the present invention, the refractive index of the glass matrix is increased to match that of the lithium disilicate phase by adding small amounts of

heavy ions such as, but not limited to, Sr, Y, Nb, Cs, Ba, Ta, Ce, Eu and Tb.

The following examples in Table 3 illustrate the effect of different additions on translucency, strength and reactivity with investment of the resulting glass ceramics. The composition of Example 11 (Table 2) was selected as a control composition for the purposes of this study. This composition was modified by adding 0.13 mole % of CeO₂, or 0.06 mole % of Tb₄O₇, or 0.26 mole % of Ta₂O₅, or La₂O₃, or Y₂O₃; and combinations of the latter with CeO₂. Opacity was measured on the pressed disk using an optical densitometer. Reactivity with investment was evaluated qualitatively by visual inspection of disks and copings prior to and after sand-blasting of the reaction layer. Surfaces of the disks were inspected for pittings under low-magnification (8×) stereomicroscope. Compositions comprising combinations of Ta₂O₅, and CeO₂ were found to have the best combination of high translucency (low opacity) and low reactivity with the investment.

TABLE 3

Oxide, wt %	Ex. 11*	Ex. 16	Ex. 17	Ex. 18	Ex. 19	Ex. 20	Ex. 21	Ex. 22	Ex. 13*	Ex. 23
SiO ₂	68.8	68.12	68.5	68.2	67.5	67.8	67.9	68.0	67.2	67.5
B ₂ O ₃	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Al ₂ O ₃	4.8	4.7	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
CaO	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
BaO	2.8	2.7	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Li ₂ O	14.4	14.3	14.3	14.3	14.1	14.2	14.2	14.2	14.1	14.1
K ₂ O	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Na ₂ O	1.5	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4
P ₂ O ₅	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3
Y ₂ O ₃	—	1.04	—	—	—	—	1.04	—	—	—
CeO ₂	—	—	0.39	—	—	—	0.39	0.39	0.39	0.39
Tb ₄ O ₇	—	—	—	0.85	—	—	—	0.85	—	—
Ta ₂ O ₅	—	—	—	—	2.02	—	—	—	2.01	—
La ₂ O ₃	—	—	—	—	—	1.5	—	—	—	1.49
3-pt Flexure Strength per ISO	420 ± 60								440 ± 60	
6872, MPa										
As-Pressed Rod 3- pt Flexure Strength,	370 ± 40								370 ± 30	
MPa										
As-pressed Opacity (relative opacity units)	42	35	39	37	27	25	31	32	25	24
Reactivity with investment material	—	Medium	Lower	Higher	Medium	Higher	Lower	Medium	Lower	The Highest

*Correspond to compositions in Table 2.

Pellets of the compositions of Examples 2, 11, 13 and 14 were used to press a variety of dental articles in the Auto-Press® dental press (Jeneric/Pentron, Wallingford, Conn.) at pressing cycles carried out under vacuum and involving heating from 700° C. to 920° C. and holding the temperature for 20 minutes prior to initiation of the pressing cycle. Pressure of 0.5 MPa was applied for 7 minutes through a mold-plunger assembly schematically shown in FIG. 1. The plunger assembly used to press the pellets into dental restorations may be the system set forth in copending commonly assigned application Ser. No. 09/431,659, filed Nov. 1, 1999, which is hereby incorporated by reference. Disks of compositions of examples 11 and 13 were pressed as described above and chemical solubility was measured according to ISO 6872 and found to be significantly lower than the acceptable limit of 100 ug/cm².

The glass-ceramics of the present invention have the capability to be pressed into a single or multi-unit dental restorations at temperatures below about 950° C. using already existing, commercially available equipment such as the Autopress® available from Jeneric/Pentron, Wallingford, Conn. Pressability or ability to flow and be pressed into complex shapes of dental restorations at these temperatures is achieved due to the presence of a sufficient amount of the residual glass in the resulting glass-ceramic, in the range of about 15%–60% by volume. The glass-ceramics of the present invention have the capability to be shaded by admixing pigments to the glass-ceramic powder by methods commonly used for dental porcelains.

