

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FAVORED TECH CORPORATION,

Petitioner,

v.

P2I LTD.,

Patent Owner.

CASE: IPR2020-01198

Patent No. 10,421,876

**DECLARATION OF DR. KAREN GLEASON
IN SUPPORT OF PETITION FOR INTER PARTES REVIEW**

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I. INTRODUCTION

1. My name is Dr. Karen K. Gleason.

2. I have been engaged by Petitioner Favored Tech Corporation to investigate and opine on certain issues relating to U.S. Patent 10,421,876 (Ex. 1001), which I will refer to here as the '876 patent, in connection with Favored Tech's petition for *inter partes* review of the '876 patent.

3. In this declaration, I will first discuss the technical background relating to the '876 patent, and then I will provide my analyses and opinions relating to claims 1-15 of the '876 patent.

4. This declaration is based on the information currently available to me. To the extent that additional information becomes available, I reserve the right to continue my investigation and study, which may include reviewing documents and information that may be produced, as well as testimony from depositions that may be taken.

II. QUALIFICATIONS AND EXPERIENCE

A. Education and Professional Experience

5. Ex. 1003 is a copy of my curriculum vitae (CV), which provides listings of my educational background, professional experience, and scientific publications that are relevant to the subject matter of this proceeding. I possess the knowledge, skills, experience, training, and education to form an expert opinion and provide expert testimony in this matter.

6. I have 33 years of experience in the field of chemical engineering, with the last 24 years having a specific focus on polymer chemistry and production of polymer coatings.

Education

7. I received bachelor of science (S.B.) and master of science (S.M.) degrees in Chemical Engineering from the Massachusetts Institute of Technology (M.I.T.) in 1982. I also received All-American honors in swimming while a student at M.I.T. I received a Ph.D. in Chemical Engineering from the University of California, Berkeley, in 1987. My doctoral thesis identified the molecular structure of defects in thin films used in the fabrication of solar cells. These thin films were produced by Chemical Vapor Deposition (CVD).

Professional Career

8. I have been employed as a professor of chemical engineering at M.I.T. since 1987. I was an assistant professor from 1987-1993 and an associate professor from 1993-2000, and I have been a full professor from 2000 to the present. I held the Herman P. Meissner Career Development Professorship in Chemical Engineering from 1987-1990 and the Esther and Harold E. Edgerton Career Development Professorship from 1991-1995. From 2006 to January 2020, I was the Alexander and I. Michael Kasser Professor of Chemical Engineering. Since January 2020, I have assumed the title of Alexander and I. Michael Kasser Professor of Chemical

Engineering, Emerita.

9. I have served in additional roles at M.I.T. during my time as a professor. I was the Executive Officer (vice chair) of the Department of Chemical Engineering from 2001-2004, the Associate Director of the Institute for Soldier Nanotechnology from 2005-2008, the Associate Dean of Engineering for Research from 2008-2011, and the Associate Provost for Space Planning and Industrial Relationships from 2014-2018.

10. I am a member of the National Academy of Engineering and a fellow of the American Institute of Chemical Engineering.

11. I am also the co-founder and Chief Scientific Advisor for GVD Corporation, which was founded in 2001. GVD manufactures CVD polymer release coatings used in the molding of rubber tires for vehicles and for seal and gasket applications.

12. The focus of my work in the most recent 24 years of my professional career has been on elucidating the mechanisms of CVD polymer growth and inventing new methods of CVD polymerization. For this research, my laboratory has built more than a dozen custom CVD reactors. My group has published on both continuous wave and pulsed plasma polymerization, also known as plasma enhanced CVD (PECVD). The applications explored ranged from low dielectric constant layers for microelectric circuits to biopassive coatings for implantable medi-

cal devices. By adding an initiator species to the reactive gas inlet, the power required for plasma polymerization is greatly reduced, a method we named iPECVD. Recently, we demonstrated that thin iPECVD layers can serve as membranes for separating individual gases from a mixture of gases. By understanding the mechanisms of plasma polymerization, two new polymer CVD methods were developed: initiated CVD (iCVD) and oxidative CVD (oCVD). Neither method requires a plasma and thus allows complete fidelity in chemical structure between the inlet monomer and the resulting polymer thin film. Using iCVD and oCVD, over 100 different monomers have been polymerized. In 2018, oCVD achieved the record for the highest electrical conductivity (>6000 S/cm) of the polymer polyethylene dioxythiophene (PEDOT), a material of great interest for fabricating flexible electronic devices.

Scientific Publications

13. I have authored more than 300 scientific publications in the fields of chemical engineering and polymer chemistry. I am the sole editor of the book *CVD Polymers Fabrication of Organic Surfaces and Devices*, first published by Wiley in 2015. I am a named inventor of more than 35 issued U.S. patents. I have also spoken about my work at numerous scientific conferences and symposia. My accompanying CV includes listings of my publications, professional speaking engagements, and patents. Ex. 1003.

B. Compensation

14. I am being compensated for the services I am providing under my engagement with Favored Tech Corporation, including the preparation of this declaration. That compensation is not contingent upon my performance, the outcome of this *inter partes* review or any other proceeding, or any issues involved in or related to this *inter partes* review or any other proceeding.

C. Documents and other materials relied upon

15. In forming my opinions, I have relied on information and evidence identified in this declaration, including the '876 patent, its prosecution history, and other references listed as exhibits in Favored Tech's *inter partes* review petition.

III. STATEMENT OF LEGAL PRINCIPLES

A. Legal standards for obviousness

16. I understand that where a prior art reference does not disclose all of the elements of a given patent claim, that patent claim is invalid if the differences between the claimed subject matter and the prior art reference are such that the claimed subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the relevant art. Obviousness can be based on a single prior art reference or a combination of references that either expressly or inherently disclose all elements of the claimed invention.

17. I further understand that, in determining whether a patent claim was obvious, one can consider whether there would have been any teaching, suggestion

or motivation (“the TSM test”) to combine the teachings of two or more prior art references that, together, contain all of the elements of the patent claim. In other words, one can consider whether the combined prior art, taken as a whole, would have rendered the claimed invention obvious to one of ordinary skill in the art at the time of the invention. I further understand that to determine whether an invention would have been obvious at the time it was made, the Board will look to four factors: (1) the scope and content of the prior art; (2) the differences between the prior art and the claimed invention; (3) the level of skill in the pertinent art; and (4) any secondary considerations of non-obviousness.

18. I understand that secondary considerations that may indicate non-obviousness can include: (1) whether there was a long-felt need for the claimed invention; (2) whether the claimed invention has achieved commercial success; (3) whether there was copying of the claimed invention by others; (4) whether there were failed attempts by others to make the claimed invention; (5) whether there was praise of the claimed invention in the field; and (6) whether there was skepticism in the field whether the claimed invention could be achieved. For secondary considerations to be accorded substantial weight, I understand that there must be a nexus between the secondary considerations and the claimed invention. For example, if a secondary consideration results from something other than what is claimed and novel, then there is no nexus. In addition, I understand that another potential

factor of that can suggest that a claimed invention *was* obviousness is the independent simultaneous invention by others.

19. To determine whether there was motivation to modify or combine prior art references to obtain the claimed invention, I am informed that such motivation may come from the nature of the problem to be solved, which would lead inventors to look to certain references for possible solutions to that problem. In other words, the test may be said to be whether a person of ordinary skill in the art would have reasonably expected to use the solution that is claimed in the patent, if the person were seeking to solve the problem addressed by the patent and that person had the prior art before them at the time. Motivation to modify references may be found in the references themselves, as well as in the general knowledge of persons skilled in the art.

20. I also understand that the TSM test is not necessarily required, and a claim can be determined obvious if the claimed combination would have resulted from common sense, would have been obvious to try (such as being one of a relatively small number of possible approaches to the problem that would have been reasonably expected to succeed), or would have been the predictable result of using prior art elements according to their known functions. I also understand that obviousness can take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

B. Claim construction

21. I understand from counsel that a claim term in an unexpired patent must be given its ordinary meaning as understood by a person of ordinary skill in the art in the same field as the patent when considered in context of the patent's claims, specification, and prosecution history. I also understand that when interpreting a term's meaning, one should consider what the inventor actually invented and intended to be covered by the claim in which the term appears. When determining a claim term's meaning, one should also consider the patent's specification and the prosecution history. In some cases, the inventor may use terms in a manner other than in their ordinary meaning by clearly, deliberately, and precisely stating that special definition in the patent specification or in the file history. I further understand that, under the legal principle of claim differentiation, two different claims in the same patent (and in particular, an independent claim and one of its dependent claims) should not be interpreted in a way that would render them identical in scope, if that result can be avoided

IV. LEVEL OF ORDINARY SKILL IN THE ART

22. I understand from counsel that the claims and specification of a patent must be read and construed through the eyes of a person of ordinary skill in the art (POSA) at the time of the patent's priority date. To determine the appropriate qualifications of a POSA, I understand that the following factors may be considered:

(a) the types of problems encountered by those working in the field and prior art solutions to such problems; (b) the sophistication of the technology in question; and (c) the typical level of training for active workers in the field.

23. I understand from counsel that I should assume for purposes of my analysis that the priority date for the '876 patent was June 9, 2015.

24. The '876 patent describes protective coatings applied to a variety of electronic devices and electronic components. Ex. 1001 at 1:5-13, 14:30-58. The patent indicates that the coatings can repel liquids such as water or can provide an electrically insulating barrier layer. Ex. 1001 at 1:8-13, 2:56-3:11.

25. The coatings are applied using plasma polymerization with a plasma containing two main components: a monomer and a crosslinker. Ex. 1001 at Abstract, 2:10-20, 2:49-55, 4:36-13:8. For the monomer, the '876 patent identifies perfluoroalkyl acrylates or perfluoroalkyl methacrylates as preferred substances. Ex. 1001 at 11:27-56, 21:7-22:21. By 2015, those monomers had been used to create hydrophobic coatings through plasma polymerization for many years, as the '876 patent acknowledges. Ex. 1001 at 1:17-19 (citing Ex. 1022, published in 1998).

26. According to the specification, combining the monomer with a crosslinker produces crosslinked co-polymer coatings that retain the monomer structure for good hydrophobicity while providing stability due to the crosslinked structure

of the coatings. Ex. 1001 at 2:49-60, 14:18-29. At the time of the '876 patent's priority date in June 2015, POSAs were familiar with the use of crosslinking reagents in polymer coatings, including coatings applied through plasma polymerization and including many of the same preferred crosslinkers in the '876 patent. Ex. 1005 4:1-9, 4:26-29, Ex. 1006 at 3:51-62, Ex. 1009 at 610, Ex. 1023 at 8724, Ex. 1026 at 6553; Ex. 1001 at 8:3-11 (most preferred crosslinkers).

27. As the '876 patent indicates, plasma polymerization was well known to POSAs by June 2015, and POSAs could perform plasma deposition using existing equipment and routine methods and would have known how to adjust plasma composition and reaction conditions to achieve desired properties in the polymer coating. Ex. 1001 at 13:61-67, 14:18-28, 14:59-67, 15:6-8. None of the coating techniques described in the '876 patent would have required advanced technical knowledge or expertise to implement.

28. A worker in the relevant field with an ordinary level of skill at the '876 patent's priority date would have required familiarity with technical principles relating to polymer chemistry and plasma generation and would have needed at least some experience operating and adjusting the operating conditions for a plasma polymerization chamber. In my experience, such workers in the field with an ordinary level of skill at the time typically had at least a bachelor's degree in a relevant discipline and some experience with plasma polymerization.

29. Based on the considerations discussed above, it is my opinion that a POSA at the time of the priority date for the '876 patent would have had at least a bachelor's degree in a field such as chemistry, physics, or chemical engineering, as well as at least two years of experience with plasma-polymerization techniques.

V. SUMMARY OF OPINIONS

30. For the reasons explained below, it is my opinion that the claims of the '876 patent would have been obvious to a POSA by June 2015. Plasma polymerization was well known by that time, as was its use for applying protective coatings to electronics. The monomers recited in the claims were known by that priority date, as the specification of the '876 patent acknowledges, the claimed crosslinking reagents were also known in the polymer field, and the prior art had already specifically suggested combining those known monomers with the same broad class of known crosslinkers to devise protective coatings with improved durability. There was nothing innovative about implementing that suggestion and combining known compounds by a known method to apply protective coatings to electronic devices that had long been targets of such treatments. I therefore conclude that the claims would have been obvious to a POSA over the prior art discussed here.

VI. TECHNICAL BACKGROUND

31. I understand that I should assume the '876 patent has a priority date of

June 9, 2015. The discussion in this section summarizes the relevant technology and the state of the art by June 2015.

A. Plasma polymerization

32. In general, a polymer is a collection of repeating structural units and is produced from small-molecule reactants, referred to as monomers, which are linked together to form extended chains or networks. By 2015, plasma polymerization was a common technique for generating polymers that had been widely used to deposit thin-film coatings on various substrates for many years. Ex. 1004 at 2:33-3:18; Ex. 1005 at 2:10-20; Ex. 1034 at 1-2. Plasma polymerization involves forming polymeric materials under plasma, which is a gas in an at least partially ionized state that contains charged molecules or atoms and free electrons. Ex. 1034 at 19.

33. In general, plasma polymerization involves vaporizing at least one monomer compound that supplies the input material to be polymerized. Ex. 1004 at 2:33-3:18. A wide variety of organic compounds have been utilized as monomers used for plasma polymerization. Ex. 1034 at 2-3.

34. The plasma state can be induced in a gas containing monomer vapor through various means, but applying an electromagnetic field was the simplest and most commonly used approach. Ex. 1004 at 3:2-5; Ex. 1005 at 2:14-20; Ex. 1019 at 20:32; Ex. 1014 at 21:20-22:2; Ex. 1034 at 19. The optical excited species in the

plasma often gives off visible light emanating from at least a portion of the resulting plasma—often referred to in the field as a “glow discharge.” Ex. 1004 at 7:14-17; Ex. 1005 at 10:17-18; Ex. 1019 at 2032; Ex. 1034 at 19-20. One example of a glow discharge occurs upon illuminating a common neon sign, which applies an electromagnetic field to a gas-filled chamber within such signs to create their familiar luminous appearance.

35. When applying an electromagnetic field to a gas to generate plasma, the electrical power was commonly applied in one of two ways: continuously (known as “continuous wave” plasma generation) or in rapid on/off cycles (known as “pulsed” plasma generation). Ex. 1019 at 2032-33 (Table 2). Pulsed plasma had recognized advantages for many coating applications because it permits application of sufficient electrical power to generate and maintain plasma but subjects the gas-phase monomer to that power for only part of the total polymerization time, thus resulting in less applied power and better preserving functional groups (such as hydrophobic perfluorocarbon pendant chains) from the original monomer structure against fragmentation or other structure rearrangement in the resulting plasma polymer coating. Ex. 1019 at 2035-36; Ex. 1023 at 8724. Better preservation of the monomer’s functional groups generally leads to better preserved functional properties in the resulting plasma polymer coatings.

36. When a plasma generated from a gas-phase monomer comes in con-

tact with a substrate, the species in the plasma impinge on the substrate surface and react to form a polymer film that is deposited as a coating on the substrate. The plasma polymerization process creates complex branched and crosslinked molecular chains due to partial fragmentation of the original monomer molecule. That resulting structural complexity distinguishes plasma polymerization from molecular polymerization techniques in which monomer molecules combine through chemical reactions to form relatively uniform chains or networks of repeating monomer units.

37. During plasma polymerization, it was very common to supply the gas-phase monomer for plasma polymerization in a mixture with an additional carrier gas, often an inert gas like helium or argon. Ex. 1004 at 7:19-23; Ex. 1021 ¶ 63; Ex. 1022 5:20-22.

38. Plasma polymerization is traditionally carried out in enclosed chambers to contain the gaseous reagents and the associated plasma during operation. Plasma chambers vary widely in size and configuration. Most were designed to be evacuated and maintained at low pressure during operation. At low pressures, the plasma can be made uniform over large substrate areas.

B. Monomer reagents for plasma polymerization

39. Monomers for plasma polymerization often contained unsaturated reactive groups, such as a vinyl group or an acrylic group, useful for forming bonds

with other molecules. Ex. 1004 at 3:20-4:3; Ex. 1005 at 7:4-32; Ex. 1014 at 16:7-19; Ex. 1022 3:14-25, 7:21-27; Ex. 1034 at 81. The monomer for a given application was typically selected based on desired polymer properties. For example, it was well known that perfluorinated carbon chains confer strong hydrophobicity, so plasma polymerization processes intended to form water-repellent polymers commonly used monomer compounds containing a perfluorinated pendant functional chain. Ex. 1004 at 12:5-22; Ex. 1005 at 9:1-16, 8:4-10; Ex. 1019 at 2032; Ex. 1022 5:3-6, 16:19-19:2.

40. Subjecting a monomer vapor to a plasma produces a mixture of reactive species that can result in polymer film formation on a surface. The plasma polymer film tends to have a more complex chemical structure than the repeating monomeric units resulting from conventional polymer synthesis. Ex. 1005 at 2:14-24; Ex. 1023 at 8724. However, some plasma conditions, such as pulsed excitation, favor the identical reaction pathways present in conventional polymerization. Ex. 1019 at 2032.

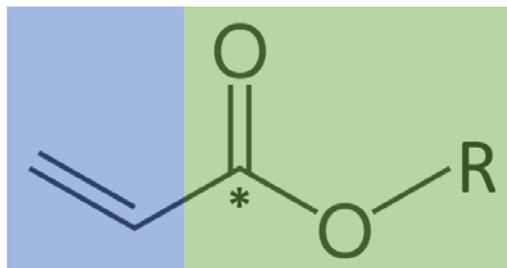
41. Plasma conditions are desired which allow a fraction of the monomers to remain intact, while the remaining fraction of the monomers decompose to form other species, including free radicals. Free radical species can combine with intact monomers to promote the conventional free radical polymerization pathway, provided the monomers contain a carbon-carbon double bond. The free radical forms a

bond to the monomer through one of the carbons of the double bond. The product is a single species where 1) the double bond is replaced by a single bond and 2) the other carbon of the former double bond becomes a free radical site, where this carbon participates in three covalent chemical bonds and retains one unpaired electron. The free radical product can react with another monomer to increase the chain length of the polymer and produce another free radical, a process known as free-radical propagation. The propagation can repeat tens or hundreds of times before another type of reaction terminates the chain growth. By 2015, monomers used for plasma polymerization frequently contained at least one double bond to take advantage of that propagation mechanism. Free radical polymerization is desirable because the resulting polymers retain the chemical functional groups present in the monomer. Ex. 1023 at 8724. The functional groups incorporated in the polymers determine the film properties.

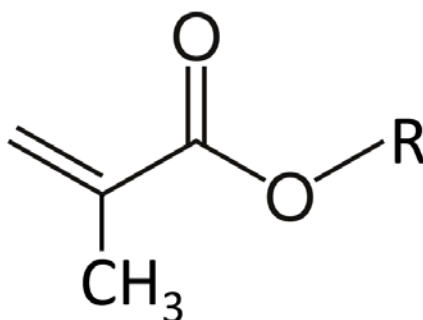
42. The plasma polymerization of acrylate monomers having different functional groups has been systematically explored and the highest average deposition rates were reported for acrylate monomers with fluorine-containing functional groups. Ex. 1035 at 26-32 and Tables 1, 2.

43. Fluorinated acrylate and methacrylate were very well-known monomers for polymer production and commonly used in plasma polymerization by 2015. Ex. 1029; Ex. 1004 12:7-22; Ex. 1005 9:10-16; Ex. 1014 11:14-12:3; Ex.

1035 at 26-33. Most acrylate monomers were esters with a vinyl group (containing a carbon-carbon double bond) linked to an ester group:



The blue shading above indicates the vinyl group, and the green shading indicates the ester group. The vinyl group is connected by a bond to the carbonyl carbon (indicated above by a star) of the ester group, and the ester group can include a variety of functional groups, indicated by an R. The structure above shows a generic acrylate monomer. In a methacrylate, the carbon-carbon double bond has an added methyl (CH₃) substituent, as shown below.



44. Fluorinated acrylates and methacrylates have been commonly used as monomers for polymer production because their reactivity allows for convenient and cost-effective polymer synthesis and because the presence of fluorinated groups provide many desirable properties. Ex. 1005 at 1:16-23; Ex. 1019 at 2032;

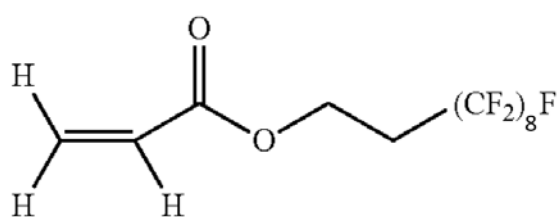
Ex. 1022 at 9:13-20; Ex. 1029 at Abstract. The acrylate and methacrylate bonding configurations of these monomers allow for rapid polymerization. Ex. 1035 at 26-33. The designation “alpha carbon” is given to the carbon atom in the double bond directly attached to the ester group. The electron density on the alpha carbon is pulled away by electronegative ester group. The reactivity of the double bond increases as the alpha carbon becomes electron poor. Electronegative functional groups, R, on the ester, can further deplete the electron density on the alpha carbon and thus enhance the reactivity of the carbon-carbon double bond. An example of an electronegative functional group is a perfluorocarbon carbon chain, such as C₈. The chemical structure of a C₈ pendent group which contains eight perfluorinated carbon atoms is shown below:



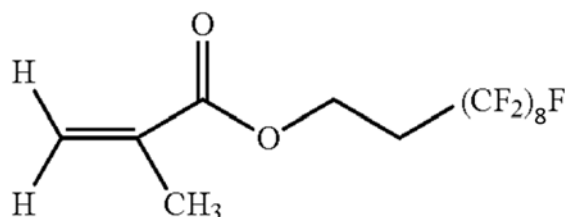
The C₈ perfluorinated chain was known to be advantageous for use in liquid-repellent coatings. Ex. 1004 at 12; Ex. 1026 at 6548-6654. Fluoropolymers like those made using fluorinated acrylates and methacrylates have many desirable properties. Ex. 1029 at 6197. For example, the low surface energy of fluoropolymers makes them difficult to wet with water and other liquids. Ex. 1029 at 6204. Fluorinated polymers, including those incorporating a fluoroalkyl chain, are known to be water repellent. Ex. 1029 at 6206. Fluorinated acrylates and methacrylates were known to have low surface energy, good thermal stability, and good chemical

resistance. Ex. 1029 at Abstract. Also, C-F bonds are strong (131 kcal/mol) relative to C-H bonds (99 kcal/mol), making fluoropolymers more thermal stable than hydrocarbon polymers. Ex. 1029 at 6204, 6209. Fluoropolymers were also known to form electrically insulating layers with low dielectric constants. Ex. 1026 at 6548.

45. Two fluorinated monomers that were routinely used for producing plasma-polymer coatings by 2015 were 1H,1H,2H,2H-perfluorodecyl acrylate (PFAC8) (CAS No. 27905-45-9; also known as 1H,1H,2H,2H heptadecafluorodecyl acrylate) and 1H,1H,2H,2H-perfluorodecyl methacrylate (PFMAC8) (CAS No. 1996-88-9). Those monomers had been used to apply protective coatings to various surfaces, including electronics. Ex. 1004 at 12:7-22, 14:7-23; Ex. 1005 at 8:15-9:27, Ex. 1014 at 16:16-27; Ex. 1019 at 2032; Ex. 1016 7:49-67; Ex. 2021 at ¶ 28; Ex. 1022 at 6:1-7:31, 16:19-17:3. The structures of PFAC8 and PFMAC8 are shown below.



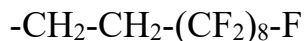
PFAC8



PFMAC8

Both monomers contain the same C₈ perfluorocarbon pendant functional group. In PFAC8 and PFMAC8, the perfluorinated C₈ group is attached to the carbonyl carbon of the ester group by a methylene bridge (-CH₂-CH₂-). The resulting pendant

group is formally designated as 1H,1H,2H,2H-perfluorodecyl as shown below:



46. As I noted above, PFAC8 and PFMAC8 both contain methylene bridge separating the fluorinated group from the oxygen atoms within those molecules. In the cases of PFAC8 and PFMAC8, the methylene bridge is a C2 alkylene (CH_2-CH_2). Fluorinated compounds containing such alkylene spacers of approximately C1-C10 in length were prevalent in the field by 2015. Ex. 1005 at 8:26-28; Ex. 1004 at 11:26-28; Ex. 1012 at 2:13-3:14; Ex. 1014 at 16:16-17:4; Ex. 1038 at Abstract. Such alkylene spacers were used to avoid positioning fluorocarbon chains and oxygen-bearing groups adjacent to one another because, as a POSA would have known, fluorocarbon chains and oxygen-bearing groups tend to be reactive, and as a result placing such groups adjacent to one another tends to compromise the stability of the reagent. Ex. 1038 at Abstract, [0005-06].

47. The normal boiling point (boiling point at standard atmospheric pressure of 1 atm) for PFAC8 is approximately 267°C, and for PFMAC8 is approximately 300°C (verified on chemspider.com using the CAS numbers noted above) (Ex. 1039 at 11-14). A POSA would have known or been able to determine those standard boiling points by consulting common reference materials or using basic experimental methods such as measuring the temperature of a boiling sample of the reagent at standard pressure.

48. Their properties motivate the use of fluoropolymers as protective coatings in a variety of applications. Fluoropolymer coatings are widely utilized in the manufacture of liquid-repellent textiles. Ex. 1022 at 26-27. For the protection of clothing and footwear, fluoropolymer coatings the preferred monomers include both the fluoroacrylate PFAC8 and the fluoromethacrylate PFMAC8. Ex. 1021 at [0028]. Fluorinated polymers are known as moisture-resistant coatings for electronic components assembled on a circuit board. Ex. 1013 at [0045]. Fluorine-containing plasma polymers are also valued for the protection of electrical components and devices, including for biomedical applications such as hearing aids. Ex. 1015 at [0030], claim 6. Plasma-polymerization from fluorine-containing acrylate and methacrylate monomers is also preferred for protecting electronic components from corrosion and exposure to liquids. Ex. 1004 at 12:7-14:23; Ex. 1014 at 11:20-12:25; Ex. 1012 at 10:13-11:16. Such protection is of particular value for the printed circuit board and SIM-cards of mobile electronic devices, including smartphones. Ex. 1014 at 1:2-12, 4:22-5:9, 10:14-12:25.

C. Crosslinking and crosslinking reagents

49. Crosslinking refers to connecting linear polymer chains by chemical bonds to form a network. Ex. 1008 at [0011]. Crosslinking is a long-standing and widely-adopted means to optimize polymer properties for a specific application. For example, crosslinking provides improved mechanical, electrical, and chemical

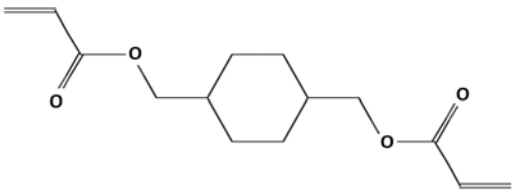
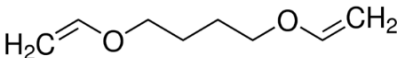
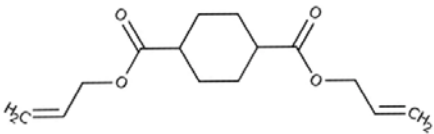
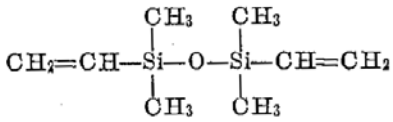
properties in polymer coatings used in the protection of electrical conductors and connectors. Ex. 1007 at 2:42-46; Ex. 1008 at [0002]. In plasma polymerization, it was well known that the amount of crosslinking could be controlled by co-polymerizing the monomer with varying amounts of a crosslinking reagent. Ex. 1024 at 10:2-7.

50. Plasma methods using crosslinkers have been reported for the synthesis of crosslinked polymer networks in the form of a thin film coating. Ex. 1005 at 4:4-9; Ex. 1008 at [0011], [0052-54]; Ex. 1009 at 607; Ex. 1023 at 8726. Crosslinking reduces the solubility of polymers in water and other liquids, thus enhances the stability of crosslinked polymer films. Ex. 1008 at [0011]; Ex. 1025 at [0034]. Many linear polymers form semi-crystalline films in which the grain boundaries between crystallites are pathways for the diffusion of small molecules such as water. Crosslinking tends to make polymer films amorphous. Ex. 1008 at [0039]; Ex. 1026 at 6551. Amorphous films lack grain boundary defects, thus improving the ability of amorphous films to act a protective barrier against moisture, oxygen, and other types of vapors and liquids. The lack of defects also makes amorphous crosslinked coatings resistant against aging and more reproducible to manufacture because when random defects appear, manufacturing yield decreases. Crosslinking can dramatically reduce the surface roughness of fluoropolymer films vapor-deposited from the PFAC8 monomer. Ex. 1026 at 6550-51. The degree of cross-

linking also controls the mechanical properties and wetting behavior of polymer films vapor deposited from PFAC8. Ex. 1026 at 6552-53. For example, crosslinking of PFAC8-based coatings was known to improve surface wetting properties by reducing contact angle hysteresis. Ex. 1026 at 6552-53. Films comprised of linear fluoroacrylate homopolymers thus were known to display excellent water repellency but could lack other characteristics desired for protective applications, such as durability and barrier performance. In contrast, crosslinked fluoroacrylate plasma polymers were known to simultaneously provide durability with water repellency. Ex. 1005 4:1-9, 4:17-5:5.

51. The formation of a crosslinked network is usually achieved using crosslinking molecules or groups. Ex. 1008 at [0011]. Cross-linked plasma polymer coatings form by using at least one organic monomer which containing two double bonds. Ex. 1005 at 4:4-5:5. The general formula for chemical structure of a cross-linking monomer as described in the prior art contains independent selection of the bridging group between the two carbon-carbon double bonds and the six substituent groups attached to the double bonded carbon groups. Ex. 1005 at 4:31-5:5. Examples included a multitude of diallylic, divinyl, divinyl ether, and polyacrylate compounds. Ex. 1007 at 3:22-4:2. I have illustrated those classes of crosslinkers below, showing the generic configuration of the two double bonds characterizing each class as well as a specific example showing an exemplary bridging

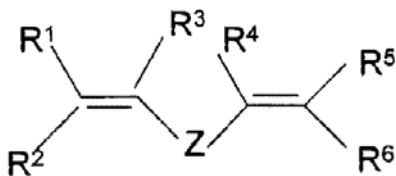
group Z for each type.

<i>Diacrylate</i>	
configuration	$\text{CH}_2=\text{CH}-(\text{C}=\text{O})-\text{O}-\text{Z}-\text{O}-(\text{C}=\text{O})-\text{CH}=\text{CH}_2$
example	 <p>cyclohexane-1,4-dimethanol diacrylate (CDMDA)</p>
<i>Divinyl ether</i>	
configuration	$\text{CH}_2=\text{CH}-\text{O}-\text{Z}-\text{O}-\text{CH}=\text{CH}_2$
example	 <p>1,4-butanediol divinyl ether (BDVE)</p>
<i>Diallyl</i>	
configuration	$\text{CH}_2=\text{CH}-\text{CH}_2-\text{Z}-\text{CH}_2-\text{CH}=\text{CH}_2$
example	 <p>diallyl 1,4-cyclohexanedicarboxylate (DCHD)</p>
<i>Divinyl</i>	
configuration	$\text{CH}_2=\text{CH}-\text{X}-\text{Z}-\text{X}-\text{CH}=\text{CH}_2$ <i>**X is not O, O-(C=O), or CH2</i>
example	 <p>divinyl tetramethyl disiloxane (DVTMDS)</p>

52. Many examples from those various classes of crosslinkers had been used in combination with acrylate monomers to produce crosslinked polymer coat-

ings. Ex. 1006 at 1:15-30, 3:50-65; Ex. 1007 at 3:20-60, Ex. 1008 at ¶¶ 11, 52-54, Ex. 1009 at 607; Ex. 1011 at 3:1-4:39; Ex. 1025 at ¶¶ 11, 20; Ex. 1029 at 6197-98.

53. Plasma polymerization is characterized by its use of plasma ignition to initiate its polymerization reactions. Once activated, plasma polymerization was known to proceed at least in part according to reaction pathways similar to those that occur following conventional activation techniques (like free-radical, solution-phase, or heat-based polymerization). Ex. 1034 at 81. POSAs therefore understood and expected that the same types of crosslinking reagents used for conventional polymerization would also work in plasma polymerization reactions. For example, Badyal taught that crosslinkers for its plasma-based techniques could be any known in the entire “polymer art,” without limiting consideration to reagents specific for plasma or any other type of polymerization. Ex. 1005 at 4:18-19. As another example, the use of ethylene glycol dimethacrylate (EGDMA) in plasma polymerization was motivated by the use of EGDMA as a crosslinking agent in conventional solution polymer synthesis. Ex. 1023 at 8725; Ex. 1029 at 6206; see also Ex. 1005 at 6:25-20 (Formula A) (describing the analogous non-methylated diacrylate ethylene glycol diacrylate (EGDA) as an exemplary crosslinking reagent for plasma polymerization). Thus, as with conventional polymerization, crosslinking agents used for plasma polymerization often were also molecules containing two or more carbon-carbon double bonds, generally depicted as



Ex. 1005 4:1-5:5. That known generic crosslinker structure encompassed diacrylate, divinyl ether, diallyl, and divinyl crosslinkers.

54. For plasma co-polymerization, both the monomer and the crosslinker must enter the vacuum reaction chamber as vapors. Ex. 1012 at 9:17-10:12. At laboratory conditions, both reactants are typically liquids. By applying heat to the vessels containing each pure liquid, two inlet vapor flows are produced. Liquids with a high boiling point will require more heating to reach a given vapor pressure than low boiling point liquids. Before entering the chamber, each type of vapor goes through a conventional delivery system that was well known in the prior art and made up of control valves and tubing. Ex. 1001 at 13:61-67; Ex. 1009 at 606 (Scheme 2); Ex. 1004 at 7:6-12, 9:4-9; Ex. 1012 at 11:17-12:11; Ex. 1014 at 25:14-22; Ex. 1025 at [0053-55], [0060-70].

55. For both reactants to flow into the chamber, the pressure developed in each delivery system must exceed the pressure in the chamber. Thus, both the monomer and the crosslinker must be heated sufficiently to achieve a vapor pressure greater than that of the pressure in the growth chamber. Reactants with higher normal boiling points are less volatile and require more heating to achieve a vapor

pressure sufficient to introduce into a vacuum chamber, so POSAs knew that reactants with lower boiling points were generally easier to vaporize and deliver to a plasma chamber. In general, molecules of higher molecular weight tend to have higher normal boiling points.

D. Applications for plasma polymerization

56. Plasma polymerization had been quite widely employed for coating a range of surfaces by 2015. Ex. 1005 at 2:10-12, 10:8-12, 11:26-27; Ex. 1004 at 6:25-7:12; Ex. 1012 at 8:22-10:12; Ex. 1016 at 1:40-50; Ex. 1017 at 3:26-40; Ex. 1027 at 1:20-41. Plasma polymerization has been used to apply thin-film coatings utilized in the fabrication of semiconductor devices such as integrated circuits. Ex. 1017 at Abstract; Ex. 1024 at Abstract. Lipid-repellent and protein-repellant plasma coatings, including crosslinked plasma coatings, have a wide range of applications including cosmetics packaging, modification of laboratory vessels, and biopassivation of implantable medical devices, such as stents, catheter, and pacemakers. Ex. 1025 [0002], [0006], [0015], [0036], [0038]; Ex. 1009 at Abstract. Plasma polymer coatings were also preferred for the protection of electronic and electrical components and devices from damage by the environment. Plasma polymers were utilized in applications that require a barrier against attack from moisture and oxygen, thus avoiding detrimental effects such as corrosion. Ex. 1008. At [0011], [0021-24]; Ex. 1013 [0046], Ex. 1014 at Abstract, 16:7-27, 32:14-33:3. For

example, water resistant plasma polymer coatings were used for preventing corrosion in electronic medical devices such as hearing aids. Ex. 1015 [0002], [0011], [0029-35]

57. POSAs in 2015 also knew that functionalizing solid surfaces with plasma fluoropolymers provided excellent repellency against liquids. Ex. 1019 at 2038. Plasma fluoropolymer coatings which resist wetting by water and oils were pursued for preserving solid surfaces including metals, ceramics, glass, paper, and plastics and for the surface modification of cloth. Ex. 1005 at 1:8-12. Plasma-modified fabrics can be waterproof and soil-resistant, making them desirable in the production of clothing such as outerwear, sports jerseys, and military uniforms. Ex. 1005 at 1:14-19. Plasma fluoropolymers with durable water repellency and soil-resistance are also desirable other outdoor products and components manufactured from fabrics and leather, such as footwear, umbrellas, tents, sleeping bags, and awnings. Ex. 1021 at [0001-12]. The plasma coating method is capable of coating the substrate surface without infilling the spaces the between surface features. Thus, the coated substrates can still retain openings for the passage of air. Crosslinking of the plasma fluoropolymers was known to be desired for durability of the coating against wear. Ex. 1005 at 4:25-29.

58. Liquid-resistant plasma coatings based on fluorinated monomers like PFAC8, PFMAC8, and other structurally similar compounds were by 2015 well

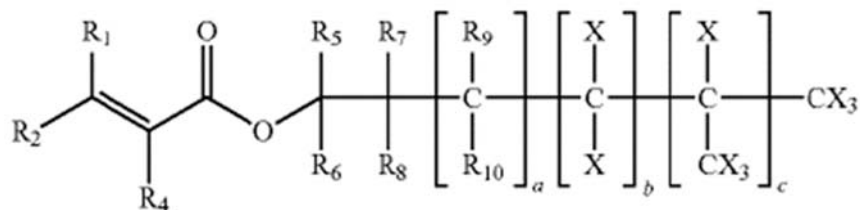
known and commonly used to protect against irreversible damage that can result from the exposure of electrical circuits to liquids, such as water. Ex. 1004 at 1:1-34, 12:7-14:23; Ex. 1014 at 16:11-27; Ex. 1029 at 6197-98. Rain has the potential to damage electronics which are located outdoors, such as lighting, antennas, and communication equipment. Accidental spillage and plumbing leaks can threaten indoor electronics, such as computers and instrumentation. Portable electronics are used both indoor and out and their small size makes them prone to accidental immersion. Mobile devices such as laptops, mobile phones, radios, cameras, and hearing aids have many different electronic components including printed circuit boards (PCBs), batteries, microphones, SIM-cards, wires, connectors, lenses, touchscreens, and external buttons that can be protected using plasma fluoropolymer coatings. Ex. 1004 at 4:17-5:6, 6:19-23; Ex. 1014 at 1:9-12, 10:14-12:25.

VII. SUMMARY OF THE '876 PATENT

59. The '876 patent (Ex. 1001) is titled "Coatings." The patent discusses crosslinked plasma polymer coatings applied to electronic devices. According to the '876 patent, the coatings can be water repellent or can form a barrier to protect the underlying electronics from damage. Ex. 1001 at 1:5-13. Most of the information provided in the patent pertains to the compounds used as monomers and crosslinkers to prepare the coatings.

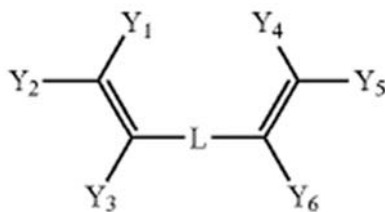
60. The patent describes monomers having a double bond. Ex. 1009 at

9:23-35. For producing “particularly preferred” types of coatings, the monomer has the following generic structure (identified as Formula I(a)):

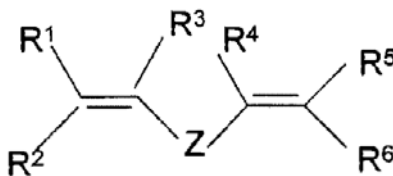


Ex. 1001 at 10:22-40 and claim 1. As a POSA would have recognized from the structure provided in the patent, that preferred monomer is an acrylate, with a vinyl group, and ester group, and an optionally halogenated functional group. A POSA also would have recognized that PFAC8 and PFMAC8 were known monomers, used for plasma deposition of protective coatings onto substrates including electronics, that fell within Formula I(a). Ex. 1004 at 12:5-22; Ex. 1005 at 7:17-9:19; Ex. 1014 at 16:11-25; see also Ex. 1001 at 1:15-20, 11:27-56, claims 12-15 (recognizing that the monomers used in the '876 patent were previously known for use in plasma polymers and describing PFAC8 and PFMAC8 as preferred).

61. For a crosslinking reagent used in the coatings, the patent states that a basic requirement the presence of two or more unsaturated bonds. Ex. 1001 at 4:36-40. The following generic crosslinker structure for a crosslinker with two double bonds joined by a bridging group (“linker moiety L”) is pointed out as a preferable form for the crosslinker:

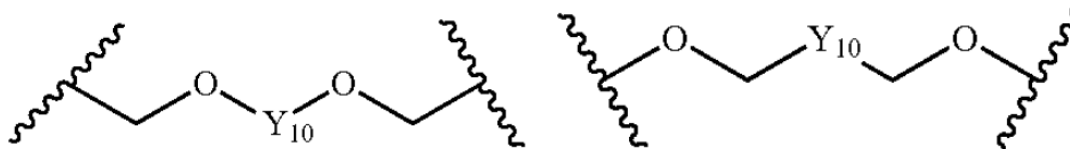


Ex. 1001 at 4:51-67, claim 1. The patent states that the identity of the bridging group is “not especially limited,” which would have indicated to a POSA that a variety of crosslinkers having different bridging-group structures between the double bonds could be used. Ex. 1001 at 4:40-45. As a POSA would have known, the same crosslinker structure had previously been described as suitable for use with acrylate monomers including PFAC8 and PFMAC8:

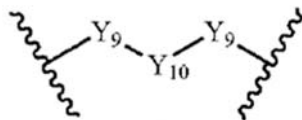


Ex. 1005 at 4:1-5:5.

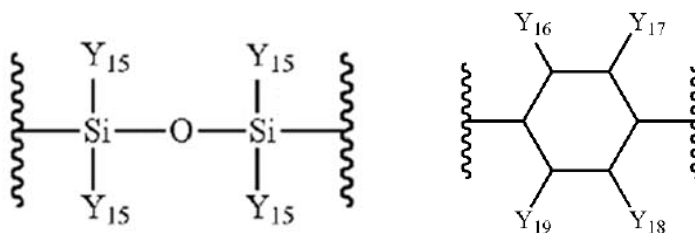
62. The '876 patent describes a large genus of crosslinkers with numerous options for the bridging group. Ex. 1001 at 5:1-8:18. Claim 1 specifies four different generic structures that can be used for the bridging group, divided into Formula A and Formula B. Claim 1 refers to the first two generic structures as Formula A:



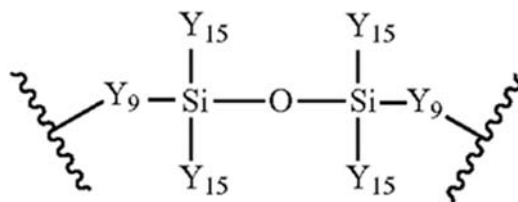
Ex. 1001 at 19:9-19. Formula B has the following generic structure:



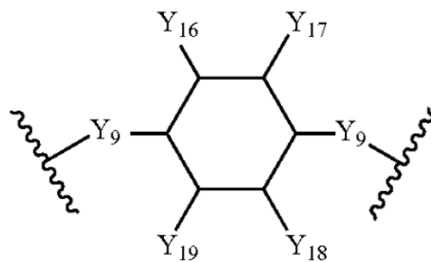
Ex. 1001 at 19:20-33. Under Formula B, claim 1 further specifies two alternative structures for substituent Y₁₀ in Formula B



Ex. 1001 at 19:33-57. I have prepared figures showing what those Y₁₀ structures would look like when incorporated into Formula B, yielding the two alternative Formula B structures under claim 1 that I will refer to as Formula B1



and Formula B2



See Ex. 1001 at 19:20-57.

63. A POSA would have recognized that crosslinkers with one of the two Formula A or two Formula B bridging group structures from claim 1 could include many different diacrylate, divinyl ether, diallyl, or divinyl crosslinkers. For example, Table 1 in the specification includes several examples such as DVTMDS (divinyl), BDVE (divinyl ether), DCHD (diallyl). Ex. 1001 at 8:20-67 (Table 1). In addition, the specification also highlights acrylate crosslinker structures as preferable. Ex. 1001 at 6:4-29 (structures (viii) and (x)), claim 4.

64. The specification describes using a monomer and crosslinker to apply plasma polymer coatings to an electronic device with standard equipment and conditions for plasma coating applications that would have been familiar to a POSA in June 2015. Ex. 1001 at 13:9-14:30, 14:59-67; *e.g.*, Ex. 1004 at 6:29-10:34, Ex. 1005 at 10:8-11:13, Ex. 1009 at 606-07; Ex. 1014 at 20:1-26:3.

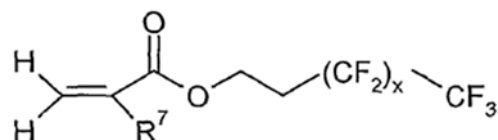
VIII. THE PRIOR ART

65. I understand from counsel that the following documents are prior art relative to the '876 patent, except for Exhibit 1028, which I understand is a copy of the '876 patent's prosecution records before the patent office, and Exhibit 1039, which is a collection of chemical information obtained from chemspider.com.

A. Exhibit 1004 – “Coulson-122”

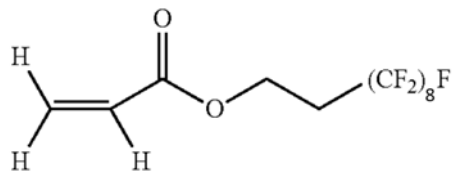
66. Coulson-122 (Ex. 1004) is International Patent Application Publication No. WO 2007/083122. The first page of the document states a publication date

of July 26, 2007. Coulson-122 described electronic or electrical devices with liquid-repellent polymer coatings to protect the devices from liquid damage. Ex. 1004 at Abstract, 1:3-2:17. To achieve liquid-repellent coating, Coulson-122 taught exposing the devices to pulsed plasma containing unsaturated monomers including those of the following formula:



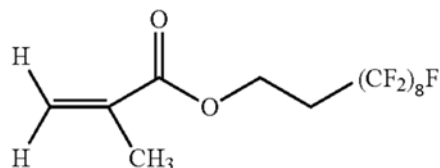
Ex. 1004 at 3:14-4:3, 11:1-12:22. The R7 position could be a hydrogen or a C1-6 alkyl group such as a methyl group, and x is an integer from 1 to 9. Ex. 1004 at 12:19-22.

67. A POSA would have understood Coulson-122's monomers of the above formula to be fluorinated acrylate or methacrylate monomers. In particular, Coulson-122 identified 1H, 1H, 2H, 2H-heptadecafluorodecylacrylate (also known as 1H, 1H, 2H, 2H-perfluorodecyl acrylate (PFAC8)), having the following structure:



Ex. 1004 at 12:21-22, 14:7-10, Claim 28. In some instances, Coulson-122 referred to that compound as “1H, 1H, 2H, 2H-heptadecafluorodecylacrylate.” Ex. 1004 at

12:21-22, 14:7-10. But a POSA would have understood that to be a typographical error, and that the correct form is 1H, 1H, 2H, 2H-heptadecafluorodecylacrylate, especially because Coulson-122 also uses the correct CAS Number for PFAC8 (27905-45-9). Ex. 1004 at 14:7-10; Ex. 1039 at 11. Alternatively, if the hydrogen at the R7 position is substituted for a methyl group, as also taught by Coulson-122 (Ex. 1004 at 12:10-21), the monomer would become 1H, 1H, 2H, 2H-perfluorodecyl methacrylate (PFMAC8) with the following structure:



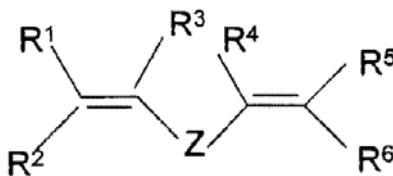
68. Coulson-122 also taught that plasma polymerization of such monomers produced “highly liquid-repellent nano-coatings,” such that treated devices like mobile phones could be “fully immersed in water ... without any lasting harm.” Ex. 1004 at 3:14-18, 4:29-5:10.

B. Exhibit 1005 – “Badyal”

69. Badyal (Ex. 1005) is International Patent Application Publication No. WO 99/64662. The first page states a publication date of December 16, 1999. Badyal concerned “the production of oil- and water-repellent surfaces” and taught that “[p]lasma deposition techniques have been quite widely used for the deposition of polymeric coatings onto a range of surfaces.” Ex. 1005 at 1:3-5, 2:10-12. Badyal’s polymeric coatings having oil- or water-repellent properties were pro-

duced by exposing “any solid substrate” to a plasma containing the same monomers as disclosed in Coulson-122, including PFAC8 and PFMAC8. Ex. 1005 4:4-15, 7:17-9:19, 9:28-30, 11:19-24. In particular, Badyal states that substrates can include fabrics and “solid materials such as biomedical devices.” Ex. 1005 at 11:22-24.

70. Furthermore, to improve the durability of such coatings, Badyal taught combining the monomer with a crosslinker, preferably of the following generic formula:

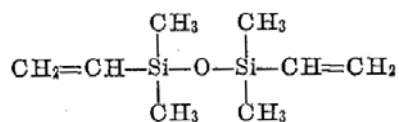


Ex. 1005 at 4:1-5:5. The R1-R6 positions could be hydrogen or alkyl groups, and bridging group Z could include substituents “known in the polymer art,” including “alkyl groups . . . interposed with oxygen atoms.” Ex. 1005 at 5:1-5, 5:18-23. Badyal provided two particular examples of specific bridging groups that fit the described general formula. Ex. 1005 6:15-20.

71. According to Badyal, the described plasma polymerization using monomers like PFAC8 and a crosslinker produced cross-linked, well-adhered coatings with excellent liquid-repellency and durability. Ex. 1005 at 4:4-29, 10:32-11:17.

C. Exhibit 1006 – “Cohen”

72. Cohen (Ex. 1007) is U.S. Patent No. 2,716,638 and says, “Patented Aug. 30, 1955,” which I understand means the patent issued on that date. Cohen is titled “Divinyltetramethyldisiloxane and polymers therefrom” and described processes of polymerizing divinyltetramethyldisiloxane (DVTMDS) to form insulating materials for electrical devices. Ex. 1007 at 1:15-20, 5:1-12. As shown in Cohen, DVTMDS has the following chemical structure:



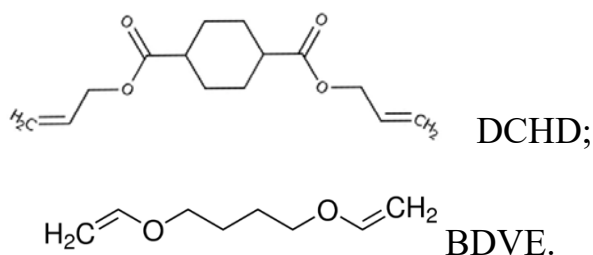
Ex. 1006 at 1:30.

73. Cohen also taught that DVTMDS can be copolymerized with other compounds, particularly esters of acrylic and methacrylic acids such as methyl acrylate, ethyl acrylate, and methyl methacrylate. Ex. 1006 at 2:25-27.

D. Exhibit 1007 – “Holliday”

74. Holliday (Ex. 1007) is U.S. Patent No. 3,816,564 and says, “Patented June 11, 1974,” which I understand means that the patent issued on that date. Holliday is entitled “Insulation coating compositions” and described polymer compositions “for use in providing electrical insulation.” Ex. 1007 at 1:11-12. Holliday’s composition comprised “a mixture of a polyolefin, polyvinyl chloride and a reactive allylic or vinylic monomer which can be crosslinked.” Ex. 1007 at 2:39-46.

Holliday taught applying the mixture to an electrical device or component and then initiating polymerization, which “cured” the composition “to form a crosslinked insulation layer” having excellent insulation properties. Ex. 1007 at 2:47-70. Holliday identified several crosslinking reagents for use in those coatings, including diallyl-1,4-cyclohexanedicarboxylate (DCHD) and 1,4-divinyl-oxybutane (also known as 1,4-butanediol divinyl ether (BDVE)), Ex. 1007 at 3:34-35, 3:52-53, which a POSA would have understood to correspond to the following chemical structures:

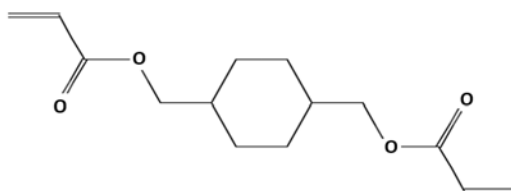


E. Exhibit 1008 – “Padiyath”

75. Padiyath (Ex. 1008) is U.S. Patent Application Publication No. 2007/0020451. The first page states a publication date of January 25, 2007. Padiyath concerned barrier assemblies having multilayer coatings and described “barrier films for protection of moisture or oxygen sensitive articles.” Ex. 1008 at Abstract, [0001]. The barrier coatings reduced or prevented “transfer of moisture and oxygen, or other contaminants, to an underlying substrate,” particularly electronic devices such as LCD or OLED display devices. Ex. 1008 at [0023-24], [0027], [0063-64]. Padiyath’s barrier coatings comprised one or more polymers, which

could be homopolymers or copolymers and could be derived from plasma polymerization. Ex. 1008 at [0005-07], [0011]. Padiyath taught that the polymers were preferably cross-linked, which was known to enhance barrier performance. Ex. 1008 at [0002], [0025], [0052].

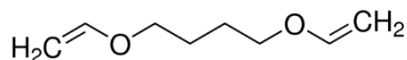
76. Particularly preferred polymers were formed by crosslinking acrylate monomers, methacrylate monomers, or their multifunctional derivatives. Ex. 1008 at [0052]. Suitable monofunctional (meth)acrylates included fluorinated (meth)acrylates in a molecular weight range between 400 and 3,000. Ex. 1008 at [0052]. As one especially preferred compound for the disclosed polymers, Padiyath described “cyclohexane dimethanol diacrylate esters (e.g., CD-406, commercially available from Sartomer Co., T_g = about 110 °C).” Ex. 1008 at [0054]. As evidenced in the Material Safety Data Sheet by Sartomer Company for product CD406 (Ex. 1032) and disclosures in other patent office publications available by 2015 (Ex. 1030 at [0144], and Ex. 1031 at [0027], [0060], [0090]), a POSA would have understood Padiyath’s reference to CD-406 as identifying the following reagent, more commonly known as cyclohexane-1,4-dimethanol diacrylate (CDMDA):



F. Exhibit 1009 – “Francesch”

77. Francesch (Ex. 1009) is a scientific journal article that was published in the journal *Plasma Processes and Polymers*. Ex. 1009. *Plasma Processes and Polymers* is a prominent journal published by Wiley-VCH Verlag GmbH & Co. in the polymer field that would have been well-known to a POSA by 2015. The copyright notice printed on the first page of the Francesch reference indicates that the article was published in the year 2005, consistent with the citation printed on each page of the article. A POSA reading Francesch would thus have understood from those notations that the article had been published and made available to the public in 2005. Additionally, a declaration signed by Dr. Salvador Borrós Gómez, whom I know to be a co-author of the Francesch article, further demonstrates that the article was made publicly available when it was published online in September 2005. Ex. 1010.

78. Francesch concerned the development of biomaterials and described methods of plasma polymerizing a new acrylate-type monomer, pentafluorophenyl methacrylate (PFM), for subsequent biotin binding to achieve versatile surface functionalization. Ex. 1009 at 605-06. For polymerization of PFM, Francesch described copolymerizing PFM with crosslinkers, including 1,4-butanediol divinyl ether (BDVE). Ex. 1009 at 606-07. As would have been known to a POSA, BDVE has the following chemical structure:

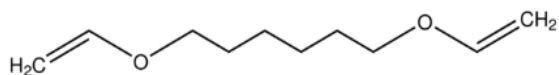


79. In particular, Francesch taught performing plasma deposition for 2-8 hours and depositing the BDVE-crosslinked copolymer at a rate of 8 nm per hour, which a POSA would have understood to translate into polymer coatings at thicknesses of 16-64 nm. Ex. 1009 at 607-08. The resulting coatings showed flat, homogenous, pinhole-free surfaces. Ex. 1009 at 609-10. Francesch taught that the BDVE crosslinker was included “to improve the solvent resistance of the resulting deposited thin films.” Ex. 1009 at 610.

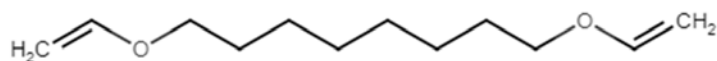
G. Exhibit 1011 – “Tropsch”

80. Tropsch (Ex. 1011) is U.S. Patent No. 5,804,669. The first page states the date of the patent as September 8, 1998, which I understand to be when the patent was issued. Tropsch described a two-phase process for preparing polymers comprising peroxydicarboxyl groups. Ex. 1011 at Abstract, 1:4-7, 1:49-2:2. Tropsch’s methods required first preparing or obtaining a polymer, and then reacting that polymer with hydrogen peroxide. Ex. 1011 at 1:49-2:2. The input polymer contained at least an unsaturated dicarboxylic anhydride monomer. Ex. 1011 at 2:3-7, 2:13-39. The input polymer further contains a comonomer, such as an acrylate or methacrylate. Ex. 1011 at 2:3-7, 3:1-8. Tropsch also disclosed the use of crosslinkers in preparing the polymer. Ex. 1011 at 3:48-51. Specifically, Tropsch taught that the “preferably employed” crosslinkers are “divinylbenzene, divi-

nylethyleneurea, alkadienes or divinyl alkyl ethers. The latter are preferably selected from α,ω -alkadienes, preferably 1,9-decadiene, or 1,4-butanediol divinyl ether, 1,6-hexanediol divinyl ether or 1,8-octanediol divinyl ether.” Ex. 1011 at 4:34-39. A POSA would have understood that 1,6-hexanediol divinyl ether (HDVE) has the chemical structure of



and 1,8-octanediol divinyl ether has the chemical structure of



H. Other References

81. Exhibit 1012 is International Patent Application Publication No. WO 2012/158953 to Legein, et al. The first page states a publication date of November 22, 2012.

82. Exhibit 1013 is U.S. Patent Application Publication No. 2013/0176700 to Stevens, et al. The first page states a publication date of July 11, 2013.

83. Exhibit 1014 is International Patent Application Publication No. WO 2014/026967 to Legein, et al. The first page states a publication date of February 20, 2014.

84. Exhibit 1015 is U.S. Patent Application Publication No.

2005/0141738 to Karamuk. The first page states a publication date of June 30, 2005.

85. Exhibit 1016 is U.S. Patent No. 6,551,950 to Badyal, et al. The first page states the date of the patent as April 22, 2003, which I understand to be when the patent was issued.

86. Exhibit 1017 is U.S. Patent No. 4,562,091 to Sachdev, et al. The first page states the date of the patent as December 31, 1985, which I understand to be when the patent was issued.

87. Exhibit 1018 is U.S. Patent No. 7,439,315 to Kunimi, et al. The first page states the date of the patent as October 21, 2008, which I understand to be when the patent was issued.

88. Exhibit 1019 is a publication by S.R. Coulson, the first named inventor of the '876 patent, and colleagues in the journal *Chemistry of Materials*, which is a well-recognized publication of the American Chemical Society (ACS). By June 2015, POSAs knew the ACS as a well-established publisher of scientific and technical literature in the field, and *Chemistry of Materials* was one such prominent journal publication that would have been well known to a POSA. The copyright notice and the journal citation printed on each page of Exhibit 1019 indicate that the article was published in 2000, consistent with the additional notation printed near the bottom of the article's first page indicating that it was "Published on

Web 06/28/2000.” By 2000, ACS and other academic journals in the field were commonly publishing their articles in online and print form, and based on that common and by then widespread practice, a POSA reading Exhibit 1019 would have understood from those notations and believed that the article had been published and made available to the public in 2000, and specifically made publicly available on the internet by June 28, 2000.

89. I understand that Exhibit 1020 is a declaration provided by the British Library regarding the date that a print copy of the Coulson article published in *Chemistry of Materials* (Exhibit 1019) was received and made available for public use by that institution.

90. Exhibit 1021 is U.S. Patent Application Publication No. 2010/0203347 to Coulson. The first page states a publication date of August 12, 2010.

91. Exhibit 1022 is International Patent Application Publication No. WO 98/58117 to Badyal, et al. The document lists a publication date of December 23, 1998, on its first page. Exhibit 1022 is referenced in the '876 patent as prior art that previously described “[t]he perfluoroalkyl chain monomers . . . used for generating hydrophobic surfaces from pulsed plasma deposition processes.” Ex. 1001 at 1:17-19.

92. Exhibit 1023 is a publication by C. Tarducci and colleagues in the

journal *Macromolecules*, which was a recognized journal in the field published by the ACS that would have been well known to a POSA in June 2015. The copyright notice and the journal citation printed on each page of Exhibit 1023 indicate that the article was published in 2002, consistent with the additional notation printed near the bottom of the first page indicating that it was “Published on Web 10/12/2002.” A POSA reading Exhibit 1023 would have understood from those notations and believed that the article had been published and made available to the public in 2002, and specifically made publicly available on the internet by October 12, 2002.

93. Exhibit 1024 is U.S. Patent No. 6,214,423 to Lee, et al. The first page states the date of the patent as April 10, 2001, which I understand to be when the patent was issued.

94. Exhibit 1025 is International Patent Application Publication No. WO 2012/168440 to Taesler. The document lists a publication date of December 13, 2012.

95. Exhibit 1026 is a publication authored by me and my colleague, Jose Luis Yagüe, in the journal of *Macromolecules*. Near the bottom of the first page, the article states that it was published on August 13, 2013. That date is consistent with my own recollection. Based on my personal knowledge as an author of the article, I know that Exhibit 1026 was published in 2013.

96. Exhibit 1027 is U.S. Patent No. 6,207,238 to Affinito. The first page states the date of the patent as March 27, 2001, which I understand to be when the patent was issued.

97. I understand that Exhibit 1028 is a copy of the prosecution history of the '876 patent.

98. Ex. 1029 is a publication by W. Yao, et al., in the journal *Polymer*, which was a recognized journal in the field published by Elsevier that would have been well known to a POSA by June 2015. Elsevier was known to POSAs as a well-established publisher of scientific journals. The copyright notice and the journal citation printed on each page of Exhibit 1029 indicate that the article was published in 2014. In addition, the "Article Info" section on the first page near the abstract states that the article was made available online as of September 30, 2014. A POSA reading Exhibit 1029 would have understood from those notations and believed that the article had been published and made available to the public in 2014, and specifically made publicly available on the internet by September 30, 2014.

99. Exhibit 1030 is U.S. Patent Application Publication No. 2013/0136936 to Morozumi, et al. The document lists a publication date of May 30, 2013.

100. Exhibit 1031 is U.S. Patent Application Publication No. 2011/0148979 to Breton, et al. The document lists a publication date of June 23,

2011.

101. Exhibit 1032 is Sartomer Company Material Safety Data Sheet for Product CD406, revised on June 9, 2005. The document identifies the CD406 product as cyclohexane dimethanol diacrylate, CAS Number 67905-41-3. Ex. 1032 at 1. The CAS Chemical Registry is a global standard for uniquely identifying chemical substances and has been used since the 1960s. A POSA in 2015 would have been very familiar with CAS registry numbers and would have known that CAS Number 67905-41-3 identified cyclohexane dimethanol diacrylate, also known as cyclohexane 1,4-dimethanol diacrylate (CDMDA). Ex. 1039 at 7. Material Safety Data Sheets would have been familiar to POSAs as product information that companies provide to their customers when offering and when supplying chemical reagents. A POSA reading Exhibit 1032 would have understood from the revision notations and believed that Exhibit 1032 was published and made available to the public in 2005.

102. Exhibit 1033 is U.S. Patent Application Publication No. 2005/0034667 to Tsuji, et al. The document lists a publication date of February 17, 2005.

103. Exhibit 1034 is an excerpted copy of a book by H. Yasuda entitled *Plasma Polymerization*. Exhibit 1034 would have been familiar to a POSA, and I have used that book as a reference for years, going back well before 2015. The

copyright notations on Exhibit 1034 indicate that it was published in 1985 by Academic Press. Academic Press was known to POSAs as a well-established publisher in the field. A POSA reading Exhibit 1034 would have understood from those copyright notations and believed that Exhibit 1034 was published and made available to the public in 1985.

104. Ex. 1035 is a publication by S. Kurosawa, et al., in the journal *Thin Solid Films*, which was a recognized journal in the field published by Elsevier that would have been known to a POSA. The copyright notice near the bottom of the first page lists a 2003 copyright date, and the journal citation printed on each page indicate that the article was published as part of the 2004 volume of *Thin Solid Films*. A POSA reading Exhibit 1035 would have understood from those notations and believed that the article had been published and made available to the public by 2004.

105. Ex. 1036 is a publication by S. Kurosawa, et al., in the journal *Thin Solid Films*, which was a recognized journal in the field published by Elsevier that would have been known to a POSA. The copyright notice near the bottom of the first page lists a 2002 copyright date, and the journal citation printed on each page indicate that the article was published as part of the 2002 volume of *Thin Solid Films*. A POSA reading Exhibit 1036 would have understood from those notations and believed that the article had been published and made available to the public

by 2002.

106. Ex. 1037 is a publication by K.G. Joback and R.C. Reid in the journal *Chemical Engineering Communications*, which was a recognized journal in the field published by Taylor & Francis that would have been well known to a POSA by June 2015. Taylor & Francis was known to POSAs as a well-established publisher of scientific journals. The copyright notice and the journal citation printed on page 233 of Exhibit 1037 indicate that the article was published in 1987. In addition, the cover page to the article near states that the article was published online as of May 21, 2007. A POSA reading Exhibit 1037 would have understood from those notations and believed that the article had been published and made available to the public before 2015, and specifically made publicly available in print in 1987 and on the internet in 2007.

107. Ex. 1038 is U.S. Patent Application Publication US 2006/0122301 to Nair and Nalewajek. The document lists a publication date of June 8, 2006. Ex. 1039 is a collection chemical information obtained from chemspider.com, which is an online resource maintained by the Royal Society of Chemistry that I and others in the field consider reliable and use regularly to look up properties of chemical reagents, such as molecular structure, boiling point, molecular weight, density, etc.

IX. CLAIM CONSTRUCTION

108. In conducting my analyses of the claims of the '876 patent, I have ap-

plied the understandings I set out below regarding the meanings of terms used in the claims. I reserve the right to update or modify my analyses if necessary to account for different meanings assigned to any of the claims.

A. “Halogen”

109. In my opinion, a POSA would have understood the term “halogen” in claim 1 of the ’876 patent to include at least at least fluorine, chlorine, and bromine. That meaning is consistent with how that term was used by those in the field in 2015 and is consistent with how that term is used in the ’876 patent’s specification.

110. Halogens are a group of non-metallic elements that appear in Group 17 (Group VIIa) of the periodic table. Each halogen is electronegative and typically participates in only a single chemical bond. The halogen elements in the first four periods of the periodic table were in common use in chemical synthesis well before 2015. These are fluorine, chlorine, bromine, and iodine. Ex. 1005 at 5.

111. In the ’876 patent, the term “halogen” is used in a manner consistent with that ordinary understanding. The specification says that a halogen may be chlorine or bromine but is preferably fluorine. Ex. 1001 at 10:57-59, 7:11-14.

112. For these reasons, I conclude that “halogen” in the ’876 patent’s claims includes at least fluorine, chlorine, and bromine.

B. Other claim terms

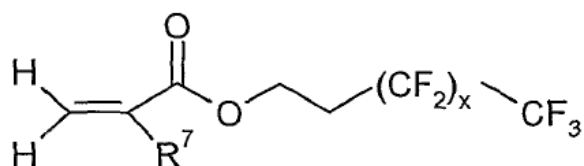
113. For purposes of this petition and comparison to the prior art, I under-

stand that all other terms in Claims 1-15 of the '876 patent should be construed according to their ordinary meaning to a POSA in the context of the '876 patent.

X. ANALYSIS OF THE CLAIMS OF THE '876 PATENT

A. All Grounds: Coulson-122 and Badyal described preparing plasma-polymer films by copolymerizing monomers including PFAC8 or PFMAC8 with a crosslinker

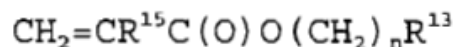
114. Coulson-122 taught that plasma polymer coatings provide protection for a diverse array of electronic or electrical devices against damage by liquids such as water and oil. Ex. 1004 at 1-6. Coulson-122 also taught that both PFAC8 and PFMAC8 were preferred monomers for forming liquid-repellent coatings by plasma polymerization, displaying the chemical structure as



where x is an integer and preferably 7. Ex. 1004 at 11-12. When $x=7$ in the structure above, the pendant perhaloalkyl functional group is known as the C8 perfluorocarbon moiety because it includes eight fluorinated carbon atoms (seven CF_2 repeats plus the terminal CF_3). Coulson-122 further specified that R^7 can be hydrogen or methyl. Ex. 1004 at 12. When $x=7$ and R^7 is hydrogen, the monomer is the acrylate PFAC8. When $x=7$ and R^7 is methyl, the monomer is the methacrylate PFMAC8. Those structures are the same as setting $n=8$ in the monomers shown at column 11, lines 30-47 of the '876 patent; the only difference is that the molecules

were drawn in the '876 patent with the terminal carbon group folded into the repeating chain.

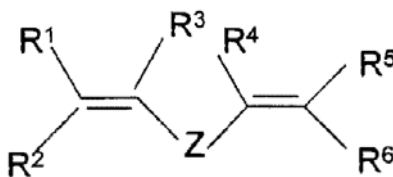
115. Badyal described the using the same monomers as Coulson-122 to prepare liquid-repelling halogen-containing plasma polymer coatings. Ex. 1005 at 7-9. Badyal taught that cross-linked plasma polymers on surfaces can form by the plasma copolymerization of a mixture of a cross-linking monomer with a further monomer. Ex. 1005 at 12 -14. For this further monomer, Badyal described the use of haloalkyl substituents and the preference for have one double bond, with acrylate monomers as a specific embodiment. Ex. 1005 at 12-14. For oil and water repellent properties, Badyal teaches that the presence of perhaloalkyl chains is preferred, along with cross-linking to provide good durability. Ex. 1005 at 4. A preferred monomer formula provided by Badyal is



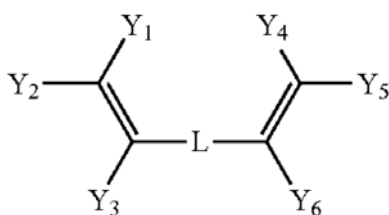
where the integer 2 was the preferred value of n, and the C8 perfluoroalkyl chain, C₈F₁₈, was preferred for R¹³. Ex. 1005 at 6-9, 14. Using hydrogen and methyl from listed as possibilities for R¹⁵ gives PFAC8, and PFMAC8, respectively.

116. Badyal also stated the desire to improve the durability of these coatings. Ex. 1005 at 3-4. Badyal taught that increased durability can be accomplished by including at least one compound possessing two double bonds can form a cross-linked plasma polymer on a surface. Ex. 1005 at 4:1-5:23. Badyal taught the cross-

linking compound according to the generic structure below, with two double bonds has a bridging or linking group between its two double bonds and does not place any limitation on the chemical structure of the bridging unit (identified as Z):



Ex. 1005 at 5:1-23. That structure is identical to the generic crosslinker with two double bonds described in the '876 patent and shown in claim 1:



Ex. 1001 at 4:51-60, 18:60-67.

117. The oil and water repellency of fluoropolymers, including fluorinated acrylate and methacrylate polymers and use of pendent C8 perfluoro functional groups, as well as copolymerization with cross-linkers containing two double bonds were all well known in the polymer art. Ex. 1004 at 13:30-14:23; Ex. 1005 at 3-5; Ex. 1019 at 2031-32, 2037-38; Ex. 1029 at 6197 and 6204-6206; Ex. 1026 at 6548-6553.

[Preamble] “An electronic or electrical device or electronic or electrical component thereof comprising”

118. Coulson-122 described coating electronics (Ex. 1004 at 1:3-7), and

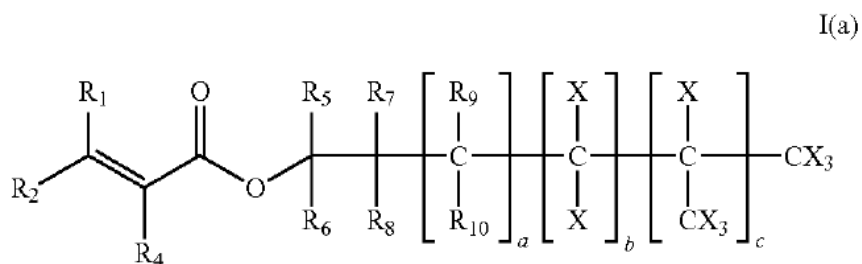
Badyal stated that its crosslinked coatings could be used for coating any solid substrate, including those of materials such as fabric, metal, glass, ceramics, paper, or polymers. Ex. 1005 at 9:28-34. By the priority date of '876 patent, it had been widely established that the dielectric properties of plasma polymer coatings enabled them to form as electrical insulating and protective coatings on electronic and electrical devices. Ex. 1004 at 1:3-4:3, Ex. 1012 at 1:9-4:4, Ex. 1013 at [0038], Ex. 1014 at 1:3-5:5. A POSA therefore would have recognized electronics as important solid substrates among those that could be coated with Badyal's versatile crosslinked coatings. As a further indication, Badyal taught as a specific example that the plasma polymer coatings could be applied to biomedical devices. Ex. 1005 at 11:19-24. A POSA would have known that a variety of biomedical devices, including wearable sensors for physiological monitoring and hearing aids, contain a variety of electronic components, Ex. 1015 at [0006], and thus can also be called electrical or electronic devices.

[Element 1a] “a protective cross-linked polymeric coating on a surface of said device or component; wherein the protective cross-linked polymeric coating is obtained by exposing said device or component to a plasma comprising a monomer compound and a crosslinking reagent for a period of time sufficient to allow formation of the protective cross-linked polymeric coating on a surface thereof,”

119. A POSA would have known that coatings used on electronics can protect the underlying electronics in a number of ways, including repelling water or other liquids, providing electrical insulation, and/or by providing a barrier to the

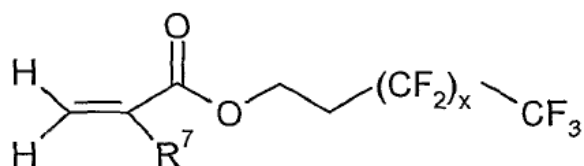
passage of liquids or gases. Ex. 1004 at 1:1-34, 4:9-15; Ex. 1008 at [0023-24]; Ex. 1014:4:5-5:13; Ex. 1017 at 3:27-41, 6:31-36; Ex. 1018 at 1:5-11. The description of protective coatings in the '876 patent is consistent with that understanding. Ex. 1001 at 1:8-13.

[Element 1b] “wherein the monomer compound is a compound of formula I(a):



wherein each of R1, R2, R4 and R5 to R10 is independently selected from hydrogen or an optionally substituted C1-C6 branched or straight chain alkyl group; each X is independently hydrogen or halogen; a is from 0-10; b is from 3 to 7; and c is 0 or 1,”

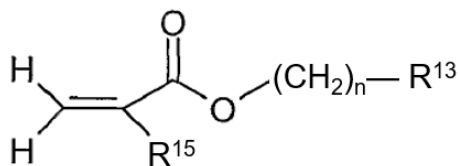
120. As noted above, Coulson-122 described preferred monomers with a structure



where and x preferably was 7 repeating CF₂ groups and R⁷ was preferably hydrogen or methyl, Ex. 1003 at 12:13-21, which a POSA would have recognized as describing PFAC8 and PFMAC8, respectively.

121. Badyal also described monomers including PFAC8 and PFMAC8.

Badyal showed a preferred monomer formula of $\text{CH}_2=\text{CR}^{15}\text{C}(\text{O})\text{O}(\text{CH}_2)_n\text{R}^{13}$. Ex. 1005 at 9:10-16 (Formula V). I have provided below the corresponding structure that any POSA would have understood from that formula:



Badyal described R^{15} as including hydrogen or methyl, which a POSA would have recognized as yielding an acrylate or methacrylate, respectively. Ex. 1005 at 9:16. I note that the formula provided by Badyal and shown above designated the number of CH_2 groups using the variable n (Ex. 1005 at 9:13), but the text used the variable m when describing the number of CH_2 groups (Ex. 1005 at 7:27-28, 8:26-28, 9:15). Based on those disclosures, a POSA would in my opinion have understood that Badyal's Formula V was intended to include m rather than n as the variable designating the number of CH_2 groups. To a POSA, Badyal therefore described the number of CH_2 groups as being from 1-10, preferably 2. Ex. 1005 at 9:15-16, 7:20-28, 8:26-28. As to R^{13} , Badyal described perfluorinated alkyl chains of the formula $\text{C}_s\text{F}_{2s+1}$ as preferred, especially where s is 10 or 8 (i.e., C_8F_{17}). Ex. 1005 at 9:15-16, 8:15-18. In view of those collective disclosures, a POSA would have recognized Badyal's preferred monomers included PFAC8 (with n/m as 2, R^{13} as C_8F_{17} , and R^{15} as hydrogen) and PFMAC8 (with n/m as 2, R^{13} as C_8F_{17} , and R^{15} as methyl).

122. Formula I(a) in claim 1 of the '876 patent encompasses the specific

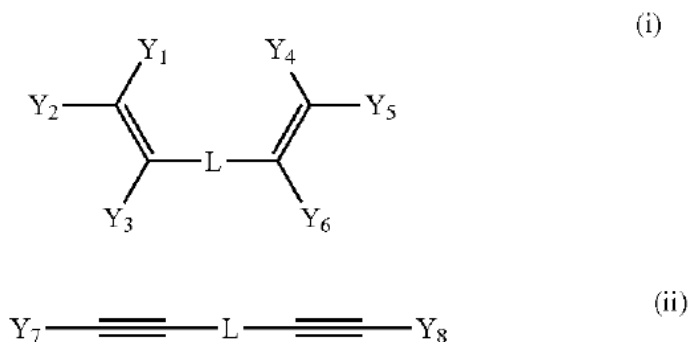
structures of PFAC8 and PFMAC8. The structures PFAC8 and PFMAC8 correspond to selecting the substituents R_1 , R_2 , R_5 , R_6 , R_7 , and R_8 in Formula I(a) as hydrogen; choosing $a=0$, $b=7$, and $c=0$; and selecting X as the halogen element fluorine. Selecting R_4 as hydrogen or the methyl alkyl group, results in the precise chemical formulas for PFAC8 and PFMAC8, respectively.

B. Ground 1: Coulson-122, Badyal, and Cohen

123. In my opinion, as explained in more detail below, claims 1-3, 9, and 11-15 of the '876 patent would have been obvious over Coulson-122 and Badyal combined with Cohen.

1. Claim 1

[Element 1c] “and wherein the crosslinking reagent comprises two or more unsaturated bonds attached by means of one or more linker moieties and has a boiling point of less than 500° C. at standard pressure, the crosslinking reagent having one of the following structures:

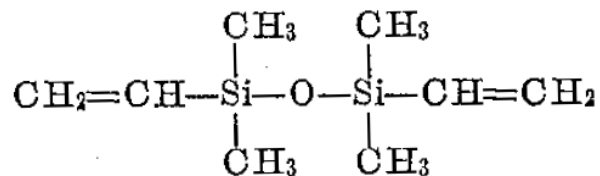


where Y_1 , Y_2 , Y_3 , Y_4 , Y_5 , Y_6 , Y_7 and Y_8 are each independently selected from hydrogen, optionally substituted cyclic, branched or straight chain C_1 - C_6 alkyl or aryl; and L is a linker moiety;”

124. Badyal taught that crosslinked polymers form when at least one of the

monomeric reagents contains two double bonds. Ex. 1005 at 4:1-29. As a matter of basic chemistry, a POSA would have known that double bonds (and triple bonds) are types of unsaturated bonds, as compared to saturated organic compounds that have only single bonds between carbon atoms and therefore tend to be less reactive. As I've noted Badyal described the same generic crosslinking reagent structure as formula (i) shown in claim 1 of the '876 patent, containing two carbon-carbon double bonds and a bridging structure which links between the two double bonds. Ex. 1005 at 5:1-5. In Badyal the bridging structure was denoted by the letter Z, and it is denoted instead by the letter L in claim 1 of the '876 patent. This change in nomenclature does not represent any change in chemical formulas encompassed between the two crosslinker structures.

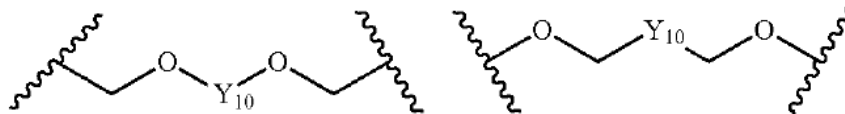
125. Badyal taught that such crosslinkers containing any bridging group known in the polymer art would be suitable for use in making the described cross-linked polymers. Ex. 1005 at 5:18-23. A POSA therefore would have considered known crosslinkers that fit Badyal's generic structure. By 2015, one well-known example in the polymer art of a crosslinking reagent with two double bonds separated by a bridging group was divinyl tetramethyl disiloxane (DVTMDS). Ex. 1006 at 1:15-34. Selecting hydrogen for each of the R^1 - R^6 positions in Badyal's generic crosslinker formula and utilizing tetramethyl disiloxane to bridge between the double bonds results in the chemical structure of DVTMDS;



DVTMDS was known as a versatile crosslinker that can be copolymerized with many different monomers including members of the acrylate and methacrylate families. Ex. 1006 at 2:14-30, 4:18-65.

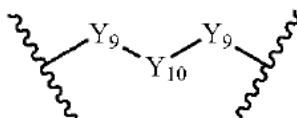
126. The boiling point of a reagent at standard pressure (also known as the normal boiling point) is a fixed physical property of that reagent. The normal boiling point of DVTMDS is approximately 137°C. Ex. 1006 at 3:44-45. Additionally, a POSA would have known that DVTMDS has sufficient volatility and reactivity for use in plasma polymerization. Ex. 1036 at 4-6.

[Element 1d] [Formula A] “wherein for compound (i) L is of formula A having one of the following structures:



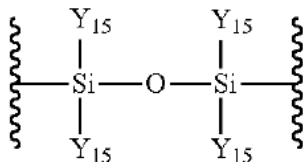
and Y₁₀ is selected from optionally substituted cyclic, branched or straight chain C₁-C₈ alkylene and a siloxane group; or

[Formula B] wherein for compound (i) L is of formula B having the following formula:



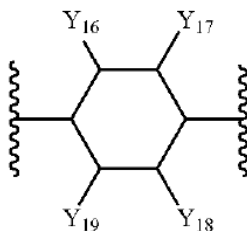
where each Y_9 is independently selected from, a bond, $—O—$, $—O—C(O)—$, $—C(O)—O—$, $—Y_{11}—O—C(O)—$, $—C(O)—O—Y_{11}—$, $—OY_{11}—$, and $—Y_{11}O—$, where Y_{11} is an optionally substituted cyclic, branched or straight chain C_1 - C_8 alkylene; and

[*Formula B1*] wherein Y_{10} has the following formula:



and each Y_{15} is independently selected from optionally substituted branched or straight chain C_1 - C_6 alkyl; or

[*Formula B2*] wherein Y_{10} has the following formula:



and Y_{16} to Y_{19} are each independently selected from H and optionally substituted branched or straight chain C_1 - C_8 alkyl or alkenyl.”

127. Formula B1 of '876 claim 1 encompasses the specific chemical structure of DVTMDS, where Y_9 is a single bond between carbon and silicon atoms and Y_{10} is a disiloxane structure having its four Y_{15} substituents each selected as a methyl alkyl group. The specific use of DVTMDS is also described as a preferred example of a crosslinker in the '876 patent. Ex. 1001 at 8:7-8.

A POSA would have used Cohen's DVTMDS crosslinker in the coatings described by Coulson-122 and Badyal

128. As a POSA would have known in 2015, the expanding market of mo-

mobile electronic devices and the well-known sensitivity of those devices to damage from exposure to environmental contaminants created incentives to protect those devices, and one common approach was to apply protective polymer coatings. Ex. 1004 at 1:1-34, 4:29-5:34. Such protective polymer coatings were often applied through plasma polymerization and provided liquid-repellency, electrical insulation, and/or barrier properties. Ex. 1004 at 4:29-5:6, 14:7-23; Ex. 1008 at Abstract, [0011], [0021]; Ex. 1012 at 2:6-20, 7:3-21; Ex. 1013 at [0003-04], [0046]; Ex. 1015 at [0001-02], [0011], [0029]. In my opinion, the recognized and growing market for such coatings in 2015 would have motivated POSAs to look for ways to improve on existing protective coatings, such as those described by Coulson-122.

129. Coulson-122 taught the value of liquid-repellent coatings for electronic protection and described forming such coatings from the plasma polymerization of fluorinated monomers including PFAC8 or PFMAC8. Ex. 1004 at 1:1-34, 12:7-22. A POSA also would have known that Badyal taught that the durability of plasma polymer coatings produced from PFAC8 or PFMAC8 could be increased by copolymerization with a crosslinking agent possessing two double bonds. Ex. 1005 at 4:1-29. A POSA would have recognized that durability is important for protective coatings applied to electronics like mobile phones or medical devices, which are used continuously for years while often being exposed to challenging conditions like liquid exposure.

130. Badyal's copolymerization method could produce crosslinked plasma polymer coatings on any solid substrate, including biomedical devices, which POSAs would have known to frequently contain electronics. Ex. 1005 at 9:28-30, 11:19-24. Furthermore, a POSA would have known that crosslinking of polymer coatings typically resulted in improved barrier properties, smoothness, and solvent resistance. Ex. 1006 at 3:50-65 (showing improved solvent resistance after crosslinking); Ex. 1026 at 6551-53 (showing that crosslinking improved smoothness, reduced hysteresis, and reduced crystallinity which reduces channels through the polymer layer thus providing a more effective barrier).

131. Thus, to improve the durability of protective coatings for electronic devices—which are solid substrates, and some of which are used as biomedical devices—a POSA would have been motivated to apply the method for crosslinked plasma polymer coatings described in Badyal with application taught by Coulson-122, particularly since both patents taught a preference for plasma polymerization of the same fluorine-containing monomers, PFAC8 or PFMAC8. A POSA reading those disclosures and noting those similarities would not have been discouraged from applying Badyal's crosslinking technique in the Coulson-122 coatings by Badyal's use of fabrics as an exemplary substrate because of the similarities between Badyal and Coulson-122 and because Badyal described the applications for its techniques much more broadly. Ex. 1005 at 9:28-34, 11:22-24. Badyal specifi-

cally emphasized that such crosslinked coatings were not limited to fabrics and could be used to protect “any solid substrate,” and a POSA would have known that electronics and electronic components are solid substrates. In addition, Badyal pointed out biomedical devices as one specific example of a solid substrate, and a POSA would have known that many biomedical devices, such as hearing aids and pacemakers, are electronic devices.

132. Badyal taught the selection of the cross-linking agent from those structures known in the polymer art. Ex. 1005 at 5:1-5, 5:18-23. An example of a known crosslinker in the polymer art with the required structure and desirable known properties was DVTMDS, which a POSA would have known had been widely used in polymer production for years before 2015. Ex. 1006 at 1:20-35; Ex. 1018 at 3:60-4:25; Ex. 1017 at 3:41-4:10. Cohen had described DVTMDS as a crosslinker useful for producing electrically insulating, solvent-resistant polymers used as dielectric layers in electronic devices. Ex. 1006 at 5:1-25; Ex. 1018 at 1:6-11; Ex. 1033 at [0037], [0045]. DVTMDS was known to be compatible with various polymerization techniques, including plasma polymerization. Ex. 1006 at 1:32-62; Ex. 1017 at Abstract, 3:40-4:24; Ex. 1027 at 1:5-11, 8:30-35; Ex. 1033 at [0037-45]; Ex. 1036 at 3-6. Coatings containing DVTMDS had been associated with water repellency, barrier, and insulating properties. Ex. 1006 at 5:1-12; Ex. 1017 at 3:27-41, 6:31-36; Ex. 1033 at [0037]. Cohen also taught that DVTMDS

may be copolymerized with a great number of copolymerizable compounds containing a double bond, including fluorine-containing monomers as well as acrylate and methacrylate monomers. Ex. 1006 at 2:14-30, 4:18-57. Those are all properties that a POSA would have been looking for in a crosslinker in view of Coulson-122 and Badyal.

133. Thus, a POSA's knowledge of DVTMDS, its structure, reactivity, and properties would have provided motivation to use DVTMDS as the crosslinker for the acrylate and methacrylate monomers of Badyal and Coulson-122 to obtain durable electrically insulating plasma polymer coatings. Additionally, a POSA would have known that the low normal boiling point of approximately 137°C for the DVTMDS enables the easy introduction of vapors of this crosslinking reagent into the vacuum chamber used for plasma deposition, including in combination with a monomer like PFAC8 or PFMAC8.

134. Plasma polymerization was a commonplace and straightforward procedure that would have been familiar and simple for a POSA to carry out in 2015. Ex. 1017 at 3:27-40; Ex. 1021 at ¶¶ 58-60; Ex. 1012 at 8:1-10:12; Ex. 1025 at ¶¶ 38-48; Ex. 1001 at 14:59-67; Ex. 1005 at 2:10-13, 10:8-12.

135. The POSA would have expected DVTMDS to work as a crosslinker for plasma polymerization with PFAC8 or PFMAC8 because Badyal taught that known crosslinkers fitting the same general structure with two double bonds and a

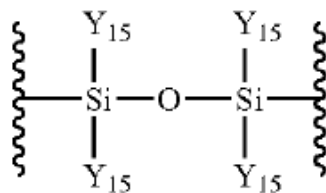
known bridging group would work for preparing the disclosed durable coatings. Ex. 1005 at 4:17-5:23. Given the known and favorable properties and applications of polymers containing DVTMDS that I described above, a POSA would have expected to be able to achieve those same properties when incorporating DVTMDS into coatings with similar properties based on monomers like PFAC8 and PFMAC8 as described by Coulson-122 and Badyal. In addition, a POSA would have known DVTMDS was compatible for co-polymerization with acrylate monomers (Ex. 1006 at 1:31-34, 2:14-29) and had been used in plasma polymerization (Ex. 1017 at 3:42-4:11; Ex. 1033 at [0040-43], Ex. 1027 at 7:64-8:34). Finally, the POSA would have expected plasma coatings prepared using PFAC8 or PFMAC8 and DVTMDS to be successful as applied to electronics because Coulson-122 and Cohen described electronics applications for those reagents, and Badyal taught that such a crosslinked combination could be applied to *any* solid surface, including that of a biomedical device.

2. Claims 2, 3

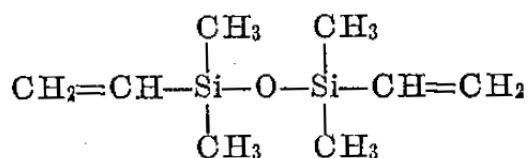
136. Claims 2 and 3 identify physical properties of the polymer coatings in claim 1. I discuss claims 2 and 3 in Section G below.

3. Claims 9 and 11-15

137. Regarding claim 9, the DVTMDS crosslinker taught by Cohen has the Formula B1 bridging group specified in claim 9, which is:



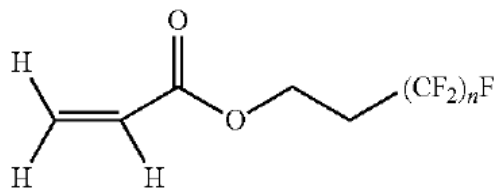
where each Y₁₅ is methyl (CH₃). Ex. 1001 at 20:39-50. DVTMDS matches that same bridging-group structure



with each Y₉ in Formula B being a bond connecting silicon atoms of the bridging group to the double-bonded carbon atoms.

138. In claim 11, DVTMDS is stated as one of the specified crosslinking reagents. Ex. 1001 at 21:2-3.

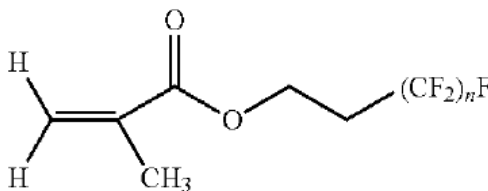
139. Claims 12 and 13 specify a subset of monomers under the generic Formula I(a) in claim 1, and the PFAC8 monomer taught by Coulson-122 and Badyal is included in both of those claims. Claim 13 states PFAC8 specifically. Claim 12 calls for a monomer with the structure



where n is from 2 to 10. Ex. 1001 at 21:7-19. PFAC8 matches that structure exactly with an 8-carbon perfluorinated tail. In other words, PFAC8 is included in the

structure above when $n = 8$.

140. Claims 14 and 15 specify a subset of monomers under the generic Formula I(a) in claim 1, and the PFMAC8 monomer taught by Coulson-122 and Badyal is included in both of those claims. Claim 15 states PFMAC8 specifically. Claim 14 calls for a monomer with the structure



where n is from 2 to 10. Ex. 1001 at 22:4-15. PFMAC8 matches that structure exactly with an 8-carbon perfluorinated tail. In other words, PFMAC8 is included in the structure above when $n = 8$.

C. Ground 2: Coulson-122, Badyal, and Holliday

141. In my opinion, as explained in more detail below, claims 1-8 and 10-15 of the '876 patent would have been obvious over Coulson-122 and Badyal combined with Holliday.

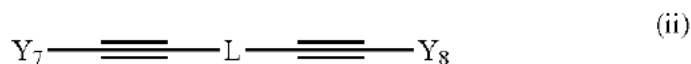
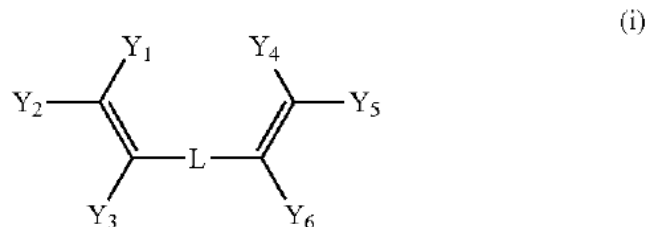
142. As I've explained above, a POSA would have been aware of Coulson-122 and Badyal and would have been seeking known crosslinkers that fit Badyal's generic crosslinker structure with two double bonds and a bridging group and preferably were suitable for use in plasma polymerization and had been associated with properties beneficial for preparing protective coatings for electronics. In my opin-

ion, Holliday described known crosslinking reagents that a POSA would have considered suitable for preparing crosslinked coatings in view of Coulson-122 and Badyal.

143. Holliday described crosslinked polymers useful for providing electrical insulation that could be applied to protect electrical conductors and connectors with electrical and chemical resistance properties. Ex. 1007 at 1:10-26, 2:17-46. Holliday refers to “curable” polymer compositions made using reagents “which can be crosslinked.” Ex. 1007 at 1:10-20, 2:17-21, 2:39-46. A POSA would have known that curing is used in the field as a synonym for crosslinking, and Holliday’s references to improved electrical, chemical, and mechanical properties of “cured” polymers refers to properties achieved after crosslinking with a crosslinking reagent. Ex. 1007 at 2:39-46, 2:50-52, 2:68-70, 4:72-5:57. Below I discuss crosslinkers described by Holliday that a POSA would have recognized as suitable and consistent with the desired crosslinker structure and properties for use in the Coulson-122/Badyal combination.

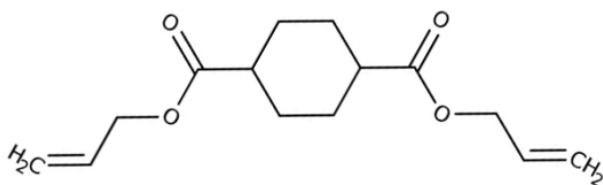
1. Claim 1

[Element 1c] “and wherein the crosslinking reagent comprises two or more unsaturated bonds attached by means of one or more linker moieties and has a boiling point of less than 500° C. at standard pressure, the crosslinking reagent having one of the following structures:

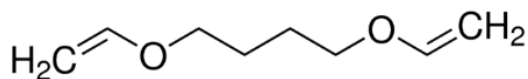


where Y₁, Y₂, Y₃, Y₄, Y₅, Y₆, Y₇ and Y₈ are each independently selected from hydrogen, optionally substituted cyclic, branched or straight chain C₁-C₆ alkyl or aryl; and L is a linker moiety;”

144. Holliday described several crosslinking reagents, including two that a POSA would have recognized as familiar and consistent with Badyal’s generic crosslinker structure: diallyl-1,4-cyclohexanedicarboxylate (DCHD) and 1,4-divinyl-oxybutane (which to a POSA is also known as 1,4-butanediol divinyl ether (BDVE)). Ex. 1007 at 3:34-35, 3:52-53; Ex. 1005 at 5:1-5. The structures of those reagents would have been known to a POSA and are shown below:



DCHD



BDVE

Both DCHD and BDVE match the structural formula (i) in claim 1 where Y₁ thru Y₆ are all hydrogen. Both DCHD and BDVE contain two carbon-carbon double bonds bridged with a linker moiety.

145. The normal boiling point of a reagent is measured at standard pressure and is a fixed physical property of that reagent. The normal boiling point of DCHD is approximately 331°C (verified using chemspider.com, CAS No. 20306-22-3) (Ex. 1039 at 3). The normal boiling point of BDVE is approximately 201°C (verified using chemspider.com, CAS No. 3891-33-6) (Ex. 1039 at 5). A POSA in 2015 using standard references would have known or been able to look up the normal boiling points of DCHD and BDVE. A POSA also would have known how to determine the normal boiling points of DCHD and BDVE using well known laboratory techniques, such as measuring the temperature of a boiling sample of each reagent at standard pressure.

146. A POSA also would have been able to accurately estimate the boiling point of an organic compound like DCHD and BDVE. For example, I calculated the normal boiling points of DCHD and BDVE using a longstanding and widely cited calculation method described by Joback and Reid in 1987. Ex. 1037. In short, knowledge of an organic compound's structure allows accurate estimation of the

compound's boiling point based on the component groups that make up its structure: the normal boiling point (in Kelvin) is estimated to equal 198.2 plus the sum of the values assigned to each constituent group in the molecule, as identified in Table 3. Ex. 1037 at 234-38, example calculation at 239. The result in Kelvin can be converted to °C by subtracting 273.15.

DCHD			
<i>Group</i>	<i>Contribution</i>	<i>No.</i>	<i>Total</i>
=CH ₂	18.18	2	36.36
=CH-	24.96	2	49.92
-CH ₂ -	22.88	2	45.76
COO	81.1	2	162.2
CH ring	21.78	2	43.56
CH ₂ ring	27.15	4	108.6
Total			446.4
Boiling Point (K)			644.6
Boiling Point (°C)			371.45

BDVE			
<i>Group</i>	<i>Contribution</i>	<i>No.</i>	<i>Total</i>
=CH ₂	18.18	2	36.36
=CH-	24.96	2	49.92
-CH ₂ -	22.88	4	91.52
O nonring	22.42	2	44.84
Total			222.64
Boiling Point (K)			420.84
Boiling Point (°C)			147.69

147. Using the Joback and Reid method, a POSA would have calculated the normal boiling points of DCHD and BDVE to be approximately 371°C and 148°C, respectively, and both well below 500°C. The normal boiling points of

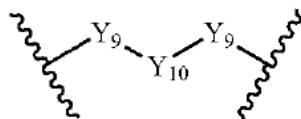
DCHD and BDVE indicate sufficient volatility to allow vapors of these crosslinking agents to enter a vacuum reaction chamber used for plasma polymerization because they were near or below the normal boiling points of other reagents that were known to be volatilizable and suitable for use in plasma polymerization. Ex. 1004 at 12:8-22 (PFAC8 and PFMAC8); Ex. 1008 at [0054], [0011] (CDMDA).

[Element 1d] [Formula A] “wherein for compound (i) L is of formula A having one of the following structures:



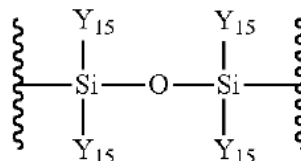
and Y_{10} is selected from optionally substituted cyclic, branched or straight chain C_1 - C_8 alkylene and a siloxane group; or

[Formula B] wherein for compound (i) L is of formula B having the following formula:



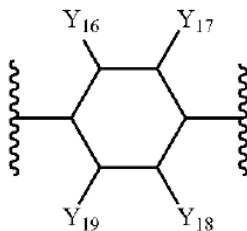
where each Y_9 is independently selected from, a bond, $—O—$, $—O—C(O)—$, $—C(O)—O—$, $—Y_{11}—O—C(O)—$, $—C(O)—O—Y_{11}—$, $—OY_{11}—$, and $—Y_{11}O—$, where Y_{11} is an optionally substituted cyclic, branched or straight chain C_1 - C_8 alkylene; and

[Formula B1] wherein Y_{10} has the following formula:



and each Y_{15} is independently selected from optionally substituted branched or straight chain C_1 - C_6 alkyl; or

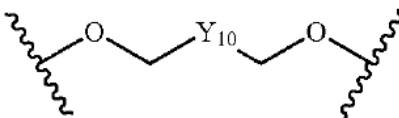
[*Formula B2*] wherein Y_{10} has the following formula:



and Y_{16} to Y_{19} are each independently selected from H and optionally substituted branched or straight chain C_1 - C_8 alkyl or alkenyl.”

148. The bridging group of DCHD follows Formula B and B2 of claim 1. Ex. 1001 at 19:20-34, 19:44-57. For Y_{10} , DCHD contains the same 6-carbon ring as in Formula B2, and the ring substituents Y_{16} to Y_{19} are all selected to be hydrogen. For Y_9 , DCHD contains $—C(O)—O—Y_{11}—$ and $—Y_{11}—O—C(O)—$ to the sides of Y_{10} . For both Y_9 selections, the Y_{11} substituent is the C_1 alkylene group, methylene ($—CH_2—$). This makes the Y_9 the selections $—C(O)—O—CH_2—$ and $—CH_2—O—C(O)—$, respectively.

149. The bridging group of BDVE follows Formula A of claim 1 with the structure



where Y_{10} is a C_2 alkylene chain ($—CH_2—$)₂.

A POSA would have used Holliday's DCHD and BDVE crosslinkers in the coatings described by Coulson-122 and Badyal

150. As Holliday shows, DCHD and BDVE both were crosslinkers that were known to those in the field well before 2015. Both have the same generic structure as the preferred crosslinker structure from Badyal: two double bonds separated by a bridging group, with hydrogen in the R1-R6 positions, and with alkyl groups interposed with oxygen atoms in the bridging group Z. Ex. 1005 at 5:1-5, 5:18-20.

151. In my opinion, a POSA would have been motivated to use the DCHD and BDVE crosslinkers described by Holliday in protective polymer films with PFAC8 or PFMAC8 based on the Coulson-122/Badyal combination. Based on Badyal's disclosures, a POSA would have viewed the structures of DCHD and BDVE consistent with those described as suitable for creating protecting plasma polymer coatings with monomers like PFAC8 and PFMAC8. Ex. 1005 at 5:1-5, 5:18-20. A POSA would have been aware that Holliday taught that both DCHD and BDVE as useful crosslinkers for protecting electrical components because the crosslinked polymers formed using DCHD or BDVE have improved mechanical, chemical, and electrical resistance properties. Ex. 1007 at 1:10-26. Holliday also taught that acrylate and methacrylate monomers could be added to the polymerizable mixture which contained the crosslinking agent. Ex. 1007 at 3:54-4:2. This would have suggested to the POSA that the DCHD and BDVE crosslinkers are re-

active with the family of acrylate and methacrylate monomers, which includes PFAC8 and PFMAC8. Since both Holliday and Coulson taught methods for producing films for electronic protection applications, a POSA would be motivated to combine one of the crosslinkers specified by Holliday, such as DCHD or BDVE, with one of the fluorine-containing monomers specified by Coulson-122 so as to achieve durable crosslinked protective coatings on the surfaces of electronic devices and components.

152. In addition, a POSA would be aware that vapors of the monomers PFAC8 and PFMAC8 could be introduced into the vacuum chamber. Since the normal boiling points of PFAC8 and PFMAC8, approximately 267°C and 300°C, respectively, are near or higher than the normal boiling points of DCHD and BDVE, a POSA would conclude that DCHD and BDVE vapors likely could be effectively introduced in the plasma reactor with PFAC8 or PFMAC8 vapors. Based on the known structures, properties, and established uses of DCHD and BDVE, a POSA would have been motivated to use DCHD and BDVE as crosslinkers in combination with PFAC8 or PFMAC8.

153. In my opinion, a POSA would have reasonably expected to succeed using Holliday's DCHD and BDVE crosslinkers to prepare plasma polymer films like those described by Coulson-122 and Badyal for a number of reasons. As I've noted, plasma polymerization was well-known and routine in the polymer field by

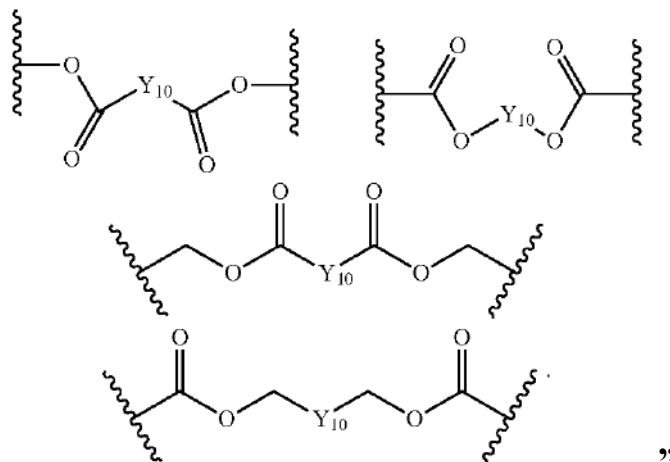
2015, and Badyal taught that crosslinkers of a generic structure that included DCHD and BDVE would be suitable for plasma co-polymerization with PFAC8 and PFMAC8. Likewise, a POSA would have known that PFAC8 and PFMAC8 are acrylate-based monomers, and Holliday taught that DCHD and BDVE could be used to make polymer coatings in conjunction with acrylates or methacrylates. Ex. 1007 at 3:55-60. A POSA would have known that BDVE could be used in plasma polymerization. Ex. 1009 at 606-07. In addition, Holliday taught that its coating reagents could be used flexibly with multiple polymerization techniques, including free-radical polymerization which is a mechanism POSAs would have known occurs during plasma deposition. Ex. 1007 at 2:47-70, 3:27-31. A POSA therefore would have expected both BDVE and DCHD to also be suitable crosslinkers for plasma polymerization. Finally, Holliday taught that DCHD and BDVE had been used successfully as crosslinkers in coatings for electronics that provided electrical insulation and chemical resistance (Ex. 1007 at 1:10-26, 2:39-46), so a POSA would have expected to attain at least those similar beneficial properties when using BDVE or DCHD in combination with PFAC8 or PFMAC8 in view of Coulson-122, Badyal, and Holliday.

2. Claims 2, 3

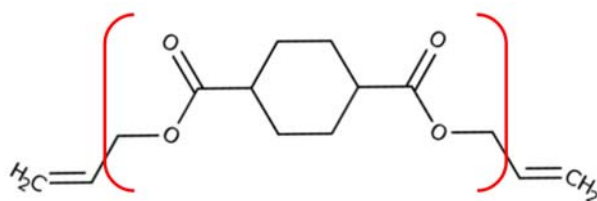
154. Claims 2 and 3 identify physical properties of the polymer coatings in claim 1. I discuss claims 2 and 3 in Section G below.

3. Claim 4

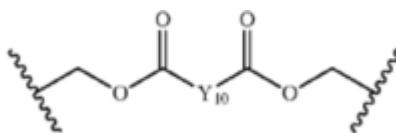
“The device or component according to claim 1, wherein when for compound (i) L is of the formula B, L has one of the following structures:



155. As I noted when discussing claim 1, the DCHD crosslinker in Holliday satisfies bridging group Formula B from '876 claim 1. Claim 4 further specifies the bridging group structure has one of four structures, as shown above. Below I've shown the structure of DCHD with the bridging group bracketed in red.



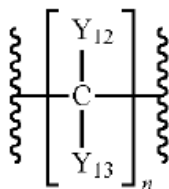
The bridging group of DCHD, emphasized above, is consistent with the third of four bridging group structures shown in claim 4



with Y₁₀ in DCHD taking the form of a para-substituted 6-carbon cyclohexane ring, consistent with Formula B2 of claim 1.

4. Claims 5 and 6

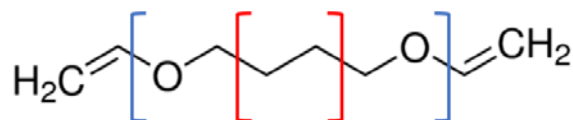
“5. The device or component according to claim 1, wherein when for compound (i) L is of formula A, Y₁₀ has the following formula:



wherein each Y₁₂ and Y₁₃ is independently selected from H, halo, optionally substituted cyclic, branched or straight chain alkyl, or —OY₁₄, where Y₁₄ is selected from optionally substituted branched or straight chain C₁-C₈ alkyl or alkenyl, and n is an integer from 1 to 10.”

“6. The device or component according to claim 5, wherein each Y₁₂ is H and each Y₁₃ is H”

156. As I noted above with reference to claim 1, the BDVE crosslinker in Holliday fits Formula A of claim 1. Claims 5 and 6 specify that Y₁₀ in Formula A has the structural formula above with n being an integer between 1 and 10, and claim 6 further specifies that each Y₁₂ and Y₁₃ is hydrogen. Ex. 1001 at 20:17-35. Below I have shown the structure of BDVE with the bridging group bracketed in blue and the Y₁₀ moiety bracketed in red.



157. For purposes of claims 5 and 6, the use of BDVE as the crosslinker

fits the specified structure because it contains a C2 alkylene ($-\text{CH}_2-$)₂ group in the Y₁₀ position and therefore matches the claimed structure with Y₁₂ and Y₁₃ as hydrogen and n = 2.

5. Claim 7

“The device or component according to claim 5, wherein each Y₁₂ is fluoro and each Y₁₃ is fluoro.”

158. A POSA would have known that perfluorinated alkyl chains confer strong hydrophobicity. Ex. 1005 5:18-23, 10:32-11:1; Ex. 1019 at 2031. In addition, Badyal taught that the bridging group in a suitable crosslinker could be perfluorinated. Ex. 1005 at 5:18-23. And a POSA would have known that water-repellency was desirable when making protective coatings for electronics. Ex. 1004 at 4:9-15. In my opinion, a POSA considering BDVE for use with Coulson-122, and Badyal therefore would have been motivated to substitute fluorine at every Y₁₂ and Y₁₃ position in BDVE to improve hydrophobicity in the resulting protective coatings. A POSA would have retained BDVE's alkylene (CH_2) groups separating the Y₁₂ and Y₁₃ groups from the oxygen of the ether groups to maintain a spacer between the oxygen and fluorocarbon moieties to promote stability of the resulting fluorine-substituted crosslinking reagent. Ex. 1038 at [0005-06]. In addition, a POSA in 2015 would have reasonably expected to succeed in obtaining and using the fluorine-substituted version of BDVE because methods to prepare fluorine-substituted divinyl ethers were known (Ex. 1038), and because Badyal taught

that the crosslinker's bridging group could include perfluoroalkyl groups, Ex. 1005 at 5:18-6:13.

6. Claim 8

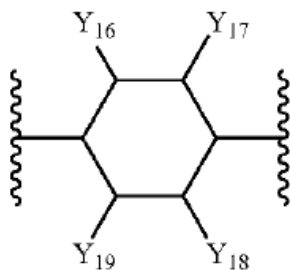
“The device or component claim 5, wherein n is from 4 to 6.”

159. A POSA also would have known as a basic matter of chemistry that longer alkyl chains, which contain a series of saturated hydrophobic $\text{—CH}_2\text{—}$ groups, tend to confer greater hydrophobicity and steric flexibility with greater length (and therefore a greater number of hydrophobic $\text{—CH}_2\text{—}$ groups). And a POSA would have known that water-repellency was desirable when making protective coatings for electronics. Ex. 1004 at 4:9-15. In my opinion, a POSA considering BDVE for use with Coulson-122 and Badyal therefore would have been motivated to extend the $(\text{CH}_2)_2 \text{Y}_{10}$ group in BDVE, for example by doubling its length, to improve the hydrophobicity of the resulting protective coatings. That would have yielded a crosslinker with four $\text{—CH}_2\text{—}$ groups as recited in claim 8, and a POSA would have recognized the resulting crosslinker as 1,6-hexanediol divinyl ether (HDVE). A POSA reasonably would have expected to succeed in obtaining and using such a modified version of BDVE because HDVE was already a known reagent in the polymer field and had been used previously as a crosslinker in combination with acrylate-based monomers. Ex. 1011 at 3:46-54, 3:1-14. In addition, a POSA in 2015 would have reasonably expected to succeed in making a variant of BDVE

with an extended alkylene chain because such modifications to the alkyl structure would have required only simple and straightforward techniques of organic synthesis that would have been known and conventional to a POSA.

7. Claim 10

“The device or component according to claim 1, wherein when for compound (i) L is of formula B and Y₁₀ has the following formula:



Y₁₈ is H or vinylene, and Y₁₆, Y₁₇ and Y₁₉ are each H.”

160. As I have described above, DCHD has a bridging group containing the same formula specified in claim 10, including a para-substituted 6-carbon cyclohexane ring like the one shown above and that includes hydrogen atoms at each of the positions labeled Y₁₆-Y₁₉ above.

8. Claims 11-15

161. In claim 11, both DCHD and BDVE are stated as specified crosslinking reagents. Ex. 1001 at 20:67, 21:3-4.

162. As I’ve already described, Coulson-122 and Badyal taught PFAC8 and PFMAC8 as monomers that would be used in the proposed combination of Holliday, Coulson-122, and Badyal, and those monomers meet the requirements set forth in claims 12-15.

D. Ground 3: Coulson-122, Badyal, and Padiyath

163. In my opinion, as explained in more detail below, claims 1-4, 10, and 12-15 of the '876 patent would have been obvious over Coulson-122 and Badyal combined with Padiyath.

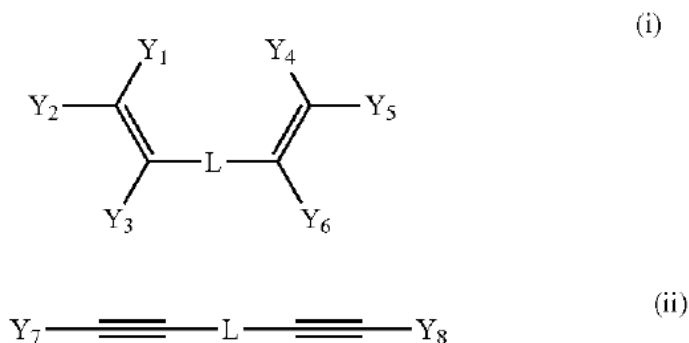
164. As previously explained, a POSA would have been aware of Coulson-122 and Badyal and would have been seeking known crosslinkers that fit Badyal's generic crosslinker structure with two double bonds and a bridging group and properties beneficial for preparing protective coatings for electronics. In my opinion, Padiyath described a known crosslinking reagent that would have met those criteria and that a POSA would have considered suitable for preparing crosslinked coatings in view of Coulson-122 and Badyal.

165. Padiyath described polymers useful for preparing barrier coatings to protect moisture or oxygen sensitive electronic devices such as organic light-emitting diodes (OLEDs), which are often used in screens for devices like televisions and mobile phones. Ex. 1008 at [0001], [0023-24], [0027], [0063-64]. Padiyath's barrier coatings could contain one or more polymer layers that could be prepared using plasma polymerization. Ex. 1008 at [0005-07], [0011], [0025], Fig. 3. The polymer layers were prepared using organic reagents, especially acrylates and methacrylates. Ex. 1008 at [0052], [0054]. Padiyath described the polymer layers as being preferably crosslinked, usually using crosslinking molecules. Ex. 1008 at

[0011], [0025], [0052]. Below I discuss Padiyath's description of a crosslinking reagent with two double bonds that a POSA would have recognized as suitable and consistent with the crosslinker structure and properties desired for use in the Coulson-122/Badyal combination.

1. Claim 1

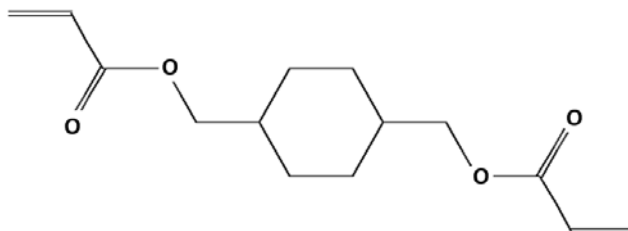
[Element 1c] “and wherein the crosslinking reagent comprises two or more unsaturated bonds attached by means of one or more linker moieties and has a boiling point of less than 500° C. at standard pressure, the crosslinking reagent having one of the following structures:



where Y₁, Y₂, Y₃, Y₄, Y₅, Y₆, Y₇ and Y₈ are each independently selected from hydrogen, optionally substituted cyclic, branched or straight chain C₁-C₆ alkyl or aryl; and L is a linker moiety;”

166. Padiyath teaches crosslinking agents possessing two double bonds which are diacrylate and dimethacrylate monomers. Ex. 1008 at [0052]. A preferred crosslinker taught by Padiyath was commercially available from the Sartomer Co. under the name CD-406, which a POSA would have known was a formulation using 100% of a component with the CAS number 67905-41-3, cyclohexane 1,4-dimethanol diacrylate (CDMDA) (also known as cyclohexane dimethanol di-

acrylate or cyclohexane dimethanol diacrylate esters). Ex. 1008 [0054]; Ex. 1030 at [0144]; Ex. 1031 at [0027]; Ex. 1032 at 1. A POSA would have known that the structure of CDMDA is as shown below:



Ex. 1030 at [0144] (and showing the structural formula of CDMDA in the provided below paragraph [0146]). Formula (i) of Claim 1 shown above matches CDMDA when the six substituents on the two double bonds, Y₁ to Y₆, are selected as hydrogen and, as will be discussed below, the appropriate bridging group bridges between the two double bonds.

167. The two unsaturated bonds of CDMDA are both part of acrylate bonding configurations, and a POSA would have expected those bonds to readily react with other acrylate and methacrylate monomers, such as PFAC8 and PFMAC8, because acrylate and methacrylate groups were known to be highly reactive in polymer applications. Padiyath, for example, indicated that it was particularly preferred to polymerize multifunctional acrylates (i.e., those like CDMDA having two or more reactive acrylate groups capable of forming bonds with other molecules) alone or in combination with other multifunctional acrylates or methacrylates or monofunctional acrylates or methacrylates (i.e., those with only one reactive acry-

late group, like PFAC8 and PFMAC8). Ex. 1008 at [0052].

168. Padiyath taught that CDMDA is a volatilizable monomer. Ex. 1008 at [0054]. The boiling point of a reagent is a fixed physical property of the reagent. A POSA would have known that the normal boiling point of CDMDA is approximately 333°C (verified on chemspider.com using CAS No. 67905-41-3) (Ex. 1039 at 7). A POSA would have known that boiling point of CDMDA, or would have been able to look it up using standard chemistry reference materials and determine it experimentally using basic laboratory techniques like measuring the temperature of a boiling sample of CDMDA at standard pressure. A POSA also would have been able to accurately estimate the normal boiling point of CDMDA using the Joback method (Ex. 1037) as I've shown below:

CDMDA			
<i>Group</i>	<i>Contribution</i>	<i>No.</i>	<i>Total</i>
=CH ₂	18.18	2	36.36
=CH-	24.96	2	49.92
-CH ₂ -	22.88	2	45.76
COO	81.1	2	162.2
CH ring	21.78	2	43.56
CH ₂ ring	27.15	4	108.6
Total			446.4
Boiling Point (K)			644.6
Boiling Point (°C)			371.45

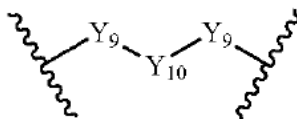
A POSA thus would have estimated the normal boiling point of CDMDA to be approximately 371°C—close to the actual normal boiling point and similarly well below 500°C and near the normal boiling points of PFAC8 and PFMAC8.

[Element 1d] [Formula A] “wherein for compound (i) L is of formula A having one of the following structures:



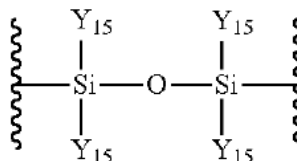
and Y_{10} is selected from optionally substituted cyclic, branched or straight chain C_1 - C_8 alkylene and a siloxane group; or

[Formula B] wherein for compound (i) L is of formula B having the following formula:



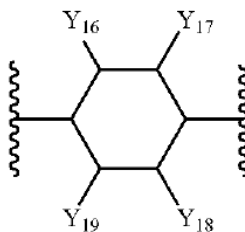
where each Y_9 is independently selected from, a bond, $—O—$, $—O—C(O)—$, $—C(O)—O—$, $—Y_{11}—O—C(O)—$, $—C(O)—O—Y_{11}—$, $—OY_{11}—$, and $—Y_{11}O—$, where Y_{11} is an optionally substituted cyclic, branched or straight chain C_1 - C_8 alkylene; and

[Formula B1] wherein Y_{10} has the following formula:



and each Y_{15} is independently selected from optionally substituted branched or straight chain C_1 - C_6 alkyl; or

[Formula B2] wherein Y_{10} has the following formula:



and Y₁₆ to Y₁₉ are each independently selected from H and optionally substituted branched or straight chain C₁-C₈ alkyl or alkenyl.”

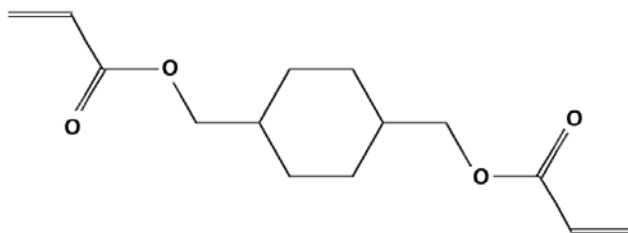
169. The bridging group of CDMDA follows Formula B and B2 of claim 1. For Y₁₀, the substituents Y₁₆ to Y₁₉ shown in Formula B2 are all hydrogen. For Y₉, the two independent selections for the left and right sides of Y₁₀ are —C(O)—O—Y₁₁— and —Y₁₁—O—C(O)—, respectively. For both Y₉ selections, the Y₁₁ substituent is the C1 alkylene group, methylene —CH₂—. Thus, the left and right selections for Y₉ are —C(O)—O—CH₂— and —CH₂—O—C(O)—, respectively.

A POSA would have used Padiyath’s CDMDA crosslinker in the coatings described by Coulson-122 and Badyal

170. Based on the teachings of Badyal, a POSA would have been aware that crosslinking improves the durability of plasma polymers utilized as protective barriers against liquids and grown using PFAC8 and PFMAC8. Ex. 1005 at 4:1-27, 8:15-18, 9:10-26. A POSA would also have known from the teachings of Coulson-122 that the plasma polymerization of PFAC8 and PFMAC8 is useful for protecting electronic devices and components. Ex. 1004 at 1:3-23, 12:7-22, 13:30-14:23.

171. A POSA motivated to select a specific crosslinking agent which followed the formula prescribed by Badyal would have considered Padiyath and its disclosure of CDMDA as a known crosslinking reagent for use in preparing protective polymer coatings. A POSA would have been aware that Padiyath taught cross-linked, multilayer polymer barriers for protecting electronic devices against water

and oxygen [0001], [0011], [0023-24], [0027], [0063-64]. And as I explained above, one reagent that Padiyath described using to make such polymers was CDMDA (Ex. 1008 at [0054]), which a POSA would have recognized as a multifunctional acrylate with two double bonds



that was consistent with the generic structure for suitable crosslinkers set forth by Badyal, including having an alkyl bridging group interposed with oxygen atoms (Ex. 1005 at 5:1-23).

172. Because CDMDA was a multifunctional diacrylate and was volatile (Ex. 1008 at [0054]) and could therefore be easily vaporized, a POSA would have recognized CDMDA as a desirable crosslinker for plasma polymerization. Padiyath reinforced that understanding because it taught that the protective barrier stack could be made entirely of polymer layers (Ex. 1008 at [0018], [0025], Fig. 3), that those polymers could be made using CDMDA (Ex. 1008 at [0054]), and that those polymers could be formed by plasma polymerization. Ex. 1008 at [0011], [0054], [0061]. Based on Padiyath's disclosures indicating the volatility of CDMDA, its suitability in preparing barrier coatings, and its suitability for plasma polymerization, along with the fact that CDMDA fit with Badyal's stated structural require-

ments for a suitable crosslinker, a POSA reading Padiyath would have been motivated to use CDMDA as a crosslinker when preparing protective coatings for electronics in view of Coulson-122 and Badyal.

173. A POSA also would reasonably have expected that the diacrylate structure of CDMDA would successfully copolymerize with other compounds in the family of acrylate and methacrylate monomers, which includes PFAC8 and PFMAC8 to create protective coatings. For one thing, Badyal taught that crosslinkers like CDMDA that have its generic crosslinker formula with two double bonds and a bridging group would be suitable for copolymerization with fluorinated monomers including PFAC8 and PFMAC8—particularly where the crosslinker (like CDMDA) does not include a fluorinated group. Ex. 1005 at 5:1-23, 6:24-7:2, 9:10-26, 8:15-19. For another, Padiyath taught that the barrier polymer layers could include monofunctional (meth)acrylates used in combination with multifunctional (meth)acrylates. Ex. 1008 at [0052]. According to Padiyath, suitable monofunctional (meth)acrylates included fluorinated (meth)acrylates in a molecular weight range between 400 and 3,000 (Ex. 1008 at [0052]), and a POSA already aware of Coulson-122 and Badyal would have known that PFAC8 (MW = 518.17) and PFMAC8 (MW = 532.19) fit within that range, so a POSA would have expected to succeed copolymerizing monofunctional fluorinated (meth)acrylates like PFAC8 and PFMAC8 with a disclosed, especially preferred multifunctional acry-

late like CDMDA (Ex. 1008 at [0052], [0054]). In addition, since both Padiyath and Coulson taught methods for producing films for electronic protection applications, a POSA would have reasonably expected to succeed to combine the crosslinker specified by Padiyath, CDMDA, with one of the fluorine-containing monomers specified by Coulson-122 to achieve durable crosslinked protective coatings on the surface of electronic devices and components.

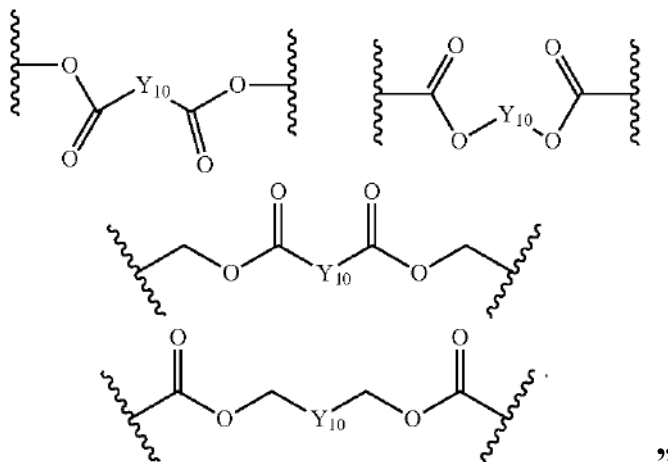
174. A POSA also would have been aware that the normal boiling points of PFAC8 and PFMAC8 are near the normal boiling point of CDMDA and therefore would have expected vapors of the monomers PFAC8 and PFMAC8 could be readily introduced into the vacuum chamber of a plasma reactor together with CDMDA crosslinking vapors.

2. Claims 2, 3

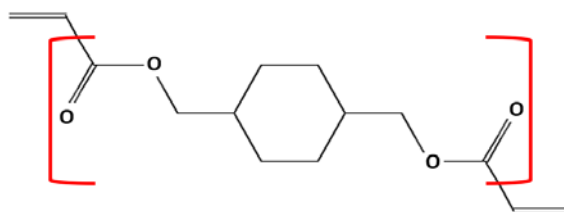
175. Claims 2 and 3 identify physical properties of the polymer coatings in claim 1. I discuss claims 2 and 3 in Section G below.

3. Claim 4

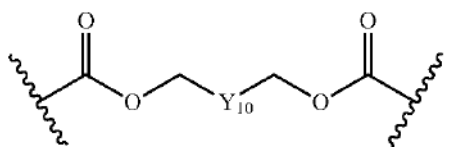
“The device or component according to claim 1, wherein when for compound (i) L is of the formula B, L has one of the following structures:



176. As noted above, the structure of CDMDA fits Formula B of claim 1. It further matches the fourth of the four bridging group structures specified in claim 4. I have provided the structure of CDMDA below, with the bridging group bracketed in red



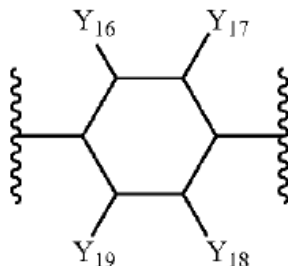
That bridging group of CDMDA matches the following claimed bridging group structure from claim 4



where for Y₁₀ CDMDA has a 6-carbon cyclohexane ring consistent with Formula B2 of claim 1.

4. Claim 10

“The device or component according to claim 1, wherein when for compound (i) L is of formula B and Y₁₀ has the following formula:



Y₁₈ is H or vinylene, and Y₁₆, Y₁₇ and Y₁₉ are each H.”

177. The bridging group of CDMDA has a 6-carbon ring identical to the one shown in claim 10, and the corresponding Y₁₆-Y₁₉ positions in the ring of CDMDA are all occupied by hydrogen, just as specified in claim 10.

5. Claims 12-15

178. As I’ve already described, Coulson-122 and Badyal taught PFAC8 and PFMAC8 as monomers that would be used in the proposed combination of Padiyath, Coulson-122, and Badyal, and those monomers meet the requirements set forth in claims 12-15.

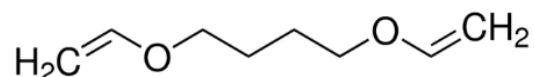
E. Ground 4: Coulson-122, Badyal, and Francesch

179. In my opinion, as explained in more detail below, claims 1-3, 5-8, and 11-15 of the ’876 patent would have been obvious over Coulson-122 and Badyal combined with Francesch.

180. As previously explained, a POSA would have been aware of Coulson-122 and Badyal and would have been seeking known crosslinkers that fit Badyal's generic crosslinker structure with two double bonds and a bridging group and properties beneficial for preparing protective coatings for electronics. In my opinion, Francesch described applying plasma polymer coatings to silicon surfaces using a fluorinated methacrylate monomer and a known crosslinking reagent—BDVE—that a POSA would have considered suitable for preparing crosslinked coatings in view of Coulson-122 and Badyal.

1. Claim 1

181. Francesch taught the plasma copolymerization of a fluorine-containing methacrylate monomer (pentafluorophenyl methacrylate (PFM)) with two different crosslinkers, one of which was BDVE



in order to deposit crosslinked polymer coatings with improved solvent resistance onto silicon substrates. Ex. 1009 at 606-07, 610. The BDVE crosslinker taught by Francesch was also described by Holliday and fit the all the structural requirements given in claim 1 for the Formula A crosslinker, as I previously explained above.

A POSA would have used Francesch's BDVE crosslinker in the coatings described by Coulson-122 and Badyal

182. In my view, several factors would have motivated a POSA to use

BDVE as a crosslinker in combination with PFAC8 or PFMAC8 to prepare protective coatings on electronics in view of Coulson-122, Badyal, and Francesch. As I explained earlier when discussing Holliday, BDVE fit the structural requirements of Badyal's generic description of suitable crosslinking reagents known in the polymer field for copolymerizing with monomers like PFAC8 and PFMAC8, including two double bonds separated by an alkyl bridging group containing interposed oxygen atoms in the preferred embodiments. Ex. 1005 at 5:1-5, 5:18-6:20. Because BDVE contained interposed oxygen atoms in its alkyl bridging group, a POSA considering Francesch in view of Badyal would have preferred BDVE over the other crosslinker described by Francesch (1,7-octadiene). A POSA would have known that 1,7-octadiene lacks the interposed oxygen atoms in its alkyl bridging group as called out by Badyal.

183. Because Francesch described using BDVE as a crosslinker to create plasma polymer coatings by co-polymerizing with a fluorinated methacrylate (PFM), a POSA would have understood that BDVE was suitable for copolymerizing with such monomers belonging to the family of acrylate and methacrylate by plasma polymerization. Ex. 1009 at 606-10. That would have reinforced the POSA's understanding that BDVE would be compatible or plasma polymerizing with other fluorinated (meth)acrylates—including PFAC8 and PFMAC8—based on its qualifying as a “suitable” crosslinker structure under the criteria set forth by

Badyal. Ex. 1005 at 5:1-23.

184. Francesch taught that co-polymerizing BDVE with PFM under pulsed plasma yielded a copolymer film with improved solvent resistance and a continuous, pinhole-free surface covering the silicon wafer substrate. Ex. 1009 at 609-610, Fig. 3(b). A POSA would have wanted to achieve solvent resistance and a pinhole-free film surface when preparing a protective coating to provide a continuous barrier because solvent resistance provides added protection and improves polymer durability, and pinholes provide gaps in the polymer through which electrical current or corrosive substances like water vapor can pass. Francesch described plasma conditions that resulted in depositing the PFM/BDVE copolymer at a rate of 8 nm per hour. Ex. 1009 at 608. Francesch also described performing plasma deposition for 2-8 hours (Ex. 1009 at 607), so a POSA would have understood that deposition time multiplied by the disclosed deposition rate meant that Francesch described depositing films containing BDVE at a thickness of approximately 16-64 nm. A POSA would have recognized that coating thicknesses in that range were suitable for providing a protective coating on electronics. Ex. 1014 at 28:23-25; Ex. 1008 at [0053]. As a result, a POSA would also be aware that BDVE could be delivered as a vapor phase reagent into a vacuum chamber used for plasma polymerization. Ex. 1009 at 606-07, 610.

185. A POSA also would have reasonably expected to succeed in using the

proposed combination of BDVE and PFAC8 or PFMAC8 to prepare protective plasma polymer coatings based on Coulson-122, Badyal, and Francesch. As I have explained, plasma polymerization was routine by 2015. Both Badyal and Francesch taught that plasma copolymerization from a mixture containing a crosslinking monomer having two double bonds and a fluorine-containing monomer from the family of acrylate and methacrylate monomers, increased the durability of the resulting protective layer, so a POSA would have expected the combination of BDVE and PFAC8 or PFMAC8 (both fluorinated, acrylate-based monomers similar to PFM) to work together for plasma polymerization. Ex. 1005 at 7:4-9:26; Ex. 1009 at 606-07, 610. A POSA would have known that BDVE has a normal boiling point near and less than PFAC8 and PFMAC8, so the POSA would have expected that BDVE vapors could be readily supplied to a plasma chamber with vapors of PFAC8 or PFMAC8. A POSA also would have expected the resulting polymer coatings to exhibit protective properties. That would have included water repellence based on the properties associated with PFAC8- and PFMAC8-based coatings reported by Coulson-122 and Badyal as well as the hydrocarbon-based bridging group of BDVE. That also would have included barrier properties because Francesch described achieving smooth, continuous, pinhole-free upon crosslinking with BDVE. Ex. 1009 at 609-10, Fig. 3(b).

186. Finally, Francesch taught successfully applying plasma-polymer coat-

ings crosslinked with BDVE to silicon wafers (Ex. 1009 at 607), which a POSA would have recognized as a similar solid surface to many electronic components and devices. A POSA would have reasonably expected to succeed in coating electronic devices with a plasma polymer based on BDVE and PFAC8 and PFMAC8 due to the success with the solid surfaces of silicon substrates in Francesch combined with the extensive disclosures about protecting electronics using monomers like PFAC8 and PFMAC8 in Coulson-122 (Ex. 1004 at 1:3-7) and the teachings in Badyal about the substrate versatility of crosslinked PFAC8 or PFMAC8 coatings (Ex. 1005 at 9:28-34, 11:22-24).

2. Claims 2, 3

187. Claims 2 and 3 identify physical properties of the polymer coatings in claim 1. I discuss claims 2 and 3 in Section G below.

3. Claims 5 and 6

188. As I explained above under Ground 2, the BDVE crosslinker described by Francesch meets the structural limitations of claims 5 and 6.

4. Claim 7

“The device or component according to claim 5, wherein each Y_{12} is fluoro and each Y_{13} is fluoro.”

189. As I explained above under Ground 2, it is my opinion that it would have been obvious to modify BDVE to obtain a fluorinated bridging group structure as specified in claim 7 in view of Badyal’s disclosures of the increased hydro-

phobicity that can be achieved using perfluoroalkyl groups.

5. Claim 8

“The device or component claim 5, wherein n is from 4 to 6.”

190. As I explained above under Ground 2, a POSA would have considered it obvious to modify BDVE to obtain the longer, more flexible and hydrophobic hydrocarbon chain in the bridging group to improve the properties of the resulting protective coatings.

6. Claims 11-15

191. In claim 11, BDVE is stated as a specified crosslinking reagent. Ex. 1001 at 20:67, 21:3-4.

192. As I’ve already described, Coulson-122 and Badyal taught PFAC8 and PFMAC8 as monomers that would be used in the proposed combination of Francesch, Coulson-122, and Badyal, and those monomers meet the requirements set forth in claims 12-15

F. Ground 5: Coulson-122, Badyal, and Tropsch

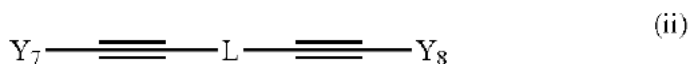
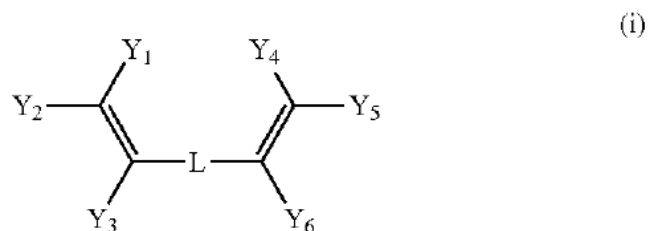
193. In my opinion, as explained in more detail below, claims 1-3, 5-8, and 12-15 of the ’876 patent would have been obvious over Coulson-122 and Badyal combined with Tropsch.

194. As previously explained, Coulson-122 and Badyal would have prompted a POSA to seek known crosslinkers that fit Badyal’s generic crosslinker structure with two double bonds and a bridging group and properties beneficial for

preparing protective coatings for electronics. Tropsch described a known crosslinking reagent that a POSA would have used for preparing crosslinked coatings in view of Coulson-122 and Badyal: 1,6-hexanediol divinyl ether (HDVE). Ex. 1011 at 4:34-38.

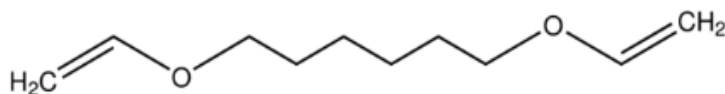
1. Claim 1

[Element 1c] “and wherein the crosslinking reagent comprises two or more unsaturated bonds attached by means of one or more linker moieties and has a boiling point of less than 500° C. at standard pressure, the crosslinking reagent having one of the following structures:



where Y₁, Y₂, Y₃, Y₄, Y₅, Y₆, Y₇ and Y₈ are each independently selected from hydrogen, optionally substituted cyclic, branched or straight chain C₁-C₆ alkyl or aryl; and L is a linker moiety;”

195. Tropsch described using HDVE as a preferred crosslinking reagent for producing polymers. Ex. 1011 at 3:48-54, 4:34-38. As a POSA would have known, the structure of HDVE is as shown below:



HDVE fit the structure (i) shown above in '876 claim 1, with two unsaturated

bonds having hydrogen at each of the Y1-Y6 positions and a bridging group between the two double bonds. A POSA would have known that the normal boiling point of HDVE is approximately 233°C (verified on chemspider.com using CAS No. 19763-13-4) (Ex. 1039 at 9). A POSA would have known that boiling point of HDVE, or would have been able to look it up using standard chemistry reference materials or determine it experimentally using basic laboratory techniques like measuring the temperature of a boiling sample of HDVE at standard pressure. A POSA also would have been able to accurately estimate the normal boiling point of HDVE using the Joback method (Ex. 1037) as I've shown below:

HDVE			
<i>Group</i>	<i>Contribution</i>	<i>No.</i>	<i>Total</i>
=CH ₂	18.18	2	36.36
=CH-	24.96	2	49.92
-CH ₂ -	22.88	6	137.28
O nonring	22.42	2	44.84
Total			268.4
Boiling Point (K)			466.6
Boiling Point (°C)			193.45

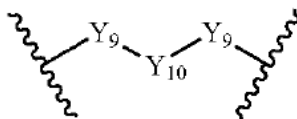
A POSA thus would have estimated the normal boiling point of HDVE to be approximately 193°C. That estimated value would have been well below 500°C, close to the actual normal boiling point, and lower than but near the normal boiling points of PFAC8 and PFMAC8.

[Element 1d] [Formula A] “wherein for compound (i) L is of formula A having one of the following structures:



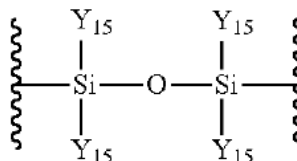
and Y₁₀ is selected from optionally substituted cyclic, branched or straight chain C₁-C₈ alkylene and a siloxane group; or

[Formula B] wherein for compound (i) L is of formula B having the following formula:



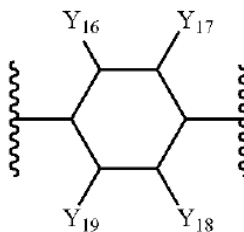
where each Y₉ is independently selected from, a bond, —O—, —O—C(O)—, —C(O)—O—, —Y₁₁—O—C(O)—, —C(O)—O—Y₁₁—, —OY₁₁—, and —Y₁₁O—, where Y₁₁ is an optionally substituted cyclic, branched or straight chain C₁-C₈ alkylene; and

[Formula B1] wherein Y₁₀ has the following formula:



and each Y₁₅ is independently selected from optionally substituted branched or straight chain C₁-C₆ alkyl; or

[Formula B2] wherein Y₁₀ has the following formula:



and Y₁₆ to Y₁₉ are each independently selected from H and optionally substituted branched or straight chain C₁-C₈ alkyl or alkenyl.”

196. HDVE fit the structure shown on the right side of Formula A in claim

1. For HDVE, Y₁₀ is a linear alkenyl chain having four carbon atoms (C₄).

A POSA would have used Tropsch's HDVE crosslinker in the coatings described by Coulson-122 and Badyal

197. Tropsch described preparing polymers containing peroxy-carboxyl groups. Ex. 1011 at 1:1-7. A disclosed preferred crosslinker in Tropsch was HDVE. Ex. 1011 at 3:48-54, 4:34-38. A POSA would have been motivated to use HDVE as a crosslinker in crosslinked Coulson-122/Badyal coatings for several reasons. HDVE was a crosslinker known in the polymer art, and HDVE's structure fell within Badyal's group of suitable crosslinkers, having two double bonds, R₁-R₆ being hydrogen, and a bridging group interposed with oxygen atoms separating the double bonds. Ex. 1005 at 5:1-23. In addition, based on the teachings of Tropsch, crosslinking building blocks can form a multitude of copolymers with one family of comonomers being the family acrylate and methacrylate monomers (Ex. 1011 at 3:1-8), which would have motivated at POSA to use HDVE as a crosslinker for the fluorine-containing monomers of Coulson-122 and Badyal include PFAC8 and PFMAC8 because those too are an acrylate and a methacrylate, respectively. A POSA also would have believed that the relatively long hydrophobic hydrocarbon chain of the HDVE bridging group would be suitable for preparing hydrophobic

polymer coatings, as would be preferred for protective coatings for use on electronics. A POSA would be aware that the normal boiling points of HDVE is approximately 233°C. That value would have suggested to a POSA that HDVE would have sufficient volatility for use as a reactant vapor for plasma co-polymerization with PFAC8 or PFMAC8, which have similar normal boiling points. Altogether, those various factors known to a POSA would have motivated combining Coulson-122, Badyal, and Tropsch to prepare electronics with a protective plasma polymer coating made using PFAC8 or PFMAC8 and HDVE as a crosslinker.

198. In my opinion, a POSA also would have reasonably expected to succeed with the proposed combination using HDVE as a crosslinker. Plasma polymerization was routine by 2015. Tropsch taught using various initiation techniques for polymer production using the disclosed crosslinkers, such as suspension polymerization and free-radical initiation using hydrogen peroxide. Ex. 1011 at 5:7-30. A POSA would have expected HDVE could be similarly polymerized with plasma methods given that activation methods could typically be substituted for one another when using reagents that can be polymerized, and especially given the similar polymerization processes that occur in free-radical and plasma polymerization. A POSA further would have recognized that HDVE is structurally similar to BDVE (the alkenyl chain in HDVE's bridging group is two carbons longer than BDVE), which was known to be suitable for crosslinking a fluorinated acrylate by

plasma polymerization (Ex. 1009 at 606-07), so a POSA would have expected similar results with HDVE.

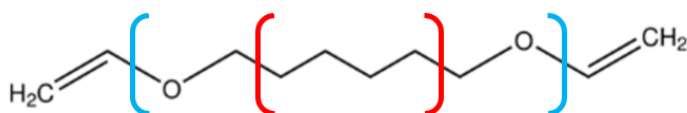
199. A POSA also would have expected compounds like HDVE that fit Badyal's generic crosslinker structure to successfully co-polymerize with the PFAC8/PFMAC8 monomers of Coulson-122 and Badyal because Badyal taught that such crosslinkers would work. Ex. 1005 at 4:17-5:19. In addition, Tropsch taught that its crosslinkers, which included HDVE as preferred, could be polymerized with acrylates (Ex. 1011 at 3:1-10, 4:34-38), which would have supported a reasonable expectation that HDVE could successfully crosslink other acrylate and methacrylate monomers like PFAC8 and PFMAC8.

2. Claims 2, 3

200. Claims 2 and 3 identify physical properties of the polymer coatings in claim 1. I discuss claims 2 and 3 in Section G below.

3. Claims 5, 6, and 8

201. The bridging group of HDVE met every additional limitation specified for the bridging group in claims 5, 6, and 8. I have provided the structure of HDVE below, with the bridging group bracketed in blue and the Y10 group bracketed in red:



202. Claim 5 specifies that Y_{10} takes the form of a carbon chain with between 1 and 10 carbon atoms in the chain, and the Y_{12} and Y_{13} groups bound to each carbon in the chain can be a number of substituents, including hydrogen. Ex. 1001 at 20:18-33. In HDVE, the Y_{10} carbon chain (red bracket) has four carbon atoms, which is an integer between 1 and 10 as claimed. In addition, each carbon in the Y_{10} carbon chain is $-\text{CH}_2-$ meaning that all of the Y_{12} and Y_{13} groups are hydrogen. Claim 6 limits each Y_{12} and Y_{13} groups to being hydrogen, which is again satisfied by the structure of HDVE.

203. Claim 8 specifies that the Y_{10} carbon chain must have a backbone of between 4 and 6 carbon atoms ($n = 4, 5, \text{ or } 6$). In HDVE, the Y_{10} carbon chain is $(-\text{CH}_2-)_4$ (i.e., $n = 4$), so HDVE satisfies claim 8 as well.

4. Claim 7

“The device or component according to claim 5, wherein each Y_{12} is fluoro and each Y_{13} is fluoro.”

204. A POSA would have known that perfluorinated alkyl chains confer strong hydrophobicity. Ex. 1005 5:18-23, 10:32-11:1; Ex. 1019 at 2031. In addition, Badyal taught that the bridging group in a suitable crosslinker could be perfluorinated. Ex. 1005 at 5:18-23. And a POSA would have known that water-repellency was desirable when making protective coatings for electronics. Ex. 1004 at 4:9-15. In my opinion, a POSA considering Tropsch, Coulson-122, and Badyal therefore would have been motivated to substitute fluorine at every Y_{12} and

Y₁₃ position in HDVE to improve hydrophobicity in the resulting protective coatings. A POSA would have retained HDVE's alkylene (CH₂) groups separating the Y₁₂ and Y₁₃ groups from the oxygen of the ether groups to maintain a spacer between the oxygen and fluorocarbon moieties to promote stability of the resulting fluorine-substituted crosslinking reagent. Ex. 1038 at [0005-06]. In addition, a POSA in 2015 would have reasonably expected to succeed in obtaining and using the fluorine-substituted version of HDVE because methods to prepare fluorine-substituted divinyl ethers were known, Ex. 1038, and because Badyal taught that the crosslinker's bridging group could include perfluoroalkyl groups, Ex. 1005 at 5:18-6:13.

5. Claims 12-15

205. As I've already described, Coulson-122 and Badyal taught PFAC8 and PFMAC8 as monomers that would be used in the proposed combination of Tropsch, Coulson-122, and Badyal, and those monomers meet the requirements set forth in claims 12-15.

G. All Grounds: Claims 2 and 3

206. In my opinion, as explained in more detail below, claims 2 and 3 of the '876 patent would have been obvious over Coulson-122 and Badyal combined with any of Cohen, Holliday, Padiyath, Francesch, and Tropsch.

1. Claim 2

“The device or component according to claim 1, wherein the protective cross-linked polymeric coating is a physical barrier to mass and electron transport.”

207. Claim 2 specifies that the coating is a physical barrier to mass and electron transport. To a POSA, a barrier to electron transport is something that impedes electrical conductance, often referred to as an electrical insulator (Ex. 1012 at 1:9-18), and that is consistent with the '876 patent's description of the coatings as able to provide electrical insulation. Ex. 1001 at 3:41, 4:7, 4:14-15. Providing electrically insulating coatings on electrical components and devices has long been known and desired to protect such components from short circuits and other electrical damage. Ex. 1007 at 1:10-52, 2:17-35; Ex. 1012 at 7:8-10; Ex. 1018 at 1:6-28; Ex. 1033 at [0001-04], [0015-16]. Similarly, a barrier to mass transport impedes passage of molecules having mass such as liquids and gases, consistent with the '876 patent's discussion of restricting the passage of water, oxygen, and ions. Ex. 1001 at 3:1-6. It was also well known that providing protective coatings for electronics that could restrict passage of such molecules was helpful for preventing corrosion by preventing those molecules from contacting the underlying electronics. Ex. 1008 at [0023-24]; Ex. 1013 at [0004]; Ex. 1007 at 1:50-52; Ex. 1014 at 1:14-17; Ex. 1029 at 6207-08, 6210.

208. A POSA would have known that plasma polymer coatings applied us-

ing fluorinated acrylate-based monomers including PFAC8 and PFMAC8 taught by Coulson-122 and Badyal provided electrically insulating and barrier properties. Ex. 1012 at 7:3-21, 13:3-14; Ex. 1014 at 4:22-55, 16:7-27. In general, a POSA would have expected crosslinking to improve the barrier and insulating properties of coatings made with those fluoroacrylates because crosslinking was known to yield more amorphous (less crystalline) polymer structure, reducing surface roughness and thus the incidence of channels or gaps (pinholes) forming in the coating. Ex. 1026 at 6550-53. A POSA would have known that channels typically present in crystalline coatings with rough, irregular surfaces could allow corrosive molecules like oxygen or water vapor to pass through to the substrate or provide a pathway for electrical conductance across the coating.

209. Consistent with those expectations, a POSA also would have known that many crosslinkers also including DVTMDS, DCHD, BDVE, and CDMDA had been associated with barrier and/or insulating properties when used in polymer coatings. DVTMDS had been used in electrically insulating coatings. Ex. 1006 at 5:1-12; Ex. 1018 at 1:6-11, 3:50-4:25; Ex. 1017 at 3:27-4:20; Ex. 1033 at [0002], [0040]. DVTMDS had also been used in barrier coatings. Ex. 1017 at 3:27-4:20. DCHD and BDVE had been used in coatings provided to achieve electrical insulation, reduced permeability, and chemical or solvent resistance. Ex. 1007 at 5:48-54, 1:10-51; Ex. 1009 at 610. CDMDA had been taught for use in preparing polymer

layers to provide a barrier against water and oxygen. Ex. 1008 at [0023-24]. Accordingly, a POSA would have expected coatings prepared using PFAC8 or PFMAC8 and a crosslinking reagent as in Grounds 1-5 to exhibit barrier and insulating properties at least as effective as those provided by coatings based on PFAC8 or PFMAC8 alone.

210. A POSA who desired to prepare a plasma-polymer coating with barrier properties using those materials also would have known that, as a basic principle, the ability of a coating to provide insulation and block the passage of contaminants from the environment typically increases as the thickness of the coating increases. Ex. 1013 at [0039]. The POSA would have known that the thickness of a plasma polymer coating can be increased by increasing the polymerization time. Ex. 1014 9:15-17, 28:23-25; Ex. 1009 at 608. It therefore would have been straightforward for a POSA seeking to enhance barrier properties in a crosslinked coating based on the combinations of monomers and crosslinkers described in Grounds 1-5 to do so by increasing the substrate's plasma exposure time to provide a coating with greater thickness and testing the resulting coatings at various thicknesses to verify that the desired barrier properties had been achieved.

211. In addition, a POSA would have known that the properties of a copolymer depend on its components. Both the monomers, PFAC8 or PFMAC8, and crosslinkers, including at least DVTMDS, DCHD, BDVE, and CDMDA, were

known to yield units in polymeric coatings with the barrier properties in claim 2. Therefore, a POSA would have expected that co-polymer coatings produced using those components in combination would necessarily exhibit the properties in claim 2.

2. Claim 3

“The device or component according to claim 1, wherein the protective cross-linked polymeric coating forms a liquid repellent surface defined by a static water contact angle (WCA) of at least 90°.”

212. Claim 3 specifies that the coating has a static water contact angle (WCA) of at least 90°C. A POSA would have known WCA as a standard metric for measuring the hydrophobicity of a surface. In general, the test is performed by placing a droplet of a liquid, such as water, on a surface to be tested and then measuring the angle formed by the liquid where it contacts the surface, as I’ve shown below:



A POSA would have understood that, generally speaking, the larger the contact angle, the more liquid-repellent the surface is considered to be. Ex. 1013 at [0041]; Ex. 1015 at [0011-17], Figs. 1-2; Ex. 1012 at 11:4-11; Ex. 1014 at 12:4-5; Ex. 1029 at 6204-06 and Fig. 19. Thus, a POSA would have concluded that the surface

illustrated on the right in the diagram above is more water-repellent than the surface on the left. As a general benchmark, a 90° contact angle was often considered a cutoff between hydrophobic and non-hydrophobic surfaces. Ex. 1013 at [0041]. A high WCA manifests in the commonly observed phenomenon of water beading on a hydrophobic surface, such as a lotus leaf or a newly waxed finish on a car.

213. As I have discussed, fluorinated monomers like the PFAC8 and PFMAC8 monomers described by Coulson-122 and Badyal were well known to yield surfaces that have hydrophobic properties and form water-repellent coatings when applied to a surface by plasma polymerization. Ex. 1004 at 3:14-4:3, 12:7-22, 13:30-14:23; Ex. 1019 at 2037-38; Ex. 1012 at 10:13-11:11; Ex. 1014 at 13:30-14:23; Badyal; Ex. 1029 at 6204-06. A POSA looking at the known bridging structures of the crosslinkers in Ground 1-5 (DVTMDS, DCHD, BDVE, CDMDA, and HDVE) would have expected that those compounds would exhibit hydrophobicity. The bridging structures for DCHD, BDVE, CDMDA, and HDVE are made up primarily of alkyl hydrocarbon groups, which were well known to be hydrophobic. Ex. 1005 at 4:21-23. The siloxane bridging group in DVTMDS with its four methyl substituents also would have been well known to a POSA as being associated with hydrophobicity. Ex. 1014 at 4:5-5:13, 16:7-14. A POSA therefore would have found hydrophobicity, with a WCA of at least 90° to be an obvious and expected property when preparing plasma coatings made with the perfluorinated PFAC8 or

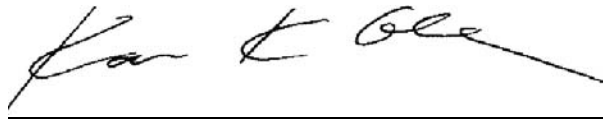
PFMAC8 monomers in combination with any of the organic crosslinkers specified in Grounds 1-5.

214. The molecular composition of a polymer determines its hydrophobicity. Because PFAC8 and PFMAC8 are inherently hydrophobic due to their perfluorinated chains (Ex. 1029 at 6204-06; Ex. 1005 at 4:23-25, 9:10-26, 8:15-19; Ex. 1016 at 4:41-44), and because the crosslinking reagents cited in Grounds 1-5 also consisted primarily of hydrophobic bridging groups, combining those reagents naturally and necessarily would have resulted in a co-polymer with hydrophobic properties, as characterized by a WCA of at least 90°.

I hereby declare that all the statements made in this Declaration are of my own knowledge and true; 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 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I declare under the penalty of perjury that all statements made in this declaration are true and correct.

Date: July 9, 2020

A handwritten signature in black ink, appearing to read "Karen K. Gleason", written over a horizontal line.

Karen K. Gleason, Ph.D.