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(54) **USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS**

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

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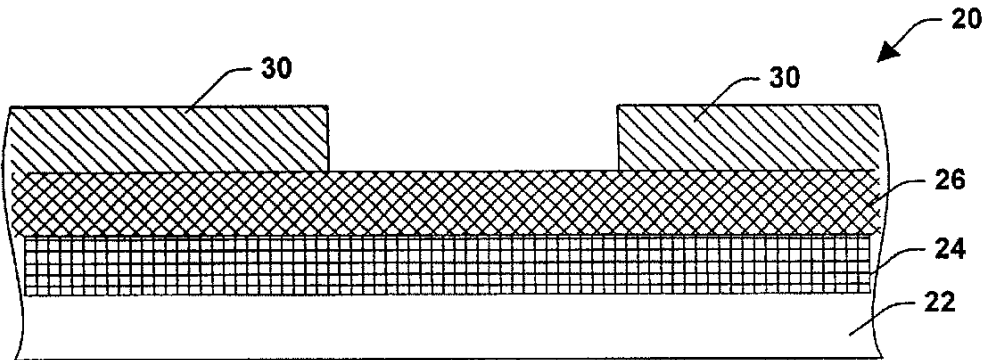
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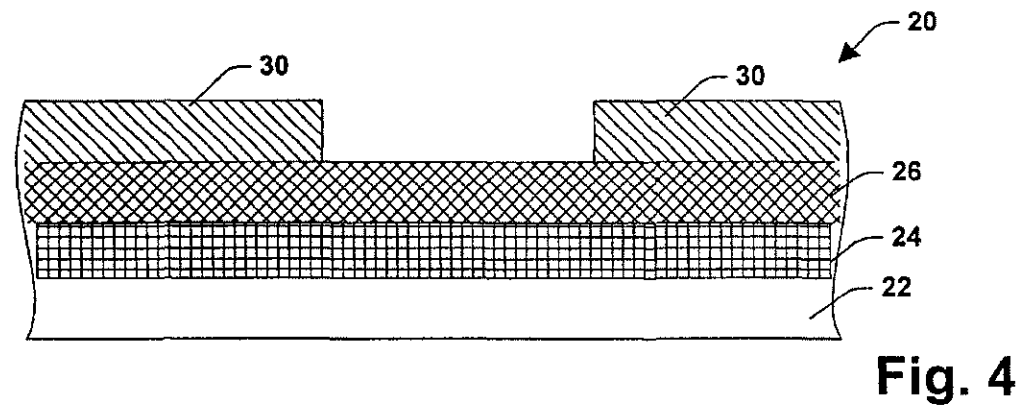
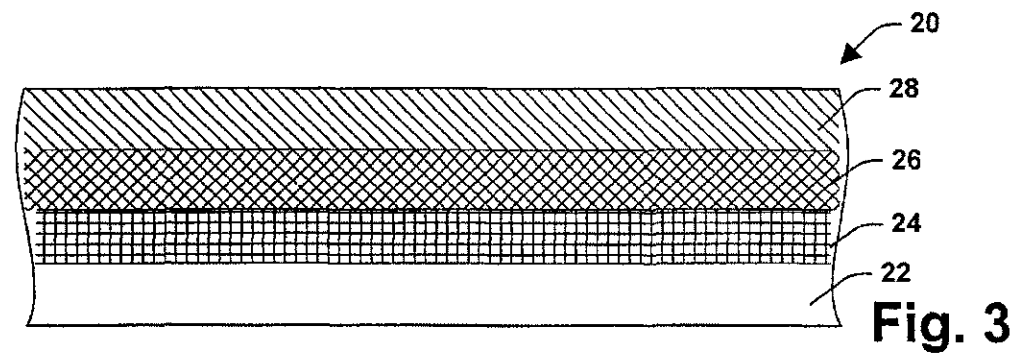
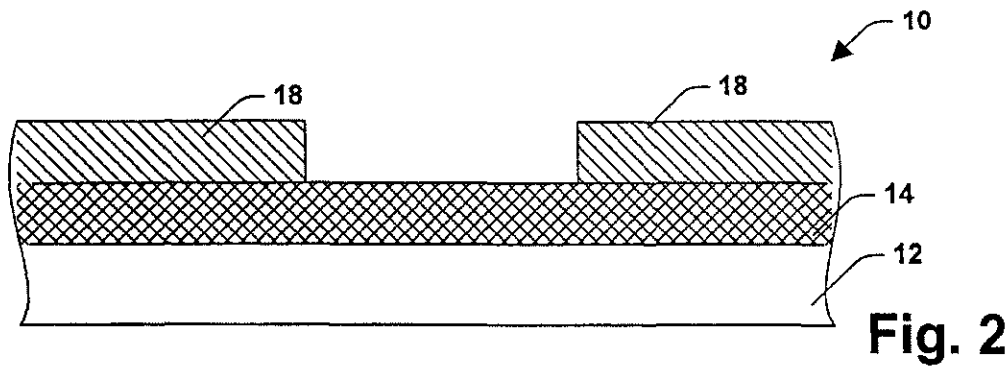
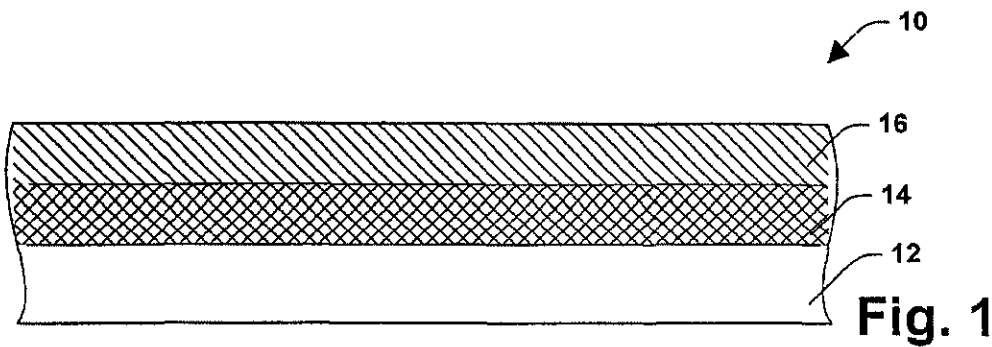
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(57) **ABSTRACT**

In one embodiment, the present invention relates to a method of forming a silicon oxynitride antireflection coating over a metal layer, involving the steps of providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate; depositing a silicon oxynitride layer over the metal layer having a thickness from about 100 Å to about 150 Å; and forming an oxide layer having a thickness from about 5 Å to about 50 Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating. In another embodiment, the present invention relates to a method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, involving forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer over the oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

20 Claims, 1 Drawing Sheet





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USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

TECHNICAL FIELD

The present invention generally relates to making and using a silicon oxynitride antireflection coating over highly reflective underlying layers. In particular, the present invention relates to providing a silicon oxynitride antireflection coating having an oxide layer well suited for use with deep UV photoresists.

BACKGROUND ART

Microolithography processes for making miniaturized electronic components, such as in the fabrication of computer chips and integrated circuits, involve using photoresists.

Generally, a coating or film of a photoresist is applied to a substrate material, such as a silicon wafer used for making integrated circuits. The substrate may contain any number of layers or devices thereon. The photoresist coated substrate is baked to evaporate any solvent in the photoresist composition and to fix the photoresist coating onto the substrate. The baked coated surface of the substrate is next subjected to selective radiation; that is, an image-wise exposure to radiation.

This radiation exposure causes a chemical transformation in the exposed areas of the photoresist coated surface. Types of radiation commonly used in microlithographic processes include visible light, ultraviolet (UV) light, electron beam and X-ray radiant energy. After selective exposure, the photoresist coated substrate is treated with a developer solution to dissolve and remove either the radiation-exposed or the unexposed areas of the photoresist.

Especially with the trend towards miniaturization of semiconductor devices, there are problems that result from the back reflection of light from highly reflective substrates (back reflection from layers underneath the photoresist). Two deleterious effects of back reflectivity are thin film interference and reflective notching. Thin film interference results in a changes in critical linewidth dimensions caused by variations in the total light intensity in the photoresist film as the thickness of the photoresist changes. Reflective notching becomes severe as the photoresist is patterned over substrates containing topographical features, which tend to scatter light through the photoresist film, leading to linewidth variations, and in extreme cases, forming regions with complete photoresist loss.

Dyed photoresists have been utilized in an effort to solve these reflectivity problems. However, dyed photoresists only reduce reflectivity from the underlying substrate, they do not totally eliminate the reflectivity. Additional shortcomings associated with dyed photoresists are that dyed photoresists tend to cause reduction in the lithographic performance of the photoresist, the undesirable possible sublimation of the dye, and incompatibility of the dye in the photoresist films.

To prevent reflection of activating radiation into a photoresist coating, it is known to provide antireflection layers or antireflection coatings (ARCs) between a substrate and a photoresist layer. ARCs generally function by absorbing the radiation used for exposing the photoresist; that is, reducing reflectivity at the photoresist/underlying substrate interface. ARCs may comprise an absorbing dye dispersed in a polymer binder, though some polymers contain sufficient chromophores (or characteristics thereof) whereby a dye is not required. When used, the dye is selected to absorb and

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attenuate radiation at the wavelength used to expose the photoresist layer thus reducing the incidence of radiation reflected back into the photoresist layer. During conventional processing of an integrated circuit substrate coated with the combination of an ARC and a photoresist layer, the photoresist is patterned to form a mask defining a desired pattern.

To alter the underlying substrate, the ARC must be removed to bare the underlying substrate in a desired pattern. However, there are problems associated with removal of the ARC including incomplete removal, and/or undesirable damage, removal or interaction with the photoresist or underlying substrate. In addition to difficulties associated with removal of an ARC, other problems are often encountered when an ARC is used in combination with a photoresist coating. One such problem is that of selecting an antireflective coating that is compatible with the photoresist used. The ARC should be inert with respect to the photoresist coating while firmly bonding to the photoresist coating. Another problem is that of selecting an ARC that firmly bonds to the underlying substrate to avoid lift-off of the unremoved photoresist coating (from development) during processing of the underlying substrate. There are also problems associated with selecting ARCs having desirable properties at certain wavelengths that simultaneously possess the above mentioned desirable compatibility properties.

Titanium nitride is conventionally used as an ARC. However, when a titanium nitride ARC is used over a metal layer having a high reflectivity (for example, about 80%), reflectivity concerns continue to exist, especially at shorter wavelength irradiation (for example, about 248 nm or 365 nm). This is because the reflectivity of a titanium nitride ARC over a metal layer generally does not go below about 25%.

Moreover, with specific regard to deep ultraviolet (UV) photoresists, compatibility concerns exist with ARCs that contain nitrogen. This is because nitrogen deleteriously effects deep UV photoresists. In particular, nitrogen may migrate from the ARC and poison a deep UV photoresist by desensitizing them to UV light, thus inhibiting development of the photoresist. Desensitized deep UV photoresists exhibit extremely poor pattern definition after development.

SUMMARY OF THE INVENTION

The present invention provides an ARC containing a silicon oxynitride layer and an oxide layer with improved optical characteristics that lead to improved critical dimension control. The present invention also provides a silicon oxynitride ARC that is compatible with deep UV photoresists since a thin oxide layer prevents nitrogen from the silicon oxynitride layer from contacting an overlying photoresist, more extensively enabling the use of deep UV photoresists. The presence of the thin oxide layer over the silicon oxynitride layer enable reworking of the photoresist since the oxide layer is not damaged and protects the silicon oxynitride layer from attack by reworking chemicals. Moreover, the present invention provides a silicon oxynitride ARC that may be tailored to the optical properties of an underlying metal layer. As a result, the present invention effectively addresses the concerns raised by the trend towards the miniaturization of semiconductor devices.

In one embodiment, the present invention relates to a method of forming a silicon oxynitride antireflection coating over a metal layer, involving the steps of providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate; depositing a sili-

con oxynitride layer over the metal layer having a thickness from about 100 Å to about 1500 Å; and forming an oxide layer having a thickness from about 5 Å to about 50 Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating.

In another embodiment, the present invention relates to a method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, involving forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

In yet another embodiment, the present invention relates to a method of processing a semiconductor substrate, involving the steps of providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%; forming a silicon oxynitride antireflection coating over the metal layer having a thickness from about 100 Å to about 1500 Å, the silicon oxynitride antireflection coating comprising an oxide layer over a silicon oxynitride layer; depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating; selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and developing the deep ultraviolet photoresist.

BRIEF DESCRIPTION OF DRAWINGS

- FIG. 1 illustrates in a cross-sectional view the methods according to one aspect of the present invention.
- FIG. 2 illustrates in a cross-sectional view the methods according to one aspect of the present invention.
- FIG. 3 illustrates in a cross-sectional view the methods according to one aspect of the present invention.
- FIG. 4 illustrates in a cross-sectional view the methods according to one aspect of the present invention.

DISCLOSURE OF INVENTION

The present invention involves making and using a silicon oxynitride ARC over highly reflective underlying layers. The silicon oxynitride ARC contains a silicon oxynitride layer and a thin oxide layer. In this connection, the silicon oxynitride ARC may be termed an oxide-silicon oxynitride ARC. The present invention more specifically involves making and using a silicon oxynitride ARC over underlying metal layers over which the reflectivity of the ARC is altered or controlled by adjusting the ratios of components and the thickness of the silicon oxynitride portion of the ARC. The optical properties of an underlying layer (a layer over which an ARC is formed) may dictate the degree of reflectivity that the ARC must possess. The present invention also involves making and using a silicon oxynitride ARC with a deep UV photoresist.

The ARCs of the present invention are used over an underlying layer having a reflectivity that may deleteriously affect the photoresist patterning process. In one embodiment, the underlying layer is a metal layer. In another embodiment, the underlying layer is a conductive metal layer. Metal layers include layers of a single metal as well as metal alloy layers containing two or more metals. Specific examples of underlying layers include aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium,

tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, metal silicides, and any other alloys thereof. Although the reflectivity may vary for each such metal layer, typically metal layers have reflectivities of about 70% to about 90% or more. For example, aluminum has a reflectivity of about 80% or more.

The silicon oxynitride ARC of the present invention is made by initially forming a silicon oxynitride layer on an underlying layer. The silicon oxynitride layer can be formed using any suitable technique including chemical vapor deposition (CVD) techniques, such as low pressure chemical vapor deposition (LPCVD) or plasma enhanced chemical vapor deposition (PECVD). In one embodiment, the silicon oxynitride layer is formed using LPCVD techniques at temperatures from about 600° C. to about 900° C. using a nitrogen containing gas, an oxygen containing gas and a silicon containing gas, such as using SiH₄, N₂O and N₂ or NH₃. In another embodiment, the silicon oxynitride layer is formed using PECVD techniques at temperatures from about 200° C. to about 400° C. using a nitrogen containing gas, an oxygen containing gas and a silicon containing gas, such as using SiH₄, N₂O and N₂ or NH₃. The relative amounts of oxygen and nitrogen incorporated into the initial silicon oxynitride layer can be varied by varying the flow rates of the nitrogen containing gas and the oxygen containing gas. Although termed a silicon oxynitride layer herein, the initial silicon oxynitride layer formed in accordance with the present invention may contain hydrogen, and thus in one embodiment is characterized by the chemical formula SiON:H.

In one embodiment, the initial silicon oxynitride layer has a thickness from about 100 Å to about 1500 Å. In another embodiment, the initial silicon oxynitride layer has a thickness from about 125 Å to about 1400 Å. In yet another embodiment, the initial silicon oxynitride layer has a thickness from about 150 Å to about 1300 Å.

After a silicon oxynitride layer is formed, a thin oxide layer is formed over the top surface of the silicon oxynitride layer to form the oxide-silicon oxynitride ARC. The thin oxide layer prevents nitrogen atoms of the silicon oxynitride layer from contacting the subsequently applied photoresist. During rework of a poorly applied or poorly developed photoresist, the thin oxide layer protects the silicon oxynitride layer against chemical attack and/or degradation by rework chemicals. The thin oxide layer is formed over the silicon oxynitride layer by any suitable manner.

In one embodiment, oxygen plasma is contacted with the silicon oxynitride layer to form an oxide layer over the silicon oxynitride layer. In another embodiment, N₂O plasma is contacted with the silicon oxynitride layer to form an oxide layer over the silicon oxynitride layer. In both of these embodiments, an inert or carrier gas may be present during the plasma treatment. In yet another embodiment, CVD (PECVD or LPCVD) techniques are employed to deposit an oxide layer over the silicon oxynitride layer. In this embodiment, SiH₄, and one of N₂O and O₂ are used to form an oxide layer.

In one embodiment, the thin oxide layer has a thickness from about 5 Å to about 50 Å. In another embodiment, the thin oxide layer has a thickness from about 10 Å to about 40 Å. In yet another embodiment, the thin oxide layer has a thickness from about 15 Å to about 35 Å.

The silicon oxynitride ARC is formed to a suitable thickness to exhibit a desired reflectivity. In one

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embodiment, the silicon oxynitride ARC formed in accordance with the present invention has a thickness from about 100 Å to about 1500 Å. In another embodiment, the silicon oxynitride ARC has a thickness from about 125 Å to about 1400 Å. In yet another embodiment, the silicon oxynitride ARC has a thickness from about 150 Å to about 1300 Å. In a preferred embodiment, the silicon oxynitride ARC has a thickness from about 125 Å to about 600 Å.