As will be appreciated, the present invention provides a simple and effective method for producing lithium disilicate glass-ceramic compositions and dental restorations therefrom. While various descriptions of the present invention are described above, it should be understood that the various features can be used singly or in any combination thereof. Therefore, this invention is not to be limited to only the specifically preferred embodiments depicted herein.

Further, it should be understood that variations and modifications within the spirit and scope of the invention may occur to those skilled in the art to which the invention pertains. Accordingly, all expedient modifications readily attainable by one versed in the art from the disclosure set forth herein that are within the scope and spirit of the present invention are to be included as further embodiments of the present invention. The scope of the present invention is accordingly defined as set forth in the appended claims.

What is claimed is:

1. A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO₂;
about 1.5 to about 6 Al₂O₃;
about 10 to about 15% Li₂O;
about 2.5 to about 5% K₂O;
about 2 to about 7% P₂O₅
up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 2.7% B₂O₃;
up to about 0.9% CaO;
up to about 3% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;

up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

2. The glass-ceramic composition of claim 1 whereby the glass-ceramic is pressable.

3. A glass-ceramic composition consisting essentially of in weight percent:

about 64 to about 70% SiO₂;
about 5.2 to about 9 Al₂O₃;
about 10 to about 15% Li₂O;
about 2 to about 7% P₂O₅;
up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 5% K₂O;
up to about 2.7% B₂O₃;
up to about 0.9% CaO;
up to about 3% Na₂O;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;
up to about 1% CeO₂;
up to about 1% Eu₂O₃;
up to about 1% Tb₄O₇;
up to about 2% Nb₂O₅; and
up to about 2% Ta₂O₅.

4. The glass-ceramic composition of claim 3 whereby the glass-ceramic is pressable.

5. A glass-ceramic composition comprising in weight percent:

about 64 to about 70% SiO₂;
about 1.5 to about 6 Al₂O₃;
about 10 to about 15% Li₂O;
about 2 to about 7% P₂O₅;
about 2.2 to about 5% K₂O;
about 0.5 to about 3% Na₂O; and
about 0.5 to about 3% B₂O₃.

6. The glass-ceramic composition of claim 5 whereby the glass-ceramic is pressable.

7. The glass-ceramic composition of claim 5 further comprising in weight percent:

up to about 1.5% F;
up to about 7% BaO;
up to about 1% SrO;
up to about 5% Cs₂O;
up to about 0.9% CaO;
up to about 2% TiO₂;
up to about 3% ZrO₂;
up to about 1% SnO₂;
up to about 1% Sb₂O₃;
up to about 3% Y₂O₃;

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up to about 1% CeO₂;
 up to about 1% Eu₂O₃;
 up to about 1% Tb₄O₇;
 up to about 2% Nb₂O₅; and
 up to about 2% Ta₂O₅.

8. A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO₂;
 about 1.5 to about 10 Al₂O₃;
 about 8 to about 19% Li₂O;
 about 0.3 to about 7% P₂O₅; and
 about 0.5 to about 8% Ta₂O₅.

9. A glass-ceramic composition comprising:

about 62 to about 76% SiO₂;
 about 1.5 to about 10 Al₂O₃;
 about 8 to about 19% Li₂O;
 about 0.3 to about 7% P₂O₅;
 about 0.5 to about 8% Ta₂O₅; and
 whereby the glass-ceramic is pressable.

10. A glass-ceramic composition comprising in weight percent:

about 62 to about 76% SiO₂;
 about 1.5 to about 10 Al₂O₃;
 about 8 to about 19% Li₂O;
 about 0.3 to about 7% P₂O₅;
 about 0.5 to about 8% Ta₂O₅;
 up to about 5% B₂O₃;
 up to about 5% Na₂O;
 up to about 7% K₂O;
 up to about 1.5% F;
 up to about 5% ZnO;
 up to about 2% MgO;
 up to about 7% BaO;
 up to about 1% SrO;
 up to about 5% Cs₂O;
 up to about 7% CaO;
 up to about 2% TiO₂;
 up to about 3% ZrO₂;
 up to about 1% SnO₂;
 up to about 1% Sb₂O₃;
 up to about 3% Y₂O₃;
 up to about 1% CeO₂;
 up to about 1% Eu₂O₃;
 up to about 1% Tb₄O₇; and
 up to about 2% Nb₂O₅.

11. A glass-ceramic composition comprising in weight percent:

about 68.8% SiO₂;
 about 1.3% B₂O₃;
 about 4.8% Al₂O₃;
 about 1.0% CaO;
 about 2.8% BaO;
 about 14.4% Li₂O;
 about 2.2% K₂O;
 about 1.5% Na₂O; and
 about 3.3% P₂O₅.

12. The glass-ceramic of claim 11 having a flexural strength in the range of 360 to 480 MPa.

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13. The glass-ceramic composition of claim 11 whereby the glass-ceramic is pressable.

14. A glass-ceramic composition comprising in weight percent:

5 about 67.2% SiO₂;
 about 1.2% B₂O₃;
 about 4.7% Al₂O₃;
 about 1.0% CaO;
 10 about 2.7% BaO;
 about 14.1% Li₂O;
 about 2.2% K₂O;
 about 1.4% Na₂O;
 about 3.2% P₂O₅;
 15 about 0.4% CeO₂; and
 about 2% Ta₂O₅.

15. The glass-ceramic of claim 14 having a flexural strength in the range of 380 to 500 MPa.

20 16. The glass-ceramic composition of claim 14 whereby the glass-ceramic is pressable.

17. A method of making a lithium disilicate dental restoration comprising:

melting a starting glass composition at temperatures
 25 within the range of about 1200 to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;

30 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.

35 18. A method of making a lithium disilicate dental product comprising:

melting a starting glass composition at temperatures
 within the range of about 1200 to about 1600° C.;
 40 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;

45 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank; and
 sintering the blank.

19. The method of claim 18 wherein the blank is manufactured to a desired shape and structure.

50 20. The method of claim 18 wherein the blank is fully sintered.

21. The method of claim 18 wherein the powder is sieved to the required mesh size prior to the compacting step.

22. The method of claim 18 further including adding
 55 additives to the powder prior to the compacting step.

23. The method of claim 22 wherein the additives comprise pigments, fluorescing agents, opacifying agents.

24. The method of claim 23 wherein the additives comprise reinforcing agents.

25. The method of claim 24 wherein the reinforcing agents comprise one of fibers, whiskers, particles and mixtures thereof.

26. The method of claim 24 wherein the reinforcing agents are fabricated of ceramic material.

65 27. The method of claim 18 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 800° to about 1000° C.

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28. The method of claim 18 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 850° to about 950° C.

29. The method of claim 18 wherein the sintered starting blank is subjected to viscous deformation at a temperature in the range of from about 850° to about 950° C. under vacuum and at a pressure not exceeding about 6 bar to obtained the desired shape.

30. The method of claim 18 wherein the sintered blank is machined to a dental restoration of desired shape.

31. The method of claim 18 wherein the dental product is a dental core and is provided with one or more coatings.

32. The method of claim 31 wherein the one or more coatings is selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof.

33. The method of claim 31 wherein the one or more coatings has a firing temperature in the range of about 700° to about 900° C. and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6}/^{\circ}\text{C.}$ of the dental product (measured at the same temperature range).

34. The method of claim 18 wherein the glass-ceramic comprises in weight percent:

about 62 to about 85% SiO_2 ;

about 1.5 to about 10% Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 2.5 to about 7% K_2O ; and

about 0.5 to about 12% P_2O_5 .

35. The method of claim 34 wherein the glass-ceramic further comprises in weight percent:

up to about 4.9% B_2O_3 ;

up to about 1.5% F;

up to about 5% ZnO;

up to about 7% CaO;

up to about 2% MgO;

up to about 7% BaO;

up to about 1% SrO;

up to about 5% Cs_2O ;

up to about 5% Na_2O ;

up to about 2% TiO_2 ;

up to about 3% ZrO_2 ;

up to about 1% SnO_2 ;

up to about 1% Sb_2O_3 ;

up to about 1% Sb_2O_3 ;

up to about 3% Y_2O_3 ;

up to about 1% CeO_2 ;

up to about 1% Eu_2O_3 ;

up to about 1% Tb_2O_3 ;

up to about 2% Nb_2O_5 ; and

up to about 2% Ta_2O_5 .

36. A method of making a lithium disilicate dental product comprising:

melting a starting glass at temperatures within the range of about 1200 to about 1600° C.;

quenching the glass;

cooling the quenched glass to the crystallization temperature to form a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank; and

sintering the blank.

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37. The method of claim 36 wherein the powder is sieved to the required mesh size prior to the compacting step.

38. The method of claim 36 further including adding additives to the powder prior to the compacting step.

39. The method of claim 38 wherein the additives comprise pigments, fluorescing agents, opacifying agents.

40. The method of claim 38 wherein the additives comprise reinforcing agents.

41. The method of claim 40 wherein the reinforcing agents comprise one of fibers, whiskers, particles and mixtures thereof.

42. The method of claim 40 wherein the reinforcing agents are fabricated of ceramic material.

43. The method of claim 36 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 800 to about 1000° C.

44. The method of claim 36 wherein the sintering of the starting blank comprises heating to a temperature in the range of about 850 to about 950° C.

45. The method of claim 36 wherein the sintered starting blank is subjected to viscous deformation at a temperature in the range of from about 850 to about 950° C. under vacuum and at a pressure not exceeding about 7 bar to obtained the desired shape.

46. The method of claim 36 wherein the sintered blank is machined to a dental restoration of desired shape.

47. The method of claim 36 wherein the dental product is a core and is provided with one or more coatings.

48. The method of claim 47 wherein the one or more coatings is selected from a ceramic, a sintered ceramic, a glass ceramic, a porcelain, a glass, a glaze, a composite and mixtures thereof.

49. The method of claim 47 wherein the one or more coatings has a firing temperature in the range of about 700 to about 900° C. and a coefficient of thermal expansion (measured from room temperature to its transition temperature) of within about $\pm 2.0 \times 10^{-6}/^{\circ}\text{C.}$ of the dental product (measured at the same temperature range).

50. The method of claim 47 wherein the glass-ceramic comprises in weight percent:

about 62 to about 85% SiO_2 ;

about 1.5 to about 10% Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 2.5 to about 7% K_2O ; and

about 0.5 to about 12% P_2O_5 .

51. A method of making a lithium disilicate dental restoration comprising:

melting a starting glass composition comprising in weight percent about 64 to about 70% SiO_2 ;

about 1.5 to about 6 Al_2O_3 ;

about 10 to about 15% Li_2O ;

about 2.5 to about 5% K_2O ; and

about 2 to about 7% P_2O_5 ; at temperatures within the range of about 1200° to about 1600° C.;

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

52. A method of making a lithium disilicate dental restoration comprising:

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melting a starting glass composition comprising in weight percent about 62 to about 85% SiO₂;
 about 5.1 to about 10 Al₂O₃;
 about 8 to about 19% Li₂O; and
 about 0.5 to about 12% P₂O₅; at temperatures within the range of about 1200° to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;
 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.
 53. A method of making a lithium disilicate dental restoration comprising:
 melting a starting glass composition comprising in weight percent about 64 to about 70% SiO₂;
 about 5.2 to about 9 Al₂O₃;
 about 10 to about 15% Li₂O; and
 about 2 to about 7% P₂O₅; at temperatures within the range of about 1200° to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;
 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.
 54. A method of making a lithium disilicate dental restoration comprising:
 melting a starting glass composition comprising in weight percent
 about 64 to about 70% SiO₂;
 about 1.5 to about 6 Al₂O₃;
 about 10 to about 15% Li₂O;
 about 2 to about 7% P₂O₅;
 about 2.2 to about 5% K₂O;
 about 0.5 to about 3% Na₂O; and
 about 0.5 to about 3% B₂O₃; at temperatures within the range of about 1200° to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;
 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.
 55. A method of making a dental restoration comprising:
 melting a starting glass composition comprising in weight percent about 68.8% SiO₂;
 about 1.3% B₂O₃;
 about 4.8% Al₂O₃;
 about 1.0% CaO;
 about 2.8% BaO;

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about 14.4% Li₂O;
 about 2.2% K₂O;
 about 1.5% Na₂O; and
 about 3.3% P₂O₅; at temperatures within the range of about 1200° to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;
 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.
 56. A method of making a dental restoration comprising:
 melting a starting glass composition comprising in weight percent about 68.8% SiO₂;
 about 1.3% B₂O₃;
 about 4.8% Al₂O₃;
 about 1.0% CaO;
 about 2.8% BaO;
 about 14.4% Li₂O;
 about 2.2% K₂O;
 about 1.5% Na₂O; and
 about 3.3% P₂O₅; at temperatures within the range of about 1200° to about 1600° C.;
 quenching the glass melt;
 subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400 to about 1100° C. to convert the glass into a glass-ceramic;
 comminuting the glass ceramic to a powder;
 compacting the powder to a starting blank;
 sintering the blank; and
 pressing the blank into the dental restoration.
 57. A dental restoration comprising a glass-ceramic consisting essentially of:
 about 62 to about 85% SiO₂;
 about 1.5 to about 10% Al₂O₃;
 about 8 to about 19% Li₂O;
 about 2.5 to about 7% K₂O;
 about 0.5 to about 12% P₂O₅;
 up to about 4.9% B₂O₃;
 up to about 1.5% F;
 up to about 7% CaO;
 up to about 7% BaO;
 up to about 1% SrO;
 up to about 5% Cs₂O;
 up to about 5% Na₂O;
 up to about 2% TiO₂;
 up to about 3% ZrO₂;
 up to about 1% SnO₂;
 up to about 1% Sb₂O₃;
 up to about 3% Y₂O₃;
 up to about 1% CeO₂;
 up to about 1% Eu₂O₃;
 up to about 1% Tb₄O₇;
 up to about 2% Nb₂O₅; and
 up to about 2% Ta₂O₅.

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58. The dental restoration of claim 57 formed into a component selected from orthodontic appliances, bridges, space maintainers, tooth replacement appliances, splints, crowns, partial crowns, dentures, posts, teeth, jackets, inlays, onlays, facing, veneers, facets, implants, abutments, cylinders, and connector.

59. A blank for machining the dental restoration of claim 57.

60. A dental restoration comprising the glass-ceramic of claim 1.

61. A dental restoration comprising the glass-ceramic composition comprising:

about 64 to about 70% SiO_2 ;

about 5.2 to about 9 Al_2O_3 ;

about 10 to about 15% Li_2O ; and

about 2 to about 7% P_2O_5 .

62. A dental restoration comprising the glass-ceramic of claim 5.

63. A dental restoration comprising the glass-ceramic comprising:

about 62 to about 76% SiO_2 ;

about 1.5 to about 10 Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 0.3 to about 7% P_2O_5 ; and

about 0.5 to about 8% Ta_2O_5 .

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64. A dental restoration comprising the glass-ceramic of claim 14.

65. A dental restoration comprising the glass-ceramic of claim 11.

66. A method of making a dental restoration comprising: melting a starting glass composition comprising in weight percent about 62 to about 76% SiO_2 ;

about 1.5 to about 10 Al_2O_3 ;

about 8 to about 19% Li_2O ;

about 0.3 to about 7% P_2O_5 ; and

about 0.5 to about 8% Ta_2O_5 ; at temperatures within the range of about 1200° to about 1600° C.;

quenching the glass melt;

subjecting the quenched glass to one or more heat treatments in the temperature range of from about 400° to about 1100° C. to convert the glass into a glass-ceramic;

comminuting the glass ceramic to a powder;

compacting the powder to a starting blank;

sintering the blank; and

pressing the blank into the dental restoration.

* * * * *

PATENT APPLICATION FEE DETERMINATION RECORD

Effective November 10, 1998

Application or Docket Number

09458919

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
FOR	NUMBER FILED	NUMBER EXTRA
BASIC FEE		
TOTAL CLAIMS	77 minus 20 = *	57
INDEPENDENT CLAIMS	18 minus 3 = *	15
MULTIPLE DEPENDENT CLAIM PRESENT		

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

	(Column 1)	(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus **	=
Independent	*	Minus ***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			

	(Column 1)	(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus **	=
Independent	*	Minus ***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			

	(Column 1)	(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus **	=
Independent	*	Minus ***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SMALL ENTITY TYPE ☒ OR

OTHER THAN SMALL ENTITY

RATE	FEE
	380.00
X\$ 9=	513
X39=	585
+130=	
TOTAL	1478

RATE	FEE
	760.00
X\$18=	
X78=	
+260=	
TOTAL	

SMALL ENTITY OR

OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE
X\$ 9=	
X39=	
+130=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X78=	
+260=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$ 9=	
X39=	
+130=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X78=	
+260=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$ 9=	
X39=	
+130=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X78=	
+260=	
TOTAL ADDIT. FEE	

ISSUE SLIP STAPLE AREA (for additional cross references)

POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION	<i>[Handwritten initials]</i>	<i>70507</i>	<i>10/28</i>
O.I.P.E. CLASSIFIER	<i>[Handwritten initials]</i>	<i>70647</i>	<i>1-13-2005</i>
FORMALITY REVIEW			
RESPONSE FORMALITY REVIEW			

INDEX OF CLAIMS

☒ Rejected
☐ Allowed
☐ (Through numeral) Canceled
☐ Restricted
☐ Non-elected
☐ Interference
☐ Appeal
☐ Objected

Claim	Date
Final	
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5/21/05	
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Claim	Date
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10/2/04	
5/21/05	
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If more than 150 claims or 10 actions
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SEARCHED

Class	Sub.	Date	Exmr.
264	16 19	11/9/01	C
106	35		
501	5		
433	201.1 202.1 212.1		
UPDATE		5/31/01	0
UPDATE		10/24/01	0
UPDATE		3/11/02	0

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
501	5	5/31/01	2
264	16 19		
106	35		
433	201.1 202.1 212.1		
UPDATE		3/11/02	5

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	Date	Exmr.
WEST	11/9/01	0

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PATENT APPLICATION



09458919

jc525 U.S. PTO

09/458919



12/10/99

INITIALS

CONTENTS

	Date Received (Incl. C. of M.) or Date Mailed	Date Received (Incl. C. of M.) or Date Mailed
1. Application papers.		
2. <i>Unpatented Invention</i>	1/19/00	
3. <i>Dr. H. H. H. H. H.</i>	2/14/00	
4. <i>Dr. H. H. H. H. H.</i>	01/31/01	
5. <i>IDS</i>	4/24/01	
6. <i>Amat H</i>	4/24/01	
7. <i>Alkware</i>	5/31/01	
8. <i>Suppl Noa</i>	6/04/01	
9. <i>IDS</i>	8/23/01	
10. <i>IDS</i>	8/14/01	
11. <i>Pa</i>	8/14/01	
12. <i>FR</i>	9-21/01	
13. <i>Dr. H. H. H. H. H.</i>	10-25-01	
14. <i>EUU, cam 1312</i>	1-31-02	
15. <i>IDS</i>	1-31-02	
16. <i>Amat B</i>	1-31-02	
17. <i>Alkware</i>	3-13-02 AS	
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