The reflectivity of the resultant silicon oxynitride ARC depends upon a number of factors including the ratio of silicon oxynitride components (the relative amounts of oxygen and nitrogen), the thickness of the initial silicon oxynitride layer, the thickness of the thin oxide layer and the thickness of the resultant silicon oxynitride ARC.

In one embodiment, a silicon oxynitride ARC having a thickness of about 200 Å (including an oxide layer having a thickness of about 50 Å) formed over an aluminum layer has a reflectivity from about 0% to about 10% (below about 10%) at a wavelength of about 248 nm. In another embodiment, a silicon oxynitride ARC having a thickness of about 200 Å formed over an aluminum layer has a reflectivity from about 1% to about 5% (below about 5%) at a wavelength of about 248 nm. In yet another embodiment, a silicon oxynitride ARC having a thickness of about 350 Å (including an oxide layer having a thickness of about 50 Å) formed over an aluminum layer has a reflectivity from about 1% to about 10% (below about 10%) at a wavelength of about 365 nm. In still yet another embodiment, a silicon oxynitride ARC having a thickness of about 350 Å (including an oxide layer having a thickness of about 50 Å) formed over an aluminum layer has a reflectivity from about 0.1 % to about 5% (below about 5%) at a wavelength of about 365 nm.

In this connection, the silicon oxynitride ARC reduces the apparent reflectivity of an underlying metal (comparing the reflectivity of a metal layer with the reflectivity of a silicon oxynitride ARC according to the present invention over the metal layer). In one embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon oxynitride ARC is at least about 60% (for instance, a metal layer having a reflectivity of 70% and a silicon oxynitride ARC having a reflectivity of 8%). In another embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon oxynitride ARC is at least about 70%. In yet another embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon oxynitride ARC is at least about 75%.

The silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 425 nm. In another embodiment, the silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 365 nm. In yet another embodiment, the silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 248 nm. As a result, the silicon oxynitride ARC is well suited for use with deep UV photoresists. Specific examples of wavelengths at which the silicon oxynitride ARC exhibits reflectivities below about 20% include about 405 nm, about 365 nm, about 308 nm, about 290 nm, about 280 nm, about 265 nm, about 248 nm, about 193 nm and about 157 nm.

Any photoresist material may be used as a photoresist over the silicon oxynitride ARC formed in accordance with the present invention. For example, a 193 nm sensitive

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photoresist, an I-line, H-line, G-line, E-line, deep UV or chemically amplified photoresist material may be spin-coated on the silicon oxynitride ARC. Photoresists are commercially available from a number of sources, including Shipley Company, Kodak Hoechst Celanese Corporation, Brewer and IBM. The photoresist is typically applied to a thickness from about 5,000 Å to about 15,000 Å, although the thickness of the photoresist is not critical to the invention.

Referring to FIGS. 1 and 2, a general embodiment of the present invention is described. A portion of a semiconductor structure 10 is shown with underlying substrate 12.

Underlying substrate 12 may be one or more layers of semiconductor materials wherein the top surface has a relatively high reflectivity (for example, above about 70%). A silicon oxynitride ARC 14 is formed over the underlying substrate 12 using a two-step process; namely, forming a silicon oxynitride layer by suitable CVD techniques followed by forming a thin oxide layer over the silicon oxynitride layer thereby forming a silicon oxynitride ARC having a desired thickness. The relative amounts of oxygen and nitrogen used to form the silicon oxynitride layer, the thickness of the silicon oxynitride layer, the thickness of the oxide layer and the thickness of the resultant silicon oxynitride ARC may be modified to adjust the reflectivity of the resultant silicon oxynitride ARC in light of the specific reflectivity of the underlying substrate 12. In preferred embodiments of using the silicon oxynitride ARC 14, the underlying layer 12 contains at least two layers wherein the top or uppermost layer is a metal layer (such as a single metal layer or metal alloy layer). A suitable photoresist 16 is deposited over the silicon oxynitride ARC 14 using known techniques. For example, the photoresist 16 is deposited using conventional spin-coating techniques.

Referring to FIG. 2, the photoresist 16 is then patterned using suitable photolithographic techniques resulting in the formation of a pattern 18. The pattern 18 is formed using electromagnetic radiation having a relatively small wavelength (for example, less than 425 nm). The exposed portion of the silicon oxynitride ARC 14 may have any desired cross-section or line-width, such as about 0.35 μm, about 0.25 μm, about 0.18 μm, about 0.15 μm, about 0.1 μm and/or about 0.05 μm. The photoresist pattern 18 is then used as a mask in subsequent processing of the semiconductor structure 10. For example, the photoresist pattern 18 may be used as an etch mask for patterning the silicon oxynitride ARC 14 and the underlying substrate 12.

Due to the presence of the silicon oxynitride ARC 14, energy which passes through the photoresist 16 is not reflected back into the photoresist 16 by the underlying layer 12 to the extent it would have been reflected back without the silicon oxynitride ARC 14. As a result of the present invention, improved critical dimension control is achieved as the dimensions of the patterns and/or various openings in the patterned photoresist 18 are controllable, crisp and of high quality. Additional layers can be incorporated into semiconductor structure 10 so long as the silicon oxynitride ARC 14 can function at least as an antireflection layer.

Referring to FIGS. 3 and 4, a specific embodiment of the present invention is described. A portion of a semiconductor structure 20 is shown with a semiconductor substrate layer 22 and an aluminum layer 24 formed on the semiconductor structure 20. Semiconductor layer 22 is made of one or more layers including substrate layers, diffusion regions, dielectric layers such as oxides and nitrides, devices, polysilicon layers, and the like. Although shown as continuous, the

aluminum layer 24 may be continuous or intermittent. A silicon oxynitride ARC 26 is formed over the aluminum layer 24 using a two-step process; namely, forming a silicon oxynitride layer by suitable CVD techniques followed by exposing the silicon oxynitride layer to oxygen plasma for a time sufficient to form an oxide layer having a thickness of about 50 Å thereby forming a silicon oxynitride ARC. In particular, PECVD is performed at a temperature about 300° C. using N₂O, N₂ and SiH₄. The silicon oxynitride layer has a thickness of about 150 Å and the silicon oxynitride ARC has a thickness of about 200 Å. A suitable photoresist 28, such as a deep UV photoresist is deposited over the silicon oxynitride ARC 26 using spin-coating techniques.

Referring to FIG. 4, the photoresist 28 is then patterned using suitable photolithographic techniques resulting in the formation of a photoresist pattern 30. The photoresist pattern 30 is formed using electromagnetic radiation having a wavelength of about 248 nm. The exposed portion of the silicon oxynitride ARC 26 may have any desired cross-section or line-width, such as about 0.35 μm, about 0.25 μm, about 0.18 μm, about 0.15 μm, about 0.1 μm and/or about 0.05 μm. The photoresist pattern 30 is then used as a mask in subsequent processing of the semiconductor structure 20. For example, the photoresist pattern 30 may be used as an etch mask for patterning the silicon oxynitride ARC 26 and the aluminum layer 24.

Due to the presence of the silicon oxynitride ARC 26, energy which passes through the photoresist 28 tends not to be reflected back into the photoresist 28 by the highly reflective underlying aluminum layer 24 to the extent it would have been reflected back without the silicon oxynitride ARC 26. As a result of the present invention, improved critical dimension control is achieved as the dimensions of the patterns and/or various openings in the patterned photoresist 30 are controllable, crisp and of high quality. In another embodiment, additional layers can be incorporated into semiconductor structure 10 so long as the silicon oxynitride ARC 26 can function at least as an antireflection layer.

In another embodiment, again referring to FIGS. 3 and 4, the present invention relates to using a metal layer 24 of one of copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides instead of the aluminum layer 24.

The precise amount of oxygen and nitrogen incorporated into the initial silicon oxynitride layer, the thickness of the silicon oxynitride layer, the thickness of the oxide layer and the thickness of the resultant silicon oxynitride ARC determine the reflectivity of the resultant silicon oxynitride ARC, which in turn may be selected in light of the reflectivity of the specific underlying metal layer. Reflective notching in submicron photoresist patterns is thus minimized and/or eliminated by using the silicon oxynitride ARCs in accordance with the invention.

Moreover, since the oxide layer of the silicon oxynitride ARC prevents nitrogen atoms from migrating from the silicon oxynitride layer to the photoresist, deep UV photoresists, which tend to be deleteriously effected by nitrogen atoms, may be used in combination with the silicon oxynitride based ARC of the present invention. And since the thin oxide layer protects the silicon oxynitride layer against chemical attack and/or since the thin oxide layer is

not substantially degraded by rework chemicals, rework of a poorly applied or poorly developed photoresist is facilitated even though a silicon oxynitride based ARC is employed.

Although the invention has been shown and described with respect to a certain preferred embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described components (assemblies, devices, circuits, etc.), the terms (including any reference to a “means”) used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiments of the invention. In addition, while a particular feature of the invention may have been disclosed with respect to only one of several embodiments, such feature may be combined with one or more other features of the other embodiments as may be desired and advantageous for any given or particular application.

- What is claimed is:
1. A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:
 - providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;
 - depositing a silicon oxynitride layer on the metal layer having a thickness from about 100 Å to about 1500 Å; and
 - forming an oxide layer having a thickness from about 5 Å to about 50 Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating, wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.
 2. The method of claim 1, wherein the metal layer comprises at least one of aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides.
 3. The method of claim 1, wherein the metal layer comprises at least one of aluminum, copper, aluminum-copper alloys, aluminum alloys and copper alloys.
 4. The method of claim 1, wherein the oxide layer is formed by contacting the silicon oxynitride layer with oxygen plasma.
 5. The method of claim 1, wherein the oxide layer is formed by contacting the silicon oxynitride layer with N₂O plasma.
 6. The method of claim 1, wherein the oxide layer is formed by chemical vapor deposition techniques using SiH₄ and at least one of N₂O and O₂.
 7. The method of claim 1, wherein the silicon oxynitride antireflection coating has a reflectivity of about 10% or less at a wavelength below about 248 nm.
 8. A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating on the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon

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oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer having a thickness from about 5 Å to about 50 Å over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

9. The method of claim 8, wherein the metal layer comprises at least one of aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides.

10. The method of claim 8, wherein second reflectivity is about 5% or less.

11. The method of claim 8, wherein the difference between the first reflectivity and the second reflectivity is determined at a wavelength below about 425 nm.

12. The method of claim 8, wherein the difference between the first reflectivity and the second reflectivity is determined at a wavelength below about 365 nm.

13. The method of claim 8, wherein the silicon oxynitride antireflection coating has a thickness from about 125 Å to about 1400 Å.

14. The method of claim 8, wherein the chemical vapor deposition is one of plasma enhanced chemical vapor deposition and low pressure chemical vapor deposition.

15. A method of processing a semiconductor substrate, comprising:

providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%;

forming a silicon oxynitride antireflection coating on the metal layer having a thickness from about 100 Å to about 1500 Å, the silicon oxynitride antireflection

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coating comprising an oxide layer having a thickness from about 5 Å to about 50 Å over a silicon oxynitride layer;

depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating;

selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and

developing the deep ultraviolet photoresist,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

16. The method of claim 15, wherein the metal layer comprises at least one of aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides.

17. The method of claim 15, wherein the silicon oxynitride ARC is formed by depositing a silicon oxynitride layer by chemical vapor deposition and contacting the silicon oxynitride layer with at least one of a oxygen plasma and a N₂O plasma.

18. The method of claim 17, wherein the silicon oxynitride layer is deposited using one of plasma enhanced chemical vapor deposition and low pressure chemical vapor deposition.

19. The method of claim 15, wherein the electromagnetic radiation has a wavelength of at least one of about 365 nm, about 248 nm, about 193 nm and about 157 nm.

20. The method of claim 15, wherein the deep ultraviolet photoresist is developed to yield fine patterns on the order of 0.25 μm.

* * * * *

PATENT APPLICATION



09207562

1c526 U.S. PTO

09/20/96



12/06/98

INITIALS _____

CONTENTS

Date received
(Incl. C. of M.)
or
Date Mailed

Date received
(Incl. C. of M.)
or
Date Mailed

1. Application _____ papers		42. _____	
2. CFR	1-28-96	43. _____	
3. Reg for Correction	3-1-99	44. _____	
4. IDS	10-7-99	45. _____	
5. 35 USC Rejection (3 months)	7-5-00	46. _____	
6. 35 USC Response	10-13-00	47. _____	
7. Final Reg.	1-3-01	48. _____	
8. Interview Summary	1-30-01	49. _____	
9. Amended a	1-29-01	50. _____	
10. PTOC-303	2/13/01	51. _____	
11. Reg CPA	3/9/01	52. _____	
12. Rejection	4/11/01	53. _____	
13. Amended B	5-14-01 5-9-01	54. _____	
14. Final Reg	7-31-01 MFR	55. _____	
15. Interview Summary	8-16-01	56. _____	
16. Response	8/27/01	57. _____	
17. PTOC-37	9/17/01	58. _____	
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12/08/98

438	Subclass
72	ISSUE CLASSIFICATION

PATENT NUMBER

6326231



6326231

U.S. UTILITY PATENT APPLICATION


 O.I.P.E.
 PATENT DATE
 DEC 04 2001
 SCANNED
 Q.A. *Drml*

SECTOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
	429	72 72	2825 1462	Rocchegiani

FILED WITH: ☐ DISK (CRF) ☐ FICHE
(Attached in pocket on right inside flap)

Semiconductors treated

CPA

PREPARED AND APPROVED FOR ISSUE

ISSUING CLASSIFICATION												
ORIGINAL				CROSS REFERENCE(S)								
CLASS		SUBCLASS		CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)							
438		72		438	770	778	787	69				
INTERNATIONAL CLASSIFICATION												
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☐ Continued on Issue Slip Inside File Jacket

10/22/01

Formal Drawings (1 shts) set

12/8/98

☐ TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Drwg. 1	Figs. Drwg. 4	Print Fig. 4	Total Claims 20	Print Claim for O.G. 1
☐ a) The term of this patent subsequent to _____ (date) has been disclaimed.	<i>Rebecca N. Richardson</i> 9/10/01 (Assistant Examiner) (Date)			NOTICE OF ALLOWANCE MAILED <i>9/17/01</i>	
☐ b) The term of this patent shall not extend beyond the expiration date of U.S. Patent. No. _____ _____ _____	MATTHEW SMITH SUPERVISORY PATENT EXAMINER TECHNICAL CENTER 2800 <i>Matthew Smith</i> 9/13/01 (Primary Examiner) (Date)			ISSUE FEE (w) Amount Due Date Paid <i>\$124000</i> <i>10-11-01</i>	
☐ c) The terminal _____ months of this patent have been disclaimed.	<i>April W. Cole</i> 9/17/01 (Legal Instruments Examiner) (Date)			ISSUE BATCH NUMBER <i>1003</i>	

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The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35, Sections 122, 181 and 368. Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.

Form **PTO-436A**
(Rev. 6/98)

Formal Drawing: _____ (s/s)

Issue Fee

(LABEL AREA)

POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION	A.H.	22197	12/10/98
O.I.P.E. CLASSIFIER		10	12/12
FORMALITY REVIEW	DR	2201	1-8-99

INDEX OF CLAIMS

- ✓ Rejected
= Allowed
- (Through numeral)... Canceled
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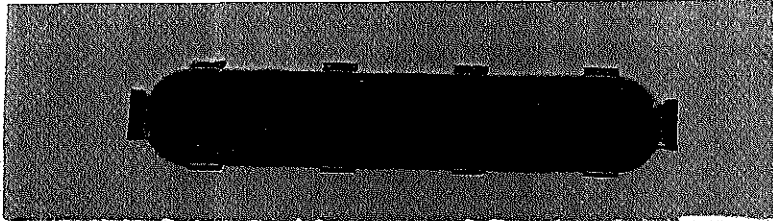
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Claim	Date									
Final	Original									
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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If more than 150 claims or 10 actions
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SEARCHED

Class	Sub.	Date	Exmr.
438	69	6/24/2000	RNR
438	72	6/26/2000	RNR
UPDATED		12/27/00	RNR
UPDATED		4/3/01	RNR
UPDATED		7/16/01	RNR
438	762	7/16/01	RNR
	770		
	775		
	778		
438	787	7/16/01	RNR
UPDATED		9/12/01	RNR

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
438	72	9/12/01	RNR
438	770	9/12/01	RNR

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	Date	Exmr.
EAST EAST	6/26/2000	RNR
	6/28/2000	RNR

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

12/17/1998 AWAYES 00000048 09207562
01 FC:101 760.00 DP

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/207,562	12/08/98	438	2812	D545

APPLICANT	RAMKUMAR SUBRAMANIAN, SAN JOSE, CA; BHANWAR SINGH, MORGAN HILL, CA; SANJAY K. YEDUR, SANTA CLARA, CA; MARINA V. PLAT, SAN JOSE, CA; CHRISTOPHER F. LYONS, FREMONT, CA; BHARATH RANGARAJAN, SANTA CLARA, CA; MICHAEL K. TEMPLETON, AHERTON, CA.
	CONTINUING DOMESTIC DATA*** VERIFIED <u>PNR</u> NONE
	371 (NAT'L STAGE) DATA*** VERIFIED <u>PNR</u> NONE
	FOREIGN APPLICATIONS*** VERIFIED <u>PNR</u> NONE
IF REQUIRED, FOREIGN FILING LICENSE GRANTED 02/22/99	

Foreign Priority claimed 35 USC 119 (a-d) conditions met	☐ yes ☒ no ☐ yes ☒ no ☐ Met after Allowance	STATE OR COUNTRY CA	SHEETS DRAWING 1	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
Verified and Acknowledged <u>PNR</u> <u>PNR</u> Examiner's Initials Initials					

ADDRESS	GREGORY TUROCY RENNER OTTO BOISSELLE & SKLAR 1621 EUCLID AVENUE 19TH FLOOR CLEVELAND OH 44115

TITLE	USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

FILING FEE RECEIVED \$760	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT NO. _____ for the following:	☐ All Fees ☐ 1.16 Fees (Fi' ☐ 1.17 Fees (F ☐ 1.18 Fees f ☐ Other ____ ☐ Credit
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12/08/98

JC498 U.S. PTO

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Please type a plus sign (+) inside this box → ☐

Approved for use through 09/30/2000. OMB 0851-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))	Attorney Docket No.	D545
	First Inventor or Application Identifier	SUBRAMANIAN
	Title	USE OF SILICON OXYNITRIDE....
	Express Mail Label No.	EE788624271US

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents.	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing)	5. ☐ Microfiche Computer Program (Appendix)
2. ☒ Specification [Total Pages 17] (preferred arrangement set forth below) - Descriptive title of the Invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure	6. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. ☐ Computer Readable Copy b. ☐ Paper Copy (identical to computer copy) c. ☐ Statement verifying identity of above copies
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 1]	
4. Oath or Declaration [Total Pages 4] a. ☒ Newly executed (original or copy) b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d)) (for continuation/divisional with Box 16 completed) i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).	

* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

ACCOMPANYING APPLICATION PARTS	
7. ☒ Assignment Papers (cover sheet & document(s))	
8. ☐ 37 C.F.R. § 3.73(b) Statement (when there is an assignee)	☐ Power of Attorney
9. ☐ English Translation Document (if applicable)	
10. ☐ Information Disclosure Statement (IDS)/PTO-1449	☐ Copies of IDS Citations
11. ☐ Preliminary Amendment	
12. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)	
13. ☐ * Small Entity Statement(s) (PTO/SB/09-12)	☐ Statement filed in prior application, Status still proper and desired
14. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)	
15. ☒ Other:	Check and Certificate of Mailing

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:
☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: _____
Prior application information: Examiner _____ Group / Art Unit: _____
For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS					
☐ Customer Number or Bar Code Label			☒ Correspondence address below		
(Insert Customer No. or Attach bar code label here)					
Name	Gregory Turocy				
	Renner, Otto, Boisselle & Sklar, P.L.L.				
Address	The Keith Building, 19th Floor				
	1621 Euclid Avenue				
City	Cleveland	State	OH	Zip Code	44115
Country	United States	Telephone	216-621-1113	Fax	216-621-6165

Name (Print/Type)	Gregory Turocy	Registration No. (Attorney/Agent)	36,952
Signature	<i>Gregory Turocy</i>	Date	Dec. 8, 1998

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

FEE TRANSMITTAL <i>Patent fees are subject to annual revision on October 1. These are the fees effective November 10, 1998. Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12. See 37 C.F.R. §§ 1.27 and 1.28.</i>	Complete if Known		
	Application Number		
	Filing Date	Herewith	
	First Named Inventor	Ramkumar SUBRAMANIAN	
	Examiner Name		
	Group / Art Unit		
TOTAL AMOUNT OF PAYMENT (\$)	800.00	Attorney Docket No.	D545

METHOD OF PAYMENT (check one)	FEE CALCULATION (continued)																																																																																																																								
1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to: Deposit Account Number: 18-0988 Deposit Account Name: Renner, Otto, Boisselle ☒ Charge Any Additional Fee Required Under 37 C.F.R. §§ 1.16 and 1.17 ☐ Charge the Issue Fee Set in 37 C.F.R. § 1.18 at the Mailing of the Notice of Allowance	3. ADDITIONAL FEES <table><thead><tr><th>Large Entity Fee Code (\$)</th><th>Small Entity Fee Code (\$)</th><th>Fee Description</th><th>Fee Paid</th></tr></thead><tbody><tr><td>105 130</td><td>205 65</td><td>Surcharge - late filing fee or oath</td><td></td></tr><tr><td>127 50</td><td>227 25</td><td>Surcharge - late provisional filing fee or cover sheet.</td><td></td></tr><tr><td>139 130</td><td>139 130</td><td>Non-English specification</td><td></td></tr><tr><td>147 2,520</td><td>147 2,520</td><td>For filing a request for reexamination</td><td></td></tr><tr><td>112 920*</td><td>112 920*</td><td>Requesting publication of SIR prior to Examiner action</td><td></td></tr><tr><td>113 1,840*</td><td>113 1,840*</td><td>Requesting publication of SIR after Examiner action</td><td></td></tr><tr><td>115 110</td><td>215 55</td><td>Extension for reply within first month</td><td></td></tr><tr><td>116 380</td><td>216 190</td><td>Extension for reply within second month</td><td></td></tr><tr><td>117 870</td><td>217 435</td><td>Extension for reply within third month</td><td></td></tr><tr><td>118 1,360</td><td>218 680</td><td>Extension for reply within fourth month</td><td></td></tr><tr><td>128 1,850</td><td>228 925</td><td>Extension for reply within fifth month</td><td></td></tr><tr><td>119 300</td><td>219 150</td><td>Notice of Appeal</td><td></td></tr><tr><td>120 300</td><td>220 150</td><td>Filing a brief in support of an appeal</td><td></td></tr><tr><td>121 260</td><td>221 130</td><td>Request for oral hearing</td><td></td></tr><tr><td>138 1,510</td><td>138 1,510</td><td>Petition to institute a public use proceeding</td><td></td></tr><tr><td>140 110</td><td>240 55</td><td>Petition to revive - unavoidable</td><td></td></tr><tr><td>141 1,210</td><td>241 605</td><td>Petition to revive - unintentional</td><td></td></tr><tr><td>142 1,210</td><td>242 605</td><td>Utility issue fee (or reissue)</td><td></td></tr><tr><td>143 430</td><td>243 215</td><td>Design issue fee</td><td></td></tr><tr><td>144 580</td><td>244 290</td><td>Plant issue fee</td><td></td></tr><tr><td>122 130</td><td>122 130</td><td>Petitions to the Commissioner</td><td></td></tr><tr><td>123 50</td><td>123 50</td><td>Petitions related to provisional applications</td><td></td></tr><tr><td>126 240</td><td>126 240</td><td>Submission of Information Disclosure Stmt</td><td></td></tr><tr><td>581 40</td><td>581 40</td><td>Recording each patent assignment per property (times number of properties)</td><td>40</td></tr><tr><td>146 760</td><td>246 380</td><td>Filing a submission after final rejection (37 CFR 1.129(a))</td><td></td></tr><tr><td>149 760</td><td>249 380</td><td>For each additional invention to be examined (37 CFR 1.129(b))</td><td></td></tr><tr><td colspan="3">Other fee (specify) _____</td><td></td></tr><tr><td colspan="3">Other fee (specify) _____</td><td></td></tr><tr><td colspan="3">SUBTOTAL (3) (\$)</td><td>40.00</td></tr></tbody></table>	Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid	105 130	205 65	Surcharge - late filing fee or oath		127 50	227 25	Surcharge - late provisional filing fee or cover sheet.		139 130	139 130	Non-English specification		147 2,520	147 2,520	For filing a request for reexamination		112 920*	112 920*	Requesting publication of SIR prior to Examiner action		113 1,840*	113 1,840*	Requesting publication of SIR after Examiner action		115 110	215 55	Extension for reply within first month		116 380	216 190	Extension for reply within second month		117 870	217 435	Extension for reply within third month		118 1,360	218 680	Extension for reply within fourth month		128 1,850	228 925	Extension for reply within fifth month		119 300	219 150	Notice of Appeal		120 300	220 150	Filing a brief in support of an appeal		121 260	221 130	Request for oral hearing		138 1,510	138 1,510	Petition to institute a public use proceeding		140 110	240 55	Petition to revive - unavoidable		141 1,210	241 605	Petition to revive - unintentional		142 1,210	242 605	Utility issue fee (or reissue)		143 430	243 215	Design issue fee		144 580	244 290	Plant issue fee		122 130	122 130	Petitions to the Commissioner		123 50	123 50	Petitions related to provisional applications		126 240	126 240	Submission of Information Disclosure Stmt		581 40	581 40	Recording each patent assignment per property (times number of properties)	40	146 760	246 380	Filing a submission after final rejection (37 CFR 1.129(a))		149 760	249 380	For each additional invention to be examined (37 CFR 1.129(b))		Other fee (specify) _____				Other fee (specify) _____				SUBTOTAL (3) (\$)			40.00
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SUBMITTED BY			Complete (if applicable)		
Typed or Printed Name	Gregory Turocy		Reg. Number	36,952	
Signature		Date	Dec. 8, 98	Deposit Account User ID	18-0988

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363021 2000060

Docket No. D545

Patent Application For:

USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

By

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Express Mail Mailing Label Number EE788624271US

Date of Deposit: December 8, 1998

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Lori Leskovec

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USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS**TECHNICAL FIELD**

The present invention generally relates to making and using a silicon oxynitride antireflection coating over highly reflective underlying layers. In particular, the present invention relates to providing a silicon oxynitride antireflection coating having an oxide layer well suited for use with deep UV photoresists.

5

BACKGROUND ART

5 Microlithography processes for making miniaturized electronic components, such as in the fabrication of computer chips and integrated circuits, involve using photoresists. Generally, a coating or film of a photoresist is applied to a substrate material, such as a
10 silicon wafer used for making integrated circuits. The substrate may contain any number of layers or devices thereon. The photoresist coated substrate is baked to evaporate any solvent in the photoresist composition and to fix the photoresist coating onto the substrate. The baked coated surface of the substrate is next subjected to selective radiation; that is, an image-wise exposure to radiation.

15

This radiation exposure causes a chemical transformation in the exposed areas of the photoresist coated surface. Types of radiation commonly used in microlithographic processes include visible light, ultraviolet (UV) light, electron beam and X-ray radiant energy. After selective exposure, the photoresist coated substrate is treated with a developer solution to dissolve and remove either the radiation-exposed or the unexposed areas of the photoresist.

20

Especially with the trend towards miniaturization of semiconductor devices, there are problems that result from the back reflection of light from highly reflective substrates (back reflection from layers underneath the photoresist). Two deleterious effects of back reflectivity are thin film interference and reflective notching. Thin film interference results in a changes in critical linewidth dimensions caused by variations in the total light intensity in
25 the photoresist film as the thickness of the photoresist changes. Reflective notching becomes

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severe as the photoresist is patterned over substrates containing topographical features, which tend to scatter light through the photoresist film, leading to linewidth variations, and in extreme cases, forming regions with complete photoresist loss.

Dyed photoresists have been utilized in an effort to solve these reflectivity problems.

However, dyed photoresists only reduce reflectivity from the underlying substrate, they do not totally eliminate the reflectivity. Additional shortcomings associated with dyed photoresists are that dyed photoresists tend to cause reduction in the lithographic performance of the photoresist, the undesirable possible sublimation of the dye, and incompatibility of the dye in the photoresist films.

To prevent reflection of activating radiation into a photoresist coating, it is known to provide antireflection layers or antireflection coatings (ARCs) between a substrate and a photoresist layer. ARCs generally function by absorbing the radiation used for exposing the photoresist; that is, reducing reflectivity at the photoresist/underlying substrate interface. ARCs may comprise an absorbing dye dispersed in a polymer binder, though some polymers contain sufficient chromophores (or characteristics thereof) whereby a dye is not required. When used, the dye is selected to absorb and attenuate radiation at the wavelength used to expose the photoresist layer thus reducing the incidence of radiation reflected back into the photoresist layer. During conventional processing of an integrated circuit substrate coated with the combination of an ARC and a photoresist layer, the photoresist is patterned to form a mask defining a desired pattern.

To alter the underlying substrate, the ARC must be removed to bare the underlying substrate in a desired pattern. However, there are problems associated with removal of the ARC including incomplete removal, and/or undesirable damage, removal or interaction with the photoresist or underlying substrate. In addition to difficulties associated with removal of an ARC, other problems are often encountered when an ARC is used in combination with a photoresist coating. One such problem is that of selecting an antireflective coating that is compatible with the photoresist used. The ARC should be inert with respect to the photoresist coating while firmly bonding to the photoresist coating. Another problem is that of selecting an ARC that firmly bonds to the underlying substrate to avoid lift-off of the unremoved photoresist coating (from development) during processing of the underlying

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substrate; depositing a silicon oxynitride layer over the metal layer having a thickness from about 100Å to about 1500Å; and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating.

5 In another embodiment, the present invention relates to a method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, involving forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor
10 deposition and forming an oxide layer over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

In yet another embodiment, the present invention relates to a method of processing a semiconductor substrate, involving the steps of providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%; forming a silicon oxynitride
15 antireflection coating over the metal layer having a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating comprising an oxide layer over a silicon oxynitride layer; depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating; selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and developing the
20 deep ultraviolet photoresist.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 illustrates in a cross-sectional view the methods according to one aspect of the present invention.

25 Figure 2 illustrates in a cross-sectional view the methods according to one aspect of the present invention.

Figure 3 illustrates in a cross-sectional view the methods according to one aspect of the present invention.

30 Figure 4 illustrates in a cross-sectional view the methods according to one aspect of the present invention.

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DISCLOSURE OF INVENTION

The present invention involves making and using a silicon oxynitride ARC over highly reflective underlying layers. The silicon oxynitride ARC contains a silicon oxynitride layer and a thin oxide layer. In this connection, the silicon oxynitride ARC may be termed an oxide-silicon oxynitride ARC. The present invention more specifically involves making and using a silicon oxynitride ARC over underlying metal layers over which the reflectivity of the ARC is altered or controlled by adjusting the ratios of components and the thickness of the silicon oxynitride portion of the ARC. The optical properties of an underlying layer (a layer over which an ARC is formed) may dictate the degree of reflectivity that the ARC must possess. The present invention also involves making and using a silicon oxynitride ARC with a deep UV photoresist.

The ARCs of the present invention are used over an underlying layer having a reflectivity that may deleteriously affect the photoresist patterning process. In one embodiment, the underlying layer is a metal layer. In another embodiment, the underlying layer is a conductive metal layer. Metal layers include layers of a single metal as well as metal alloy layers containing two or more metals. Specific examples of underlying layers include aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, metal silicides, and any other alloys thereof. Although the reflectivity may vary for each such metal layer, typically metal layers have reflectivities of about 70% to about 90% or more. For example, aluminum has a reflectivity of about 80% or more.

The silicon oxynitride ARC of the present invention is made by initially forming a silicon oxynitride layer on an underlying layer. The silicon oxynitride layer can be formed using any suitable technique including chemical vapor deposition (CVD) techniques, such as low pressure chemical vapor deposition (LPCVD) or plasma enhanced chemical vapor deposition (PECVD). In one embodiment, the silicon oxynitride layer is formed using LPCVD techniques at temperatures from about 600°C to about 900°C using a nitrogen

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containing gas, an oxygen containing gas and a silicon containing gas, such as using SiH_4 , N_2O and N_2 or NH_3 . In another embodiment, the silicon oxynitride layer is formed using PECVD techniques at temperatures from about 200°C to about 400°C using a nitrogen containing gas, an oxygen containing gas and a silicon containing gas, such as using SiH_4 , N_2O and N_2 or NH_3 . The relative amounts of oxygen and nitrogen incorporated into the initial silicon oxynitride layer can be varied by varying the flow rates of the nitrogen containing gas and the oxygen containing gas. Although termed a silicon oxynitride layer herein, the initial silicon oxynitride layer formed in accordance with the present invention may contain hydrogen, and thus in one embodiment is characterized by the chemical formula SiON:H .

In one embodiment, the initial silicon oxynitride layer has a thickness from about $100\text{\AA}$ to about $1500\text{\AA}$. In another embodiment, the initial silicon oxynitride layer has a thickness from about $125\text{\AA}$ to about $1400\text{\AA}$. In yet another embodiment, the initial silicon oxynitride layer has a thickness from about $150\text{\AA}$ to about $1300\text{\AA}$.

After a silicon oxynitride layer is formed, a thin oxide layer is formed over the top surface of the silicon oxynitride layer to form the oxide-silicon oxynitride ARC. The thin oxide layer prevents nitrogen atoms of the silicon oxynitride layer from contacting the subsequently applied photoresist. During rework of a poorly applied or poorly developed photoresist, the thin oxide layer protects the silicon oxynitride layer against chemical attack and/or degradation by rework chemicals. The thin oxide layer is formed over the silicon oxynitride layer by any suitable manner.

In one embodiment, oxygen plasma is contacted with the silicon oxynitride layer to form an oxide layer over the silicon oxynitride layer. In another embodiment, N_2O plasma is contacted with the silicon oxynitride layer to form an oxide layer over the silicon oxynitride layer. In both of these embodiments, an inert or carrier gas may be present during the plasma treatment. In yet another embodiment, CVD (PECVD or LPCVD) techniques are employed to deposit an oxide layer over the silicon oxynitride layer. In this embodiment, SiH_4 , and one of N_2O and O_2 are used to form an oxide layer.

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In one embodiment, the thin oxide layer has a thickness from about 5Å to about 50Å. In another embodiment, the thin oxide layer has a thickness from about 10Å to about 40Å. In yet another embodiment, the thin oxide layer has a thickness from about 15Å to about 35Å.

The silicon oxynitride ARC is formed to a suitable thickness to exhibit a desired reflectivity. In one embodiment, the silicon oxynitride ARC formed in accordance with the present invention has a thickness from about 100Å to about 1500Å. In another embodiment, the silicon oxynitride ARC has a thickness from about 125Å to about 1400Å. In yet another embodiment, the silicon oxynitride ARC has a thickness from about 150Å to about 1300Å. In a preferred embodiment, the silicon oxynitride ARC has a thickness from about 125Å to about 600Å.

The reflectivity of the resultant silicon oxynitride ARC depends upon a number of factors including the ratio of silicon oxynitride components (the relative amounts of oxygen and nitrogen), the thickness of the initial silicon oxynitride layer, the thickness of the thin oxide layer and the thickness of the resultant silicon oxynitride ARC.

In one embodiment, a silicon oxynitride ARC having a thickness of about 200Å (including an oxide layer having a thickness of about 50Å) formed over an aluminum layer has a reflectivity from about 0% to about 10% (below about 10%) at a wavelength of about 248 nm. In another embodiment, a silicon oxynitride ARC having a thickness of about 200Å formed over an aluminum layer has a reflectivity from about 1% to about 5% (below about 5%) at a wavelength of about 248 nm. In yet another embodiment, a silicon oxynitride ARC having a thickness of about 350Å (including an oxide layer having a thickness of about 50Å) formed over an aluminum layer has a reflectivity from about 1% to about 10% (below about 10%) at a wavelength of about 365 nm. In still yet another embodiment, a silicon oxynitride ARC having a thickness of about 350Å (including an oxide layer having a thickness of about 50Å) formed over an aluminum layer has a reflectivity from about 0.1% to about 5% (below about 5%) at a wavelength of about 365 nm.

In this connection, the silicon oxynitride ARC reduces the apparent reflectivity of an underlying metal (comparing the reflectivity of a metal layer with the reflectivity of a silicon oxynitride ARC according to the present invention over the metal layer). In one embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon

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oxynitride ARC is at least about 60% (for instance, a metal layer having a reflectivity of 70% and a silicon oxynitride ARC having a reflectivity of 8%). In another embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon oxynitride ARC is at least about 70%. In yet another embodiment, the difference between the reflectivity of the metal layer and the reflectivity of the silicon oxynitride ARC is at least about 75%.

The silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 425 nm. In another embodiment, the silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 365 nm. In yet another embodiment, the silicon oxynitride ARC formed in accordance with the present invention has strong absorption characteristics at wavelengths below about 248 nm. As a result, the silicon oxynitride ARC is well suited for use with deep UV photoresists. Specific examples of wavelengths at which the silicon oxynitride ARC exhibits reflectivities below about 20% include about 405 nm, about 365 nm, about 308 nm, about 290 nm, about 280 nm, about 265 nm, about 248 nm, about 193 nm and about 157 nm.

Any photoresist material may be used as a photoresist over the silicon oxynitride ARC formed in accordance with the present invention. For example, a 193 nm sensitive photoresist, an I-line, H-line, G-line, E-line, deep UV or chemically amplified photoresist material may be spin-coated on the silicon oxynitride ARC. Photoresists are commercially available from a number of sources, including Shipley Company, Kodak, Hoechst Celanese Corporation, Brewer and IBM. The photoresist is typically applied to a thickness from about 5,000Å to about 15,000Å, although the thickness of the photoresist is not critical to the invention.

Referring to Figures 1 and 2, a general embodiment of the present invention is described. A portion of a semiconductor structure 10 is shown with underlying substrate 12. Underlying substrate 12 may be one or more layers of semiconductor materials wherein the top surface has a relatively high reflectivity (for example, above about 70%). A silicon oxynitride ARC 14 is formed over the underlying substrate 12 using a two-step process; namely, forming a silicon oxynitride layer by suitable CVD techniques followed by forming a

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thin oxide layer over the silicon oxynitride layer thereby forming a silicon oxynitride ARC having a desired thickness. The relative amounts of oxygen and nitrogen used to form the silicon oxynitride layer, the thickness of the silicon oxynitride layer, the thickness of the oxide layer and the thickness of the resultant silicon oxynitride ARC may be modified to adjust the reflectivity of the resultant silicon oxynitride ARC in light of the specific reflectivity of the underlying substrate 12. In preferred embodiments of using the silicon oxynitride ARC 14, the underlying layer 12 contains at least two layers wherein the top or uppermost layer is a metal layer (such as a single metal layer or metal alloy layer). A suitable photoresist 16 is deposited over the silicon oxynitride ARC 14 using known techniques. For example, the photoresist 16 is deposited using conventional spin-coating techniques.

Referring to Figure 2, the photoresist 16 is then patterned using suitable photolithographic techniques resulting in the formation of a pattern 18. The pattern 18 is formed using electromagnetic radiation having a relatively small wavelength (for example, less than 425 nm). The exposed portion of the silicon oxynitride ARC 14 may have any desired cross-section or line-width, such as about 0.35 μm , about 0.25 μm , about 0.18 μm , about 0.15 μm , about 0.1 μm and/or about 0.05 μm . The photoresist pattern 18 is then used as a mask in subsequent processing of the semiconductor structure 10. For example, the photoresist pattern 18 may be used as an etch mask for patterning the silicon oxynitride ARC 14 and the underlying substrate 12.

Due to the presence of the silicon oxynitride ARC 14, energy which passes through the photoresist 16 is not reflected back into the photoresist 16 by the underlying layer 12 to the extent it would have been reflected back without the silicon oxynitride ARC 14. As a result of the present invention, improved critical dimension control is achieved as the dimensions of the patterns and/or various openings in the patterned photoresist 18 are controllable, crisp and of high quality. Additional layers can be incorporated into semiconductor structure 10 so long as the silicon oxynitride ARC 14 can function at least as an antireflection layer.

Referring to Figures 3 and 4, a specific embodiment of the present invention is described. A portion of a semiconductor structure 20 is shown with a semiconductor substrate layer 22 and an aluminum layer 24 formed on the semiconductor structure 20.

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Semiconductor layer 22 is made of one or more layers including substrate layers, diffusion regions, dielectric layers such as oxides and nitrides, devices, polysilicon layers, and the like. Although shown as continuous, the aluminum layer 24 may be continuous or intermittent. A silicon oxynitride ARC 26 is formed over the aluminum layer 24 using a two-step process; namely, forming a silicon oxynitride layer by suitable CVD techniques followed by exposing the silicon oxynitride layer to oxygen plasma for a time sufficient to form an oxide layer having a thickness of about 50Å thereby forming a silicon oxynitride ARC. In particular, PECVD is performed at a temperature about 300°C using N₂O, N₂ and SiH₄. The silicon oxynitride layer has a thickness of about 150Å and the silicon oxynitride ARC has a thickness of about 200Å. A suitable photoresist 28, such as a deep UV photoresist is deposited over the silicon oxynitride ARC 26 using spin-coating techniques.

Referring to Figure 4, the photoresist 28 is then patterned using suitable photolithographic techniques resulting in the formation of a photoresist pattern 30. The photoresist pattern 30 is formed using electromagnetic radiation having a wavelength of about 248 nm. The exposed portion of the silicon oxynitride ARC 26 may have any desired cross-section or line-width, such as about 0.35 μm, about 0.25 μm, about 0.18 μm, about 0.15 μm, about 0.1 μm and/or about 0.05 μm. The photoresist pattern 30 is then used as a mask in subsequent processing of the semiconductor structure 20. For example, the photoresist pattern 30 may be used as an etch mask for patterning the silicon oxynitride ARC 26 and the aluminum layer 24.

Due to the presence of the silicon oxynitride ARC 26, energy which passes through the photoresist 28 tends not to be reflected back into the photoresist 28 by the highly reflective underlying aluminum layer 24 to the extent it would have been reflected back without the silicon oxynitride ARC 26. As a result of the present invention, improved critical dimension control is achieved as the dimensions of the patterns and/or various openings in the patterned photoresist 30 are controllable, crisp and of high quality. In another embodiment, additional layers can be incorporated into semiconductor structure 10 so long as the silicon oxynitride ARC 26 can function at least as an antireflection layer.

In another embodiment, again referring to Figures 3 and 4, the present invention relates to using a metal layer 24 of one of copper, gold, nickel, palladium, platinum, silver,

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tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides instead of the aluminum layer 24.

5 The precise amount of oxygen and nitrogen incorporated into the initial silicon oxynitride layer, the thickness of the silicon oxynitride layer, the thickness of the oxide layer and the thickness of the resultant silicon oxynitride ARC determine the reflectivity of the resultant silicon oxynitride ARC, which in turn may be selected in light of the reflectivity of the specific underlying metal layer. Reflective notching in submicron photoresist patterns is
10 thus minimized and/or eliminated by using the silicon oxynitride ARCs in accordance with the invention.

 Moreover, since the oxide layer of the silicon oxynitride ARC prevents nitrogen atoms from migrating from the silicon oxynitride layer to the photoresist, deep UV photoresists, which tend to be deleteriously effected by nitrogen atoms, may be used in
15 combination with the silicon oxynitride based ARC of the present invention. And since the thin oxide layer protects the silicon oxynitride layer against chemical attack and/or since the thin oxide layer is not substantially degraded by rework chemicals, rework of a poorly applied or poorly developed photoresist is facilitated even though a silicon oxynitride based ARC is employed.

20 Although the invention has been shown and described with respect to a certain preferred embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described components (assemblies, devices, circuits, etc.), the terms
25 (including any reference to a "means") used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiments of the invention. In addition, while a particular feature of
30 the invention may have been disclosed with respect to only one of several embodiments, such

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feature may be combined with one or more other features of the other embodiments as may be desired and advantageous for any given or particular application.

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CLAIMS

What is claimed is:

1. A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:
- providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;
- depositing a silicon oxynitride layer over the metal layer having a thickness from about 100Å to about 1500Å; and
- forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating.
2. The method of claim 1, wherein the metal layer comprises at least one of aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides.
3. The method of claim 1, wherein the metal layer comprises at least one of aluminum, copper, aluminum-copper alloys, aluminum alloys and copper alloys.
4. The method of claim 1, wherein the oxide layer is formed by contacting the silicon oxynitride layer with oxygen plasma.
5. The method of claim 1, wherein the oxide layer is formed by contacting the silicon oxynitride layer with N₂O plasma.
6. The method of claim 1, wherein the oxide layer is formed by chemical vapor deposition techniques using SiH₄ and at least one of N₂O and O₂.

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7. The method of claim 1, wherein the silicon oxynitride antireflection coating has a reflectivity of about 10% or less at a wavelength below about 248 nm.

8. A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

9. The method of claim 8, wherein the metal layer comprises at least one of aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten, zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys, silver alloys, tantalum alloys, zinc alloys, and metal silicides.

10. The method of claim 8, wherein second reflectivity is about 5% or less.

11. The method of claim 8, wherein the difference between the first reflectivity and the second reflectivity is determined at a wavelength below about 425 nm.

12. The method of claim 8, wherein the difference between the first reflectivity and the second reflectivity is determined at a wavelength below about 365 nm.

13. The method of claim 8, wherein the silicon oxynitride antireflection coating has a thickness from about 125Å to about 1400Å.

14. The method of claim 8, wherein the chemical vapor deposition is one of plasma enhanced chemical vapor deposition and low pressure chemical vapor deposition.

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Sub 23

5 15. A method of processing a semiconductor substrate, comprising:
providing a semiconductor substrate comprising a metal layer having a
reflectivity of at least 80%;
forming a silicon oxynitride antireflection coating over the metal layer having
a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating
comprising an oxide layer over a silicon oxynitride layer;
depositing a deep ultraviolet photoresist over the silicon oxynitride
antireflection coating;
10 selectively irradiating the deep ultraviolet photoresist with electromagnetic
radiation having a wavelength of about 248 nm or less; and
developing the deep ultraviolet photoresist.

16. The method of claim 15, wherein the metal layer comprises at least one of
aluminum, copper, gold, nickel, palladium, platinum, silver, tantalum, titanium, tungsten,
15 zinc, aluminum-copper alloys, aluminum alloys, copper alloys, titanium alloys, tungsten
alloys, titanium-tungsten alloys, gold alloys, nickel alloys, palladium alloys, platinum alloys,
silver alloys, tantalum alloys, zinc alloys, and metal silicides.

17. The method of claim 15, wherein the silicon oxynitride ARC is formed by
depositing a silicon oxynitride layer by chemical vapor deposition and contacting the silicon
oxynitride layer with at least one of a oxygen plasma and a N₂O plasma.

20 18. The method of claim 17, wherein the silicon oxynitride layer is deposited
using one of plasma enhanced chemical vapor deposition and low pressure chemical vapor
deposition.

19. The method of claim 15, wherein the electromagnetic radiation has a
wavelength of at least one of about 365 nm, about 248 nm, about 193 nm and about 157 nm.

D545

20. The method of claim 15, wherein the deep ultraviolet photoresist is developed to yield fine patterns on the order of $0.25\ \mu\text{m}$.

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ABSTRACT OF THE DISCLOSURE

In one embodiment, the present invention relates to a method of forming a silicon oxynitride antireflection coating over a metal layer, involving the steps of providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate; depositing a silicon oxynitride layer over the metal layer having a thickness from about 100Å to about 1500Å; and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating. In another embodiment, the present invention relates to a method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, involving forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

COMBINED DECLARATION AND POWER OF ATTORNEY
(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

the specification of which

- (a) ☒ is attached hereto.
- (b) ☐ was filed on _____ as ☐ Serial No. 0 / _____ or Express Mail No. _____, as Serial No. not yet known, and was amended on _____ (if applicable).
- (c) ☐ was described and claimed in PCT International Application No. _____ filed on _____ and amended under PCT Article 19 on _____ (if any).

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

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

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

- (d) ☒ no such applications have been filed.
- (e) ☐ such applications have been filed as follows.

EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35, USC 119
_____	_____	_____	☐ Yes ☐ No
_____	_____	_____	☐ Yes ☐ No
_____	_____	_____	☐ Yes ☐ No

ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

POWER OF ATTORNEY

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

Warren A. Sklar, Reg. No. 26,373; Neil A. DuChez, Reg. No. 26,725; Mark D. Saralino, Reg. No. 34,243; Gregory Turocy, Reg. No. 36,952; Thomas G. Eschweiler, Reg. No. 36, 981; Himanshu S. Amin, Reg. No. 40,894.

William D. Zahrt II, Reg. No. 26,070; Richard J. Roddy, Reg. No. 27,688; Vincenzo D. Pitruzzella, Reg. No. 28,656; J. Vincent Tortolano, Reg. No. 28,656; Paul S. Drake, Reg. No. 33,491; Louise K. Miller, Reg. No. 36,609; Louis A. Riley, Reg. No. 39,817; Rita M. Wisor, Reg. No. 41,382.

The undersigned to this declaration and power of attorney hereby authorizes the U.S. attorney(s) named herein to accept and follow instructions from

Name(s) of authorized representative(s) _____
Address _____

as to any actions to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney(s) and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorney(s) will be so notified by the undersigned.

Send Correspondence To:

Gregory Turocy
Renner, Otto, Boisselle & Sklar, P.L.L.
1621 Euclid Ave., 19th Floor
Cleveland, Ohio 44115

Direct Telephone Calls To:

(name and telephone number)

Gregory Turocy
(216) 621-1113

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

Full name of sole or first inventor, if any: Ramkumar Subramanian
Inventor's signature: [Signature]
Date: 12/3/98 Country of Citizenship: India
Residence: San Jose, California
Post Office Address: 4271 Norwalk Drive, X-105
San Jose, California 95050

Full name of second joint inventor, if any: Bhanwar Singh
Inventor's signature: [Signature]
Date: 12/3/98 Country of Citizenship: United States of America
Residence: Morgan Hill, California
Post Office Address: 17122 Heatherwood
Morgan Hill, California 95037

Full name of third joint inventor, if any: Sanjay K. Yedur
Inventor's signature: [Signature]
Date: 12/3/98 Country of Citizenship: India
Residence: Santa Clara, California
Post Office Address: 444 Saratoga Avenue, #27A
Santa Clara, California 95050

Full name of fourth joint inventor, if any Marina V. Plat
Inventor's signature Marina V. Plat
Date 12.03.98 Country of Citizenship United States of America
Residence San Jose, California
Post Office Address 4620 Corrida Circle
San Jose, California 95129

CHECK FOR ANY OF THE FOLLOWING ADDED PAGE(S) WHICH
FORM A PART OF THIS DECLARATION

- ☒ Signature for subsequent joint inventors. Number of pages added 1.
- ☐ Added page to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (CIP) application.
- ☐ This declaration ends with this page.

ADDED PAGE TO COMBINED DECLARATION AND POWER OF ATTORNEY
FOR SIGNATURE BY SUBSEQUENT INVENTORS

Full name of fifth joint inventor Christopher F. Lyons
Inventor's signature C. F. Lyons
Date 12/3/98 Country of Citizenship United States of America
Residence Fremont, California
Post Office Address 42681 Lerwick Street
Fremont, California 94539

Full name of sixth joint inventor, if any: Bharath Rangarajan
Inventor's signature: Bharath Rangarajan
Date: 3rd Dec, 1998 Country of Citizenship: India
Residence: Santa Clara, California
Post Office Address: 2295 Dolores Avenue
Santa Clara, California 95050

Full name of seventh joint inventor, if any: Michael K. Templeton
Inventor's signature: Michael K. Templeton
Date: 7-Dec-98 Country of Citizenship: United States of America
Residence: Atherton, California
Post Office Address: 80 Palmer Lane
Atherton, California 94027

C:\GT\Amds\211\Declaration.App

APPROVED	DATE	FILE
BY	DATE	FILE
DRAFTSMAN		

6326231

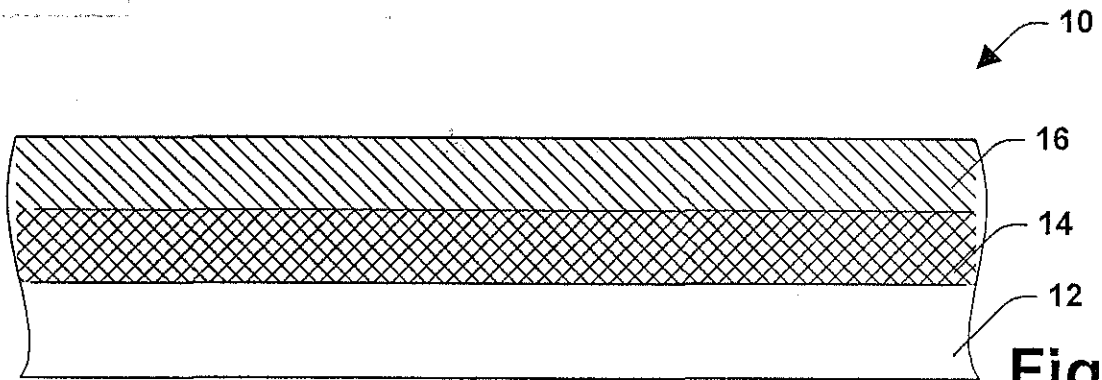


Fig. 1

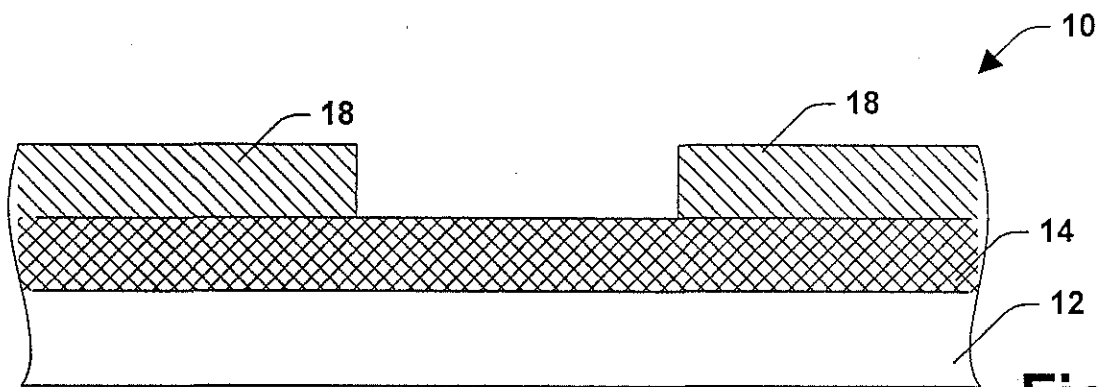


Fig. 2

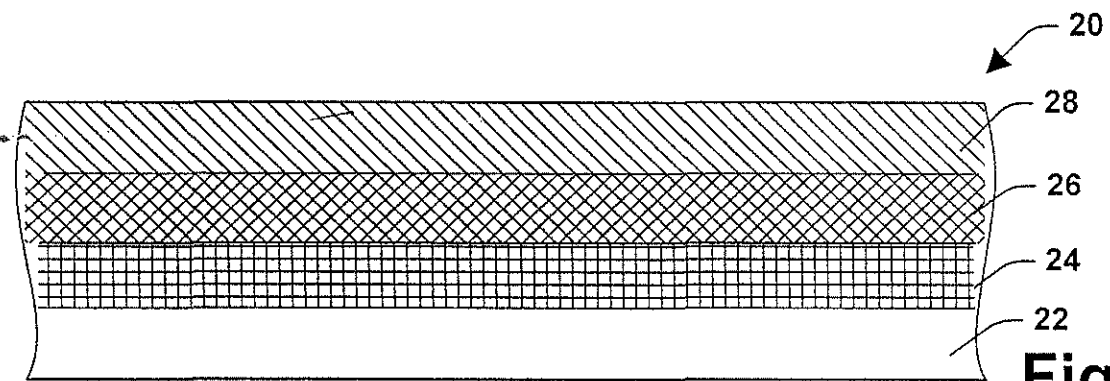


Fig. 3

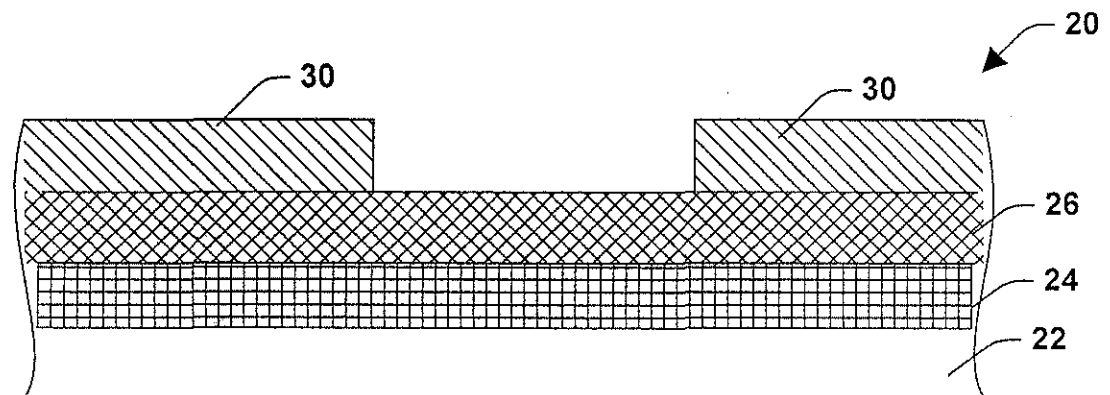


Fig. 4

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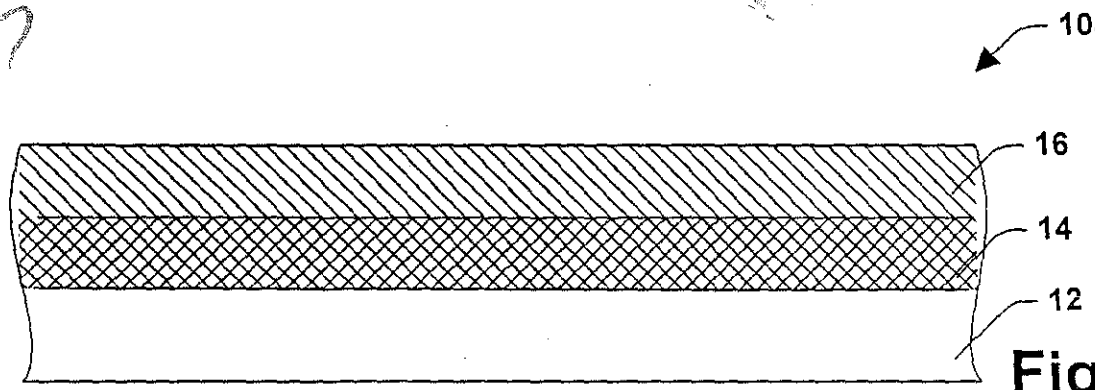


Fig. 1

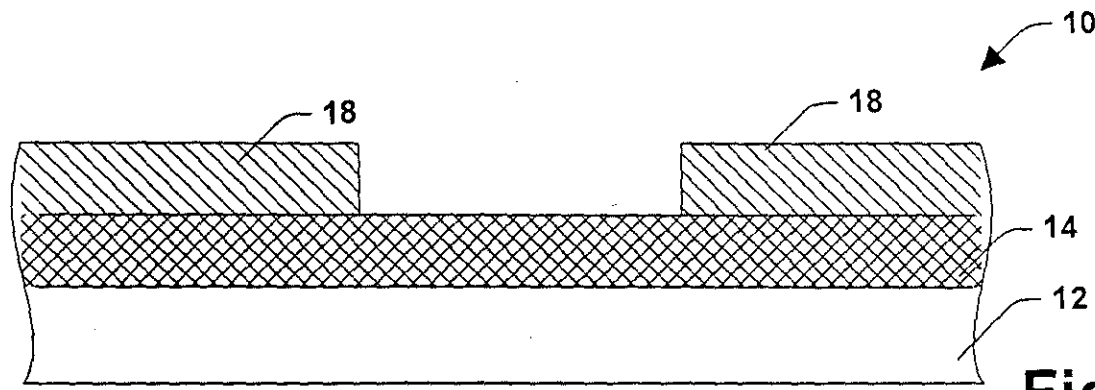


Fig. 2

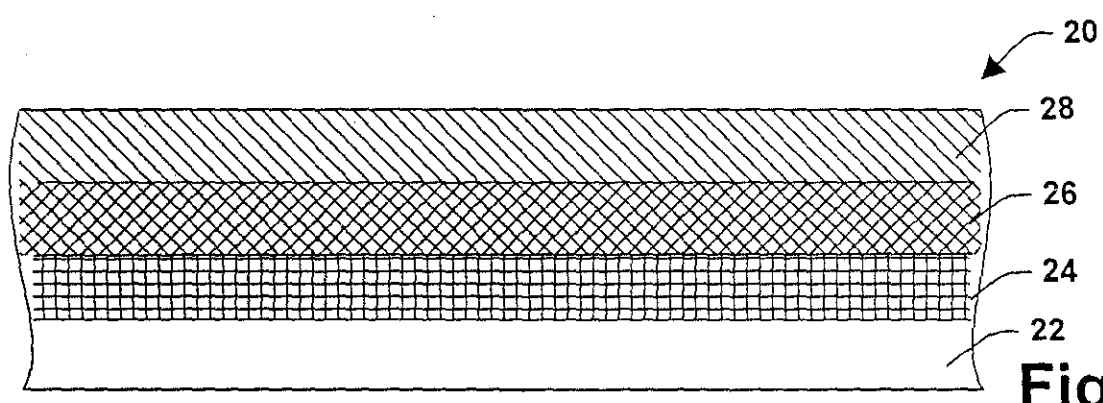


Fig. 3

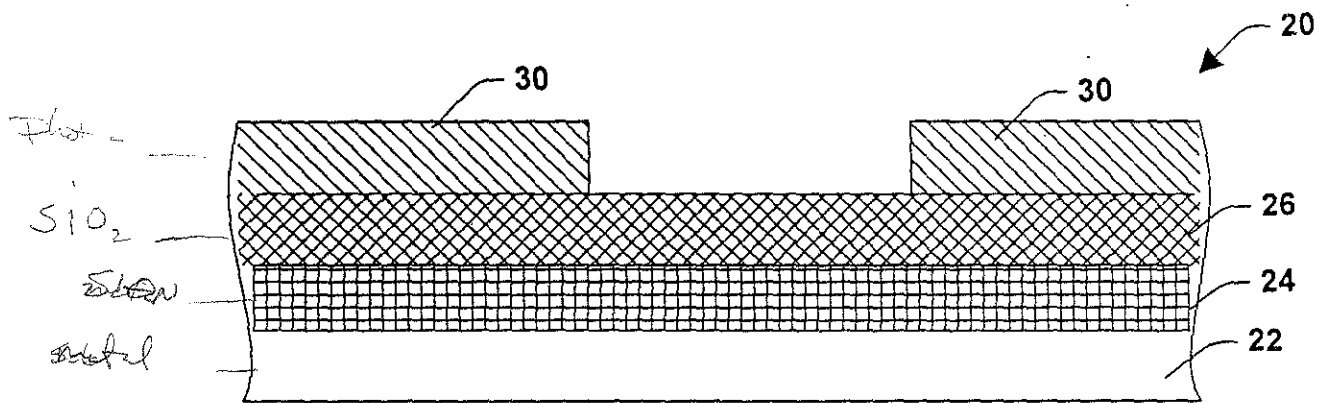
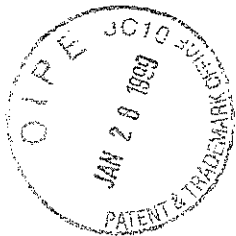


Fig. 4

2801

09/207,562



CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231.

Lori Leskova
(Signature of person mailing paper)

Jan 25, 99
(Date)

Lori Leskova

(Type or print name of person mailing paper)

Docket No. D545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Subramanian et al.
Serial No.: 09/207,562
Filed: December 8, 1998
Title: USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

REQUEST FOR CORRECTED FILING RECEIPT

Application Processing Division's
Customer Correction Branch
Assistant Commissioner for Patents
Washington, D.C. 20231

RECEIVED

FEB 08 1999

GROUP 9100

Dear Sir:

This letter is to request that a corrected Filing Receipt be issued to correct typographical errors in identifying the names of the inventors in the above application. Specifically, Applicants' request that the first named Applicant be changed from "Ramkumar Subramania" to read --Ramkumar Subramanian". In addition, the following names were omitted on the Filing Receipt and should be included:

09/207,562

D545

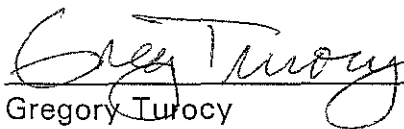
--Christopher F. Lyons, Fremont, California; Bharath Rangarajan, Santa Clara, California; Michael K. Templeton, Atherton, California--.

If any questions arise concerning this request, the Patent Office is invited to contact Applicants' undersigned representative at the telephone number listed below.

If any fees are due with the filing of this paper, the Commissioner is authorized to charge our Deposit Account No. 18-0988.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, P.L.L.

A handwritten signature in cursive script, appearing to read "Greg Turocy", is written over a horizontal line.

Gregory Turocy
Reg. No. 36,952

1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115-2191
Telephone: 216/621-1113
Facsimile: 216/621-6165

FILING RECEIPT



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

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTORNEY DOCKET NO.	DRWGS	TOT CL	IND CL
09/207,562	12/08/98	1762	\$760.00 D545		1	20	3

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115



Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Application Processing Division's Customer Correction Branch within 10 days of receipt. Please provide a copy of the Filing Receipt with the changes noted thereon.

Applicant(s)

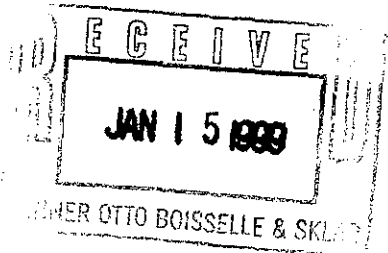
→ subramanian
RAMKUMAR SUBRAMANIA, SAN JOSE, CA; BHANWAR SINGH,
MORGAN HILL, CA; SANJAY K. YEDUR, SANTA CLARA, CA;
MARINA V. PLAT, SAN JOSE, CA.

*add: Christopher F. Lyons, Fremont, California;
Bharath Rangarajan, Santa Clara, California;
Michael K. Templeton, Atherton, California*

TITLE
USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

PRELIMINARY CLASS: 427

RECEIVED
FEB 08 1999
GROUP 3100



DATA ENTRY BY: RORIE, DEANNA

TEAM: 03 DATE: 01/08/99

(see reverse)

09/207,562



#3/ Correction
3/26/99 Receipt
J. Jones

D545

CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231

Jon Leskover

(Signature of person mailing paper)

Feb 26 99

(Date)

Lori Leskover

(Type or print name of person mailing paper)

Docket No. D545

MAR 01 1999
GROUP 2100

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Subramanian et al.
Serial No.: 09/207,562
Filed: December 8, 1998
Title: USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

SECOND REQUEST FOR CORRECTED FILING RECEIPT

Application Processing Division's
Customer Correction Branch
Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

This letter is to request that a corrected Filing Receipt be issued to correct a typographical error in identifying the names of the inventors in the above application. Specifically, the following names were omitted on the Filing Receipt and should be included:

--Christopher F. Lyons, Fremont, California; Bharath Rangarajan, Santa Clara, California; Michael K. Templeton, Atherton, California--.

09/207,562

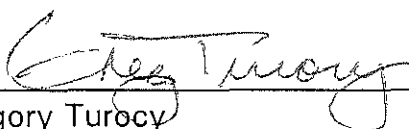
D545

If any questions arise concerning this request, the Patent Office is invited to contact Applicants' undersigned representative at the telephone number listed below.

If any fees are due with the filing of this paper, the Commissioner is authorized to charge our Deposit Account No. 18-0988.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, P.L.L.



Gregory Turocy
Reg. No. 36,952

1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115-2191
Telephone: 216/621-1113
Facsimile: 216/621-6165

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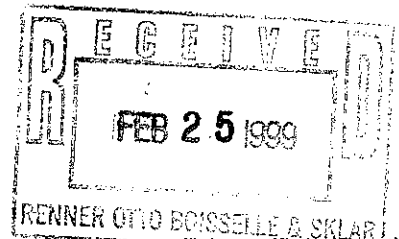
FILING RECEIPT



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

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTORNEY DOCKET NO.	DRWGS	TOT CL	IND CL
09/207,562	12/08/98	2812	\$760.00 D545		1	20	3

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115



Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please write to the Application Processing Division's Customer Correction Branch within 10 days of receipt. Please provide a copy of the Filing Receipt with the changes noted thereon.

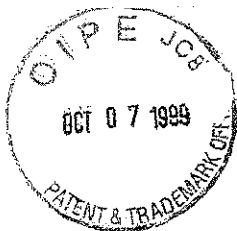
Applicant(s)

RAMKUMAR SUBRAMANIAN, SAN JOSE, CA; BHANWAR SINGH,
MORGAN HILL, CA; SANJAY K. YEDUR, SANTA CLARA, CA;
MARINA V. PLAT, SAN JOSE, CA.

FOREIGN FILING LICENSE GRANTED 02/22/99
TITLE
USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

PRELIMINARY CLASS: 438

ADD TO APPLICANTS:
CHRISTOPHER F. LYONS, FREMONT, CALIFORNIA;
BHARATH RANGARAJAN, SANTA CLARA, CALIFORNIA
MICHAEL K. TEMPLETON, ATHERTON,
CALIFORNIA



Docket No. D545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Applicant: Subramanian et al.
Serial No.: 09/207,562
Filed: December 8, 1998
For: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

Art Unit: 2812
Examiner: -----

INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

RECEIVED

OCT 12 1999

Sir:

TECHNOLOGY CENTER 2800

1. Pursuant to 37 C.F.R. 1.97 and 1.98, and in compliance with 37 C.F.R. 1.56, the Office's attention is directed to the patents, pending applications, publications and other information listed on the attached PTO-1449. A copy of each listed document is enclosed except for: (a) pending applications or (b) those previously cited or submitted to the Office in the following application(s) upon which this application relies for an earlier filing date under 35 U.S.C. 120:

Serial No.: _____
Filing Date: _____

Regarding any document, publication or other information for which a date is not given on the attached PTO-1449, Applicant(s) believe(s) the same may qualify as "prior" art to this application and should be treated accordingly, although Applicant(s) reserve(s) the right to contest the prior art status of any document, publication or information, should issue arise.

2. Regarding each listed document that is not in the English language, an English-language translation accompanies this Statement as indicated on the attached PTO-1449 or a concise explanation of the relevance of the document is set forth in the following document(s):

- (a) ☐ Copy of each English language version of a search report indicating the degree of relevance found by the foreign office of each document being submitted from the search report.
- (b) ☐ Attachment entitled "Concise Explanation of Relevance of Non-English Language Documents".

3. Pursuant to 37 C.F.R. 1.97(b) this Statement is being filed (one must be checked):

- (a) ☐ Within 3 months of the filing date or date of entry into the National Stage.
- (b) ☒ Before the mailing date of a first Office Action on the merits. If this Statement is not filed before the mailing date of a first Office Action on the merits, the required certification is given below or, in the absence thereof, the Office is authorized to charge the required fee set forth in 37 C.F.R. 1.17(p) to Deposit Account No. 18-0988 for consideration of this Statement.
- (c) ☐ Before the mailing date of a first Office Action on the merits after a first or second submission after final rejection under 37 C.F.R. 1.129(a).

(d) ____ After the period set forth in 37 C.F.R. 1.97(b) but before the mailing date of either a final action or a notice of allowance.

(1) ____ The required certification is given below, or

(2) ____ Enclosed is a check covering the fee set forth in 37 C.F.R. 1.17(p) for consideration of this Statement, or

(3) ____ Charge the fee set forth in 37 C.F.R. 1.17(p) to Deposit Account No. 18-0988

(e) ____ After the mailing date of either a final action or a notice of allowance, but before payment of the issue fee. Petition hereby is made for consideration of this Statement and the required certification is indicated below.

(1) ____ Enclosed is a check covering the fee set forth in 37 C.F.R. 1.17(i)(1), or

(2) ____ Charge the fee set forth in 37 C.F.R. 1.17(i)(1) to Deposit Account No. 18-0988.

4. Certification (if applicable)

(a) ____ The undersigned hereby certifies that each item of information contained in this Statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than 3 months prior to the filing of this Statement.

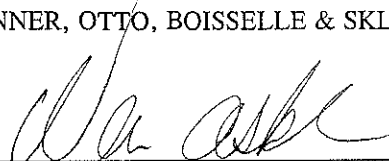
(b) ____ The undersigned hereby certifies that no item of information contained in this Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the undersigned's knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. 1.56(c) more than 3 months prior to the filing of this Statement.

5. The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to Deposit Account No. 18-0988.

Respectfully Submitted,

RENNER, OTTO, BOISSELLE & SKLAR

By



Warren A. Sklar
Reg. No. 26,373

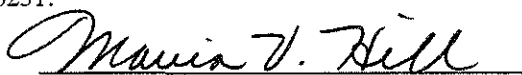
1621 Euclid Avenue, 19th Floor
Cleveland, Ohio 44115
(216) 621-1113

CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence (along with any paper referenced as being attached or enclosed) is being deposited on the below date with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Assistant Commissioner of Patents, Washington, D.C. 20231.

Date:

10/4/99



Marcia V. Hill

IDS-1-FRM (8/95)



Sheet 1 of 1

Form PTO-1449 (Modified) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	Atty Docket No.	Serial No.
	D545	09/207,562
	Applicant: Subramanian et al.	
	Filing Date	Group
	December 8, 1998	2812

U.S. PATENT DOCUMENTS

Examiner Initial	Document Number	Date	Name	Class	Sub-class	Filing Date if Appropriate
RMC	5,672,243	9/30/97	Hsia et al.	156	659.11	
RMC	5,710,067	1/20/98	Foote et al.	437	238	

FOREIGN PATENT DOCUMENTS

Examiner Initial	Document Number	Date	Country	Class	Sub-class	Translation	
						Yes	No

OTHER ART

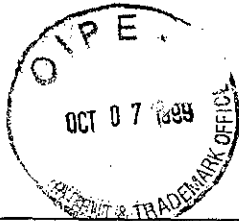
Examiner Initial	Author, Title, Date, Pertinent Pages, etc.

EXAMINER <i>Renzo Roudyian</i>	DATE CONSIDERED <i>6/28/2000</i>
--------------------------------	----------------------------------

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

Information Disclosure Statement PTO-1449 (Modified)

The identification of any reference is not intended to be, and should not be understood as being, an admission that such publication, in fact, constitutes "prior art" within the meaning of applicable law since, for example, a given reference may have a later effective date than first seems apparent or the reference may have an effective date which can be antedated. The "prior art" status of any reference is a matter to be resolved during prosecution.



Sheet 1 of 1

Form PTO-1449 (Modified) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	Atty Docket No. D545	Serial No. 09/207,562
	Applicant: Subramanian et al.	
	Filing Date December 8, 1998	Group 2812

U.S. PATENT DOCUMENTS

Examiner Initial	Document Number	Date	Name	Class	Sub-class	Filing Date if Appropriate
RM	5,672,243	9/30/97	Hsia et al.	156	659.11	
RM	5,710,067	1/20/98	Foote et al.	437	238	

FOREIGN PATENT DOCUMENTS

Examiner Initial	Document Number	Date	Country	Class	Sub-class	Translation	
						Yes	No

OTHER ART

Examiner Initial	Author, Title, Date, Pertinent Pages, etc.

EXAMINER <i>Renzo Rochyiani</i>	DATE CONSIDERED <i>6/28/2000</i>
---------------------------------	----------------------------------

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

Information Disclosure Statement PTO-1449 (Modified)

The identification of any reference is not intended to be, and should not be understood as being, an admission that such publication, in fact, constitutes "prior art" within the meaning of applicable law since, for example, a given reference may have a later effective date than first seems apparent or the reference may have an effective date which can be antedated. The "prior art" status of any reference is a matter to be resolved during prosecution.



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Patent and Trademark Office

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/207,562 12/08/98 SUBRAMANIAN R D545

MMC2/0705

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115

EXAMINER

ROCCHEGIANI, R

ART UNIT

PAPER NUMBER

2825

DATE MAILED:

07/05/00

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

Commissioner of Patents and Trademarks

Office Action Summary

Application No.
09/207,562

Applicant(s)
Subramanian et al.

Examiner
RENZO ROCCHEGIANI

Group Art Unit
2825



☒ Responsive to communication(s) filed on Dec 8, 1998

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 35 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claim

☒ Claim(s) 1-20 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-20 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☒ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

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

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 4

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

Claim Rejections - 35 USC § 103

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

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

2. Claims 1-3, 7-13, 15-16 and 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 5,639,687 (Roman et al.) in view of U.S. Patent N. 6,013,582 (Ionov et al.).

Roman et al. disclose a process to form a semiconductor device wherein a metal layer, comprising aluminum or tungsten or an alloy thereof, is deposited over a substrate (col. 2, lines 34-45). An antireflective layer is then deposited over the metal layer (col. 2, lines 46-49) by way of CVD (col. 3, lines 4-6). The thickness of the antireflective layer may be varied depending of a number of factors (col. 2, lines 55-67). A possible thickness for the antireflective coating is 500 Å (col. 3, lines 20-25). An oxide layer is formed over the antireflective layer (col. 3, lines 50-57). This structure reduces the reflectivity to less than 15% or even 5% at a wavelength of 248 nm (col. 3, lines 25-33). Finally a photoresist is deposited over the oxide layer and used as a patterning mask via lithographic technique (col. 3, lines 34-42).

Art Unit: 2825

Roman et al. disclose the use of silicon rich silicon nitride material to form the antireflective layer as opposed to the present invention where silicon oxynitride material is used. Furthermore, Roman et al. do not specify the photoresist material to be a deep ultraviolet photoresist material.

Ionov et al. teach a process to a semiconductor device where they teach the use of different materials to form an antireflective coating, between such materials are silicon rich silicon nitride and silicon oxynitride (col. 1, lines 30-51). Ionov et al. also teach that such materials are used in combination with photolithographic processes wherein deep ultraviolet photoresist material is used (col. 1, lines 30-51).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Ionov et al. to the invention disclosed by Roman et al., since Ionov et al. teaches the equivalency of using a silicon oxynitride material over the use of silicon rich silicon nitride and the use of deep ultraviolet photoresist material associated with the antireflective material. Also, it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Furthermore, it would have been obvious to one having ordinary skill in the specific art to determine the thickness of the oxynitride layer and of the oxide layer thereby affecting the reflectivity, since Roman et al. discloses that such variables are subject to change and discovering

Art Unit: 2825

the optimum or workable ranges where the general conditions of a claim are disclosed in the prior art, involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

3. Claims 4-6, 14 and 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 5,639,687 (Roman et al.) in view of U.S. Patent N. 6,013,582 (Ionov et al.) and further in view of U.S. Patent N. 4,527,007 (Fuse).

As stated in the preceding paragraph, all the limitations of these claims have been met except for specifying the deposition process for the oxide layer.

Fuse teaches a process to form an oxide capping layer by way of plasma CVD in the presence of silane gas and either NO₂ or O₂ (abstract) at a reduced pressure (col. 4, lines 3-13).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Fuse to the invention disclosed by Roman et al., since the process of forming an oxide is a very well known process in the art.

Application/Control Number: 09/207,562

Page 5

Art Unit: 2825

Conclusion

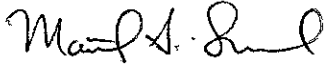
4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Additional prior art that is hereby made of record is U.S. Patent N. 5,230,746 (Wiedeman et al.), U.S. Patent N. 6,004,850 (Lucas et al.), U.S. Patent N. 5,880,018 (Boeck et al.), U.S. Patent N. 5,721,167 (Subramanian et al.), U.S. Patent N. 5,580,815 (Hsu et al.), U.S. Patent N. 5,441,914 (Taft et al.) and U.S. Patent N. 5,918,147 (Filipiak et al.).

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Renzo Rocchegiani whose telephone number is (703) 308-5839. The examiner can normally be reached on Monday through Friday from 8:30 a.m. to 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (703) 308-1323. The fax phone number for the organization where this application or proceeding is assigned is (703) 305-3432.

RNR

June 28, 2000


MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

Notice of References Cited				Application No. 09/207,562		Applicant(s) Subramanian et al.	
				Examiner RENZO ROCCHEGIANI		Group Art Unit 2825	
						Page 1 of 1	
U.S. PATENT DOCUMENTS							
		DOCUMENT NO.	DATE	NAME		CLASS	SUBCLASS
	A	5,918,147	6/1999	Filipiak et al.		438	636
	B	5,441,914	8/1995	Taft et al.		437	189
	C	5,580,815	12/1996	Hsu et al.		437	69
	D	5,721,167	2/1998	Subramanian et al.		438	238
	E	5,880,018	3/1999	Boeck et al.		438	619
	F	6,004,850	12/1999	Lucas et al.		438	301
	G	5,230,746	7/1993	Wiedeman et al.		136	249
	H	4,527,007	7/1985	Fuse		136	256
	I	5,639,687	6/1997	Roman et al.		437	186
	J	6,013,582	1/2000	Ionov et al.		438	738
	K						
	L						
	M						
FOREIGN PATENT DOCUMENTS							
		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
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NON-PATENT DOCUMENTS							
		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)					DATE
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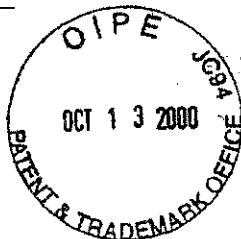
CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D. C. 20231.

Date: 10/10/00

Stephanie Wernhardt
Stephanie Wernhardt
(Signature of person mailing paper)

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w/Response
chusa
10-27-00*



AMDSP0211US

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In re patent application:

Applicant:	Subramanian, et al.	:	Art Unit:	2825
Serial No.:	09/207,562	:	Examiner:	R. Rocchegiani
Filed:	December 8, 1998	:		

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

REPLY TO OFFICE ACTION MAILED JULY 5, 2000

Assistant Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

This paper is responsive to the Office Action mailed for which a three (3) month period of response was given. Accordingly, Applicant's Petition and fee for a one month extension is filed together herewith. Favorable reconsideration of the present application is respectfully requested.

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Page 1 of 6

REMARKS

Claims 1-20 are pending in the application. Favorable reconsideration in light of the remarks which follow is respectfully requested.

I. Present Invention:

The present invention relates to an antireflective coating containing a silicon oxynitride layer and an oxide layer with improved optical characteristics that lead to improved critical dimension control. The present invention provides a silicon oxynitride ARC that is compatible with deep UV photoresists since the oxide layer prevents contact between nitrogen in the silicon oxynitride layer and an overlying photoresist, which more extensively enables the use of deep UV photoresists. The presence of the thin oxide layer over the silicon oxynitride layer also enables reworking of the photoresist since the oxide layer is not damaged by, so protects the silicon oxynitride layer from attack by, reworking chemicals. The present invention provides a silicon oxynitride ARC that may be tailored to the optical properties of an underlying metal layer. As a result, the present invention effectively addresses the concerns raised by the trend towards the miniaturization of semiconductor devices. The combination of features of the presently claimed invention is neither disclosed nor suggested by the asserted combination of prior art references.

II. Prior Art Rejections:

a. Rejection over Roman et al in view of Ionov et al:

Claims 1-3, 7-13, 15-16, and 19-20 stand rejected under 35 U.S.C. § 103(a) as obvious over Roman et al (U.S. Patent No. 5,639,687) in view of Ionov et al (U.S. Patent No. 6,013,582). Claims 4-6, 14, and 17-18 stand as obvious over Roman et

al in view of Ionov et al and further in view of Fuse (U.S. Patent No. 4,527,007). Applicants respectfully traverse these rejections for the following reasons.

Roman et al disclose a method of forming a semiconductor device including forming a device layer which may be tungsten or aluminum (col. 2, lines 40-42), forming an antireflective layer consisting of silicon-rich silicon nitride (col. 3, lines 3-4), and optionally forming an insulating layer over the silicon-rich silicon nitride layer, which may be formed of silicon dioxide (col. 3, lines 50-57). Roman et al further disclose that the insulating layer may be formed *below* the silicon-rich silicon nitride antireflective coating layer (col. 3, lines 58-65), which negates any suggestion that the silicon oxide layer is intended to provide protection against the etchants used subsequently, as disclosed in Applicants' specification. Roman et al do not suggest that the silicon oxide layer forms an integral, essential part of an antireflective coating, as in the presently claimed invention. Rather, Roman et al only disclose a silicon oxide layer as an optional layer, which may be either above or below the silicon-rich silicon nitride antireflective coating layer.

Roman et al fail to disclose or suggest that any other material could be substituted for the silicon-rich silicon nitride layer. Roman discloses *only* silicon-rich silicon nitride as a suitable antireflective coating for obtaining the desired reductions in reflectivity of the underlying layers. Roman et al fail to provide any motivation for changing this material. If one set out to improve upon Roman et al, one would likely start by further enriching the amount of silicon in the silicon-rich silicon nitride, not by effecting a wholesale replacement of the antireflective coating itself.

Ionov et al disclose a method for etching a metal stack on a silicon wafer substrate, in which the stack includes an aluminum alloy layer overlain by titanium and titanium nitride layers, over which is a silicon oxynitride antireflection layer. The antireflection layer is in turn covered by a photoresist layer (col. 9, line 54 to col. 10, line 29). As asserted by the Examiner, Ionov et al disclose at col. 1, lines 49-51 that

both silicon oxide materials and silicon oxynitride materials may be used for antireflective layers. Ionov et al primarily relate to etching the silicon oxynitride. Ionov et al contain no suggestion or motivation which would lead a person to substitute the silicon oxynitride for other antireflective coating materials in other devices, such as that of Roman et al.

Furthermore, Ionov et al fail to disclose or suggest that *both* silicon oxynitride *and* silicon oxide should be used *together* as presently disclosed and claimed. Ionov et al fail to provide any motivation to replace the silicon-rich silicon nitride layer of Roman et al with a silicon oxynitride, such as that disclosed in Ionov et al and no suggestion to both retain the silicon oxide layer of Roman et al and place it over the antireflective coating. The Examiner asserted that Ionov et al show that different materials may be used for the antireflective coating, as a basis for asserting the obviousness of replacing the silicon-rich silicon nitride antireflective coating of Roman et al with the silicon oxynitride antireflective coating of Ionov et al. However, if, based on the disclosure of Ionov et al, one set out to modify the antireflective coating of Roman et al by replacing it (rather than simply modifying the degree of enrichment of silicon), one would use the silicon oxynitride layer alone, since there would be no apparent reason to include an oxygen containing layer above the (already) oxygen-containing silicon oxynitride antireflective coating layer. Such would not provide the presently disclosed benefit of separating and protecting the N of the silicon oxynitride layer from the etchants.

Thus, the presently claimed invention set forth in claims 1-3, 7-13, 15-16 and 19-20 would not have been obvious over the asserted combination of Roman et al and Ionov et al. There is neither suggestion nor motivation in either reference to make the presently claimed combination. The only way one would know to make the presently claimed combination is after reading Applicants' claims and/or specification. That is, the asserted obviousness of Applicants' claimed invention can only be based upon

hindsight reconstruction of Applicants' invention resulting from the use of Applicants' specification as a road map to lead to the asserted obvious combination. Such is an improper basis for an assertion of *prima facie* obviousness.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Roman et al and Ionov et al.

b. Rejection over Roman et al and Ionov et al and further in view of Fuse:

Claims 4-6, 14 and 17-18 stand rejected as obvious over the above combination of Roman et al and Ionov et al, further in view of Fuse. Applicants respectfully traverse this rejection for the above reasons with respect to the primary and secondary references, and for the following additional reasons with respect to the asserted combination including Fuse.

Fuse fails to remedy the deficiencies of the primary and secondary references. Fuse provides only a method for making a silicon oxide layer. Formation of a silicon oxide layer is old in the art. However, like the primary and secondary references, Fuse provides no suggestion or motivation that the silicon oxide layer should be used in conjunction with a silicon oxynitride layer to form an antireflection coating, such as in the presently claimed invention. Fuse does not remedy the shortcomings of the primary and secondary references, and, even if combined with the teachings of those references, still fails to lead one unambiguously to Applicants' claimed invention, particularly as set forth in presently pending claims 4-6, 14 and 17-18.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Roman et al, Ionov et al and Fuse.

IV. Conclusion

For the foregoing reasons, Applicants respectfully assert that the presently claimed invention patentably distinguishes over the cited prior art references. The

Application No. 09/207,562

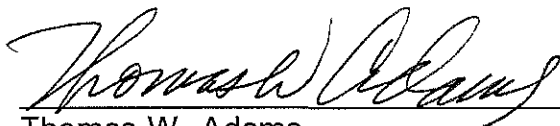
Attorney Docket No.: D545

Examiner is requested to reconsider and withdraw the asserted rejections and to allow the claims. Notice to such effect is respectfully requested.

Should the Examiner believe that a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact the Applicant's undersigned attorney at the telephone number listed below.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 18-0988 under Attorney Docket No. AMDSP0211US.

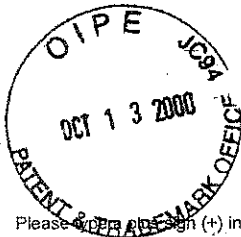
Respectfully submitted,
RENNER, OTTO, BOISSELLE & SKLAR, LLP



Thomas W. Adams
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Nineteenth Floor
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Telephone (216) 621-1113
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TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	09/207,562	
	Filing Date	12/8/98	
	First Named Inventor	Subramanian, et al.	
	Group Art Unit	2825	
	Examiner Name	R. Rocchegiani	
Total Number of Pages in This Submission	8	Attorney Docket Number	AMDSP119US

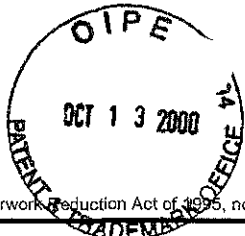
ENCLOSURES (check all that apply)		
☒ Fee Transmittal Form	☐ Assignment Papers (for an Application)	☐ After Allowance Communication to Group
☒ Fee Attached	☐ Drawing(s)	☐ Appeal Communication to Board of Appeals and Interferences
☒ Amendment / Response	☐ Licensing-related Papers	☐ Appeal Communication to Group (Appeal Notice, Brief, Reply Brief)
☐ After Final	☐ Petition Routing Slip (PTO/SB/69) and Accompanying Petition	☐ Proprietary Information
☐ Affidavits/declaration(s)	☐ To Convert a Provisional Application	☐ Status Letter
☒ Extension of Time Request	☐ Power of Attorney, Revocation Change of Correspondence Address	☒ Additional Enclosure(s) (please identify below):
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☐ Information Disclosure Statement	☐ Small Entity Statement	
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☐ Response to Missing Parts/Incomplete Application	Remarks	
☐ Response to Missing Parts under 37 CFR 1.52 or 1.53		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT	
Firm or Individual name	Thomas W. Adams, Reg. No. 35,047
Signature	<i>Thomas W. Adams</i>
Date	10 Oct 2000

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FEE TRANSMITTAL		Complete if Known	
Patent fees are subject to annual revision on October 1. These are the fees effective November 10, 1998. Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12. See 37 C.F.R. §§ 1.27 and 1.28.		Application Number	09/207,562
		Filing Date	12/8/98
		First Named Inventor	Subramanian, et al.
		Examiner Name	R. Rocchegiani
		Group / Art Unit	2825
		Attorney Docket No.	AMDSP0211US
TOTAL AMOUNT OF PAYMENT (\$)		110.00	

METHOD OF PAYMENT (check one)		FEE CALCULATION (continued)																																																																																																																																																																																																																																																																																																															
1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to: Deposit Account Number: 18-0988 Deposit Account Name: Renner, Otto, Boisselle ☒ Charge Any Additional Fee Required Under 37 C.F.R. §§ 1.16 and 1.17 ☐ Charge the Issue Fee Set in 37 C.F.R. § 1.18 at the Mailing of the Notice of Allowance		3. ADDITIONAL FEES <table border="1"><thead><tr><th>Large Entity Fee Code</th><th>Small Entity Fee Code</th><th>Fee Description</th><th>Fee Paid</th></tr></thead><tbody><tr><td>105</td><td>130</td><td>205</td><td>65</td><td>Surcharge - late filing fee or oath</td><td></td></tr><tr><td>127</td><td>50</td><td>227</td><td>25</td><td>Surcharge - late provisional filing fee or cover sheet.</td><td></td></tr><tr><td>139</td><td>130</td><td>139</td><td>130</td><td>Non-English specification</td><td></td></tr><tr><td>147</td><td>2,520</td><td>147</td><td>2,520</td><td>For filing a request for reexamination</td><td></td></tr><tr><td>112</td><td>920*</td><td>112</td><td>920*</td><td>Requesting publication of SIR prior to Examiner action</td><td></td></tr><tr><td>113</td><td>1,840*</td><td>113</td><td>1,840*</td><td>Requesting publication of SIR after Examiner action</td><td></td></tr><tr><td>115</td><td>110</td><td>215</td><td>55</td><td>Extension for reply within first month</td><td></td></tr><tr><td>116</td><td>380</td><td>216</td><td>190</td><td>Extension for reply within second month</td><td></td></tr><tr><td>117</td><td>870</td><td>217</td><td>435</td><td>Extension for reply within third month</td><td></td></tr><tr><td>118</td><td>1,360</td><td>218</td><td>680</td><td>Extension for reply within fourth month</td><td></td></tr><tr><td>128</td><td>1,850</td><td>228</td><td>925</td><td>Extension for reply within fifth month</td><td></td></tr><tr><td>119</td><td>300</td><td>219</td><td>150</td><td>Notice of Appeal</td><td></td></tr><tr><td>120</td><td>300</td><td>220</td><td>150</td><td>Filing a brief in support of an appeal</td><td></td></tr><tr><td>121</td><td>260</td><td>221</td><td>130</td><td>Request for oral hearing</td><td></td></tr><tr><td>138</td><td>1,510</td><td>138</td><td>1,510</td><td>Petition to institute a public use proceeding</td><td></td></tr><tr><td>140</td><td>110</td><td>240</td><td>55</td><td>Petition to revive - unavoidable</td><td></td></tr><tr><td>141</td><td>1,210</td><td>241</td><td>605</td><td>Petition to revive - unintentional</td><td></td></tr><tr><td>142</td><td>1,210</td><td>242</td><td>605</td><td>Utility issue fee (or reissue)</td><td></td></tr><tr><td>143</td><td>430</td><td>243</td><td>215</td><td>Design issue fee</td><td></td></tr><tr><td>144</td><td>580</td><td>244</td><td>290</td><td>Plant issue fee</td><td></td></tr><tr><td>122</td><td>130</td><td>122</td><td>130</td><td>Petitions to the Commissioner</td><td></td></tr><tr><td>123</td><td>50</td><td>123</td><td>50</td><td>Petitions related to provisional applications</td><td></td></tr><tr><td>126</td><td>240</td><td>126</td><td>240</td><td>Submission of Information Disclosure Stmt</td><td></td></tr><tr><td>581</td><td>40</td><td>581</td><td>40</td><td>Recording each patent assignment per property (times number of properties)</td><td></td></tr><tr><td>146</td><td>690</td><td>246</td><td>345</td><td>Filing a submission after final rejection (37 CFR 1.129(a))</td><td></td></tr><tr><td>149</td><td>690</td><td>249</td><td>345</td><td>For each additional invention to be examined (37 CFR 1.129(b))</td><td></td></tr><tr><td colspan="5">Other fee (specify) _____</td><td></td></tr><tr><td colspan="5">Other fee (specify) _____</td><td></td></tr><tr><td colspan="5">* Reduced by Basic Filing Fee Paid</td><td></td></tr><tr><td colspan="5">SUBTOTAL (3) (\$)</td><td>110.00</td></tr></tbody></table> <table border="1"><thead><tr><th colspan="2">1. 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Adams</td><td>Reg. Number</td><td>35,047</td></tr><tr><td>Signature</td><td><i>Thomas W. 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Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/207,562 12/08/98 SUBRAMANIAN

R D545

EXAMINER

MMC2/0103

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115

RODCHEGIANI, R

ART UNIT

PAPER NUMBER

2825

DATE MAILED:

01/03/01

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

Commissioner of Patents and Trademarks

Office Action Summary

Application No.
09/207,562

Applicant(s)
Subramanian et al.

Examiner
RENZO ROCCHEGIANI

Group Art Unit
2825



☒ Responsive to communication(s) filed on 10/13/2000

☒ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 35 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claim

☒ Claim(s) 1-20 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-20 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☒ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

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

Attachment(s)

☐ Notice of References Cited, PTO-892

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). _____

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

Art Unit: 2825

DETAILED ACTION

Claim Rejections - 35 USC § 103

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

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

2. Claims 1-3, 7-13, 15-16 and 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 5,639,687 (Roman et al.) in view of U.S. Patent N. 6,013,582 (Ionov et al.).

Roman et al. disclose a process to form a semiconductor device wherein a metal layer, comprising aluminum or tungsten or an alloy thereof, is deposited over a substrate (col. 2, lines 34-45). An antireflective layer is then deposited over the metal layer (col. 2, lines 46-49) by way of CVD (col. 3, lines 4-6). The thickness of the antireflective layer may be varied depending of a number of factors (col. 2, lines 55-67). A possible thickness for the antireflective coating is 500 Å (col. 3, lines 20-25). An oxide layer is formed over the antireflective layer (col. 3, lines 50-57). This structure reduces the reflectivity to less than 15% or even 5% at a wavelength of 248 nm (col. 3, lines 25-33). Finally a photoresist is deposited over the oxide layer and used as a patterning mask via lithographic technique (col. 3, lines 34-42).

Art Unit: 2825

Roman et al. disclose the use of silicon rich silicon nitride material to form the antireflective layer as opposed to the present invention where silicon oxynitride material is used. Furthermore, Roman et al. do not specify the photoresist material to be a deep ultraviolet photoresist material.

Ionov et al. teach a process to a semiconductor device where they teach the use of different materials to form an antireflective coating, between such materials are silicon rich silicon nitride and silicon oxynitride (col. 1, lines 30-51). Ionov et al. also teach that such materials are used in combination with photolithographic processes wherein deep ultraviolet photoresist material is used (col. 1, lines 30-51).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Ionov et al. to the invention disclosed by Roman et al., since Ionov et al. teaches the equivalency of using a silicon oxynitride material over the use of silicon rich silicon nitride and the use of deep ultraviolet photoresist material associated with the antireflective material. Also, it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Furthermore, it would have been obvious to one having ordinary skill in the specific art to determine the thickness of the oxynitride layer and of the oxide layer thereby affecting the reflectivity, since Roman et al. discloses that such variables are subject to change and discovering

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the optimum or workable ranges where the general conditions of a claim are disclosed in the prior art, involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

3. Claims 4-6, 14 and 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 5,639,687 (Roman et al.) in view of U.S. Patent N. 6,013,582 (Ionov et al.) and further in view of U.S. Patent N. 4,527,007 (Fuse).

As stated in the preceding paragraph, all the limitations of these claims have been met except for specifying the deposition process for the oxide layer.

Fuse teaches a process to form an oxide capping layer by way of plasma CVD in the presence of silane gas and either NO₂ or O₂ (abstract) at a reduced pressure (col. 4, lines 3-13).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Fuse to the invention disclosed by Roman et al., since the process of forming an oxide is a very well known process in the art.

Response to Arguments

4. Applicant's arguments filed on October 13, 2000 have been fully considered but they are not persuasive. The applicant asserts that the rejections presented in the previous action should be withdrawn because there lacks motivation to combine the references and because even by combining the references the limitations would still not be rendered obvious. The examiner disagrees. Roman et al. disclose a process wherein an oxide film may be deposited over the

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antireflective coating, this is exactly what the present invention is claiming therefore this limitation is being anticipated. Furthermore, the applicant grants that Ionov et al. suggest different materials that may be used as antireflective coatings but then asserts that one with ordinary skill in the specific art would use silicon oxynitride in place of both the silicon rich silicon nitride and the oxide layer. Nowhere in the patent Ionov et al. suggest such substitution, the only comparison made by Ionov et al. is the interchangeable use of silicon rich silicon nitride and silicon oxynitride. Thus, one skilled in the art would only replace the one layer and not both. The examiner is not persuaded by the applicant's argument and has decided to maintain the previous rejections.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner

Application/Control Number: 09/207,562

Page 6

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should be directed to Renzo Rocchegiani whose telephone number is (703) 308-5839. The examiner can normally be reached on Monday through Friday from 8:30 a.m. to 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (703) 308-1323. The fax phone number for the organization where this application or proceeding is assigned is (703) 305-3432.

RNR

December 28, 2000



MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/207,562	12/08/98	SUBRAMANIAN	D545

GREGORY TUROCY
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MM92/0130

EXAMINER	
ROCCHEGIANI, R	
ART UNIT	PAPER NUMBER
2825	

DATE MAILED: 01/30/01

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

Commissioner of Patents and Trademarks

Interview Summary

Application No.
09/207,562

Applicant(s)
Subramanian et al.

Examiner
RENZO ROCCHEGIANI

Group Art Unit
2825



All participants (applicant, applicant's representative, PTO personnel):

(1) RENZO ROCCHEGIANI (3) _____

(2) Thomas Adams (4) _____

Date of Interview Jan 25, 2001

Type: ☒ Telephonic ☐ Personal (copy is given to applicant applicant's representative).

Exhibit shown or demonstration conducted: ☐ Yes ☒ No. If yes, brief description:

Agreement ☐ was reached. ☒ was not reached.

Claim(s) discussed: 1 and 4-6

Identification of prior art discussed:

All the art cited in the rejections

Description of the general nature of what was agreed to if an agreement was reached, or any other comments:

The discussion revolved around claim language and how it reads on the prior art. The incorporation of the limitation of using the oxide layer as a nitrogen barrier is a possibility that may overcome the prior art. Also, claim language for claims 4-6 was discussed, possible amendments may be made to clarify the present invention and how it differs from the prior art.

(A fuller description, if necessary, and a copy of the amendments, if available, which the examiner agreed would render the claims allowable must be attached. Also, where no copy of the amendments which would render the claims allowable is available, a summary thereof must be attached.)

1. ☒ It is not necessary for applicant to provide a separate record of the substance of the interview.

Unless the paragraph above has been checked to indicate to the contrary, A FORMAL WRITTEN RESPONSE TO THE LAST OFFICE ACTION IS NOT WAIVED AND MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a response to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW.

2. ☐ Since the Examiner's interview summary above (including any attachments) reflects a complete response to each of the objections, rejections and requirements that may be present in the last Office action, and since the claims are now allowable, this completed form is considered to fulfill the response requirements of the last Office action. Applicant is not relieved from providing a separate record of the interview unless box 1 above is also checked.

MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

Examiner Note: You must sign and stamp this form unless it is an attachment to a signed Office action.

#9/Amendment
2.1.01
ary

CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D. C. 20231.

Date: 1/26/01



R. D. Hall
R. D. Hall
(Signature of person mailing paper)

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D545/AMDSP0211US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application:

Applicant:	Subramanian, et al.	:	Art Unit:	2825
Serial No.:	09/207,562	:	Examiner:	R. Rocchegiani
Filed:	December 8, 1998	:		

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

PROPOSED REPLY TO FINAL OFFICE ACTION MAILED JANUARY 3, 2001

Assistant Commissioner for Patents
Washington, D. C. 20231

**RESPONSE AFTER FINAL--
EXPEDITED HANDLING
REQUESTED**

Dear Sir:

This paper is responsive to the Office Action mailed January 3, 2001, for which a three (3) month period of response was given. Accordingly, Applicant's Reply is timely filed. The Examiner is requested to enter the amendment, for the reason that the amendment renders the claims allowable over the prior art of record. Favorable reconsideration of the present application is respectfully requested.

AMENDMENTS

Please amend claims 1, 8 and 15 so as to read as follows:

1. (Amended) A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:

providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;

depositing a silicon oxynitride layer over the metal layer having a thickness from about 100Å to about 1500Å; and

forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

8. (Amended) A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

15. (Amended) A method of processing a semiconductor substrate, comprising:

providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%;

forming a silicon oxynitride antireflection coating over the metal layer having a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating comprising an oxide layer having a thickness from about 5Å to about 50Å over a silicon oxynitride layer;

depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating;

selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and

developing the deep ultraviolet photoresist,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

A version of the above amended claims marked to indicate the specific amendments may be found in the attached Appendix, in accordance with 37 CFR 1.121(c)(1).

Telephone Interview

Applicants' undersigned attorney wishes to thank the Examiner for returning his telephone call and for the courteous and helpful discussion of the present application on January 25, 2001. During the interview, the rejections of the independent claims were discussed. Possible amendments of the claims were discussed. Applicants' attorney pointed out features of the invention not disclosed in the prior art, specifically features relating to the oxide layer. The Examiner indicated that claimed amended to identify such features would appear to distinguish the present invention over the art

of record. Upon consideration of the pending claims, the present Office action and the Examiner's comments in the telephone interview, Applicants herein submit the foregoing proposed claim amendments, which are intended to better point out the novel features of Applicants' invention. this statement constitutes Applicants' interview summary, in accordance with 37 CFR 1.133 and MPEP 713.04.

REMARKS

Claims 1-20 are pending in the application. Claims 1, 8 and 15 have been amended herein. Favorable reconsideration in light of the amendments and the remarks which follow is respectfully requested.

Rejection over Roman et al in view of Ionov et al:

Claims 1-3, 7-13, 15-16, and 19-20 stand rejected under 35 U.S.C. § 103(a) as obvious over Roman et al (U.S. Patent No. 5,639,687) in view of Ionov et al (U.S. Patent No. 6,013,582). Claims 4-6, 14, and 17-18 stand as obvious over Roman et al in view of Ionov et al and further in view of Fuse (U.S. Patent No. 4,527,007).

In the Office action mailed January 3, 2001, in response to Applicants' arguments in the Reply filed October 10, 2000, the Examiner asserted that Roman et al disclose a process including forming an oxide film over the antireflective coating ("ARC"), and asserts that this is the same as Applicants' claimed features, when the ARC of Ionov et al is substituted for that of Roman et al. The Examiner dismissed Applicants' argument that a person of skill in the art would substitute SiON for both the silicon-rich silicon nitride layer and the oxide layer on the basis that only the silicon-rich silicon nitride would be replaced. The Examiner did not address Applicants' argument that a person would not make the substitution in the first instance. The Examiner thereupon made the rejection final.

Applicants respectfully traverse these final rejections for the following reasons.

Applicants' claims are amended herein to specify the function of the oxide layer, which is to solve a problem neither recognized nor addressed by Roman et al or Ionov et al. In addition, claims 8 and 15 have been amended to include the feature that the oxide layer has a thickness from about 5Å to about 50Å. Applicants' claims, as amended herein, specify that the oxide layer, having a thickness from about 5Å to about 50Å, forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer. These features are neither disclosed nor suggested by the prior art of record.

Roman et al and Ionov et al fail to recognize the problem solved by the thin oxide layer of the presently claimed invention. The problem solved by the thin oxide layer is incompatibility between nitrogen atoms in and migrating from the ARC and a deep UV photoresist which is subsequently applied thereover. As disclosed in the specification at page 3, lines 9-14,

Moreover, with specific regard to deep ultraviolet (UV) photoresists, compatibility concerns exist with ARCs that contain nitrogen. This is because nitrogen deleteriously effects deep UV photoresists. In particular, nitrogen may migrate from the ARC and poison a deep UV photoresist by desensitizing them to UV light, thus inhibiting development of the photoresist. Desensitized deep UV photoresists exhibit extremely poor pattern definition after development.

The present invention solves this problem, as disclosed in the specification, e.g., at page 3, lines 18-21. This problem is not even recognized by either Roman et al or Ionov et al. In addition, as disclosed in the specification at page 3, lines 21-23, the claimed oxide layer provides protection from reworking chemicals.

As noted in response to the previous Office action, Roman et al teach an oxide insulating layer which is optional. In describing the optional oxide layer, Roman et al state that, if present, it could be applied either above or below the ARC. Roman et al do not describe any purpose for the oxide layer, other than to describe it as an

“insulating” layer. Presumably, the insulating layer is present to electrically insulate the ARC or other layers from underlying or overlying conductive layers (metal or metal silicide, for example). Alternatively, the insulating layer may be present to provide a stress-relieving function such as performed by a pad oxide in some applications. A layer such as an electrical insulating layer or a pad layer must be thicker than the presently claimed about 5Å to about 50Å in order to provide those functions. Certainly there is no suggestion in Roman et al that the oxide layer could be so thin or could function as a barrier layer to prevent migration of nitrogen atoms from the antireflective coating layer to an overlying deep UV photoresist.

With respect to the thicknesses of Applicants’ oxide layer, the claimed range is adequate to provide a barrier against migration of nitrogen atoms from the ARC to an overlying deep UV photoresist, but would not provide any electrical or stress-relieving insulating effect.

Further with respect to the thicknesses of the layers, in the original rejection, the Examiner asserted that Roman et al teach that “such variables” may be adjusted. In fact, Roman et al teach only that the antireflective coating layer thickness may be adjusted along with its absorptivity, to obtain a desired reflectivity. Applicants are aware of no teaching in Roman et al relating to the thickness of the oxide layer, or of any teaching which would lead a person to adjust the thickness of the oxide layer, and no suggestion to adjust the thickness downward to the very thin range recited in Applicants’ claims. Furthermore, as noted above, the presently claimed oxide layer is very thin, from about 5Å to about 50Å, and there is no suggestion that adjusting the thickness of any layer to this degree. Roman et al discloses 500Å as the exemplary thickness for the ARC, and any adjusted thicknesses would be expected to remain at this order of magnitude.

With respect to the asserted replacement of the silicon rich silicon nitride ARC of Roman et al by an ARC disclosed by Ionov et al, Applicants note that Roman et al

actually teach away from replacing their ARC with one such as the silicon oxynitride ARC of Ionov et al. At col. 4, lines 21-25, Roman et al teach:

Furthermore, silicon-rich silicon nitride deposited by chemical vapor deposition also has a low hydrogen content. Therefore, it is compatible with the formation of submicron transistors, which are known to be adversely effected by films containing a high concentration of hydrogen.

Thus, Roman et al teach that an ARC which includes a significant amount of hydrogen should not be used with submicron transistors.

Ionov et al teach that the silicon oxynitride ARC contains a significant amount of hydrogen. At col. 1, lines 52-62, Ionov et al teach that silicon oxynitride typically has a formula $\text{SiO}_x\text{N}_y\text{H}_z$, where x ranges from 0 to about 2, y ranges from 0 to about 1, and z ranges from 0 to about 1, and that x, y and z typically range between about 0.2 and about 0.5. Thus, a person of skill in the art would be led away from substituting the silicon oxynitride of Ionov et al for the ARC of Roman et al, due to the presence of significant levels of hydrogen which Roman et al teach to be detrimental to submicron transistors.

Therefore, Roman et al may be considered to teach away from replacement of their ARC with that of Ionov et al, which is also the ARC claimed by Applicants. Thus, although Ionov et al teach a variety of materials for use as an ARC, it is not correct that Ionov et al teach the equivalency of these materials. This is particularly true in view of the distinction made by Roman et al between H-containing and non-H-containing ARC materials.

For the foregoing reasons, the presently claimed invention set forth in the amended claims would not have been obvious over the asserted combination of Roman et al and Ionov et al. There is neither suggestion nor motivation in either reference to make the presently claimed combination. The only way one would know to make the presently claimed combination is after reading Applicants' claims and/or specification.

That is, the asserted obviousness of Applicants' claimed invention must have been based on a hindsight reconstruction of Applicants' invention.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Roman et al and Ionov et al.

Rejection over Roman et al and Ionov et al and further in view of Fuse:

Claims 4-6, 14 and 17-18 stand rejected as obvious over the above combination of Roman et al and Ionov et al, further in view of Fuse. Applicants respectfully traverse this rejection for the above reasons with respect to the primary and secondary references, and for the following additional reasons with respect to the asserted combination including Fuse.

Fuse fails to remedy the deficiencies of the primary and secondary references. As stated by the Examiner, Fuse provides only a method for making a silicon oxide layer by use of silane gas and oxygen or nitrous oxide (N_2O). Fuse forms this silicon oxide layer on ITO, not on silicon oxynitride. Like the primary and secondary references, Fuse provides no suggestion or motivation that the silicon oxide layer should be used in conjunction with a silicon oxynitride layer to form an antireflection coating, such as in the presently claimed invention. Fuse does not remedy the shortcomings of the primary and secondary references, and, even if combined with the teachings of those references, still fails to lead one unambiguously to Applicants' claimed invention, particularly as recited in pending claims 4-6, 14 and 17-18.

Fuse provides no suggestion to form an oxide layer as thin as the claimed range of about 50 Å to about 500 Å. Although Fuse does not appear to specify the thickness of the oxide layer, Fuse's other layers have thicknesses ranging from 1500 Å to 1 μm (col. 3, lines 52-60). Thus, a person of skill in the art would expect the oxide thickness to be of the same order of magnitude.

Specifically with reference to claims 4, 5 and 17, Fuse fails to disclose or suggest forming a silicon oxide layer by contacting the silicon oxynitride layer with

either an oxygen plasma or an N₂O plasma. The Examiner stated correctly that Fuse discloses formation of a silicon oxide layer by plasma CVD in the presence of silane gas and either oxygen or nitrous oxide. This is not the same as the process recited in claims 4, 5 and 17, in which the Si of the silicon oxynitride layer is oxidized to SiO₂ by exposing the silicon oxynitride to an oxygen plasma or an N₂O plasma. Silane gas is not used in the process of claims 4, 5 and 17. Thus, for this reason alone, claims 4, 5 and 17 would not have been obvious over Roman et al in view of Ionov et al and further in view of Fuse.

With respect to claims 14 and 18, these claims specify the CVD process by which Applicants' silicon oxynitride is formed. Fuse does not teach formation of a silicon oxynitride layer by one of plasma enhanced CVD and low pressure CVD. As stated by the Examiner, Fuse provides only a method for making a silicon oxide layer by use of silane gas and oxygen or nitrous oxide (N₂O). Fuse forms this silicon oxide layer on ITO, not on silicon oxynitride.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Roman et al, Ionov et al and Fuse.

Conclusion

For the foregoing reasons, Applicants respectfully assert that the presently claimed invention patentably distinguishes over the cited prior art references. There is no suggestion in the references to provide an oxide layer such as that presently claimed. The Examiner is requested to reconsider and withdraw the asserted rejections and to allow the claims. Notice to such effect is respectfully requested.

Should the Examiner consider that a further telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact the Applicant's undersigned attorney at the telephone number listed below.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 18-0988 under Attorney Docket No. AMDSP0211US.

APPENDIX

The claims as shown above have been amended in the following manner:

1. (Amended) A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:

providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;

depositing a silicon oxynitride layer over the metal layer having a thickness from about 100Å to about 1500Å; and

forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

8. (Amended) A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%.

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

15. (Amended) A method of processing a semiconductor substrate, comprising:

providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%;

forming a silicon oxynitride antireflection coating over the metal layer having a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating comprising an oxide layer having a thickness from about 5Å to about 50Å over a silicon oxynitride layer;

depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating;

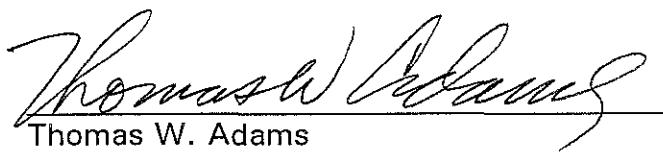
selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and

developing the deep ultraviolet photoresist,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

Respectfully submitted,
RENNER, OTTO, BOISSELLE & SKLAR, LLP

26 January 2001


Thomas W. Adams
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TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	09/207,562	
	Filing Date	December 8, 1998	
	First Named Inventor	Subramanian, et al.	
	Group Art Unit	2825	
	Examiner Name	R. Rocchegiani	
Total Number of Pages in This Submission	13	Attorney Docket Number	D545

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☒ Amendment / Response	☐ Licensing-related Papers	☐ Appeal Communication to Group (Appeal Notice, Brief, Reply Brief)
☒ After Final	☐ Petition Routing Slip (PTO/SB/69) and Accompanying Petition	☐ Proprietary Information
☐ Affidavits/declaration(s)	☐ Petition to Convert to a Provisional Application	☐ Status Letter
☐ Extension of Time Request	☐ Power of Attorney, Revocation Change of Correspondence Address	☒ Additional Enclosure(s) (please identify below):
☐ Express Abandonment Request	☐ Terminal Disclaimer	Postcard
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☐ Response to Missing Parts/Incomplete Application	Remarks	
☐ Response to Missing Parts under 37 CFR 1.52 or 1.53		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT	
Firm or Individual name	Thomas W. Adams, Reg. No. 35,047
Signature	
Date	January 26, 2001

CERTIFICATE OF MAILING	
I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on this date: 1/26/01	
Typed or printed name	Kim D. Hall
Signature	
Date	1/26/01

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/207,562	12/08/98	SUBRAMANIAN	R D545

MM92/0213

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EXAMINER

ROCCEGANI, R

ART UNIT

PAPER NUMBER

2825

DATE MAILED: 02/13/01

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

Commissioner of Patents and Trademarks

Advisory Action

Application No.

09/207,562

Applicant(s)

Subramanian et al.

Examiner

RENZO ROCCHEGIANI

Group Art Unit

2825



THE PERIOD FOR RESPONSE: [check only a) or b)]

- a) ☐ expires _____ months from the mailing date of the final rejection.
- b) ☒ expires either three months from the mailing date of the final rejection, or on the mailing date of this Advisory Action, whichever is later. In no event, however, will the statutory period for the response expire later than six months from the date of the final rejection.

Any extension of time must be obtained by filing a petition under 37 CFR 1.136(a), the proposed response and the appropriate fee. The date on which the response, the petition, and the fee have been filed is the date of the response and also the date for the purposes of determining the period of extension and the corresponding amount of the fee. Any extension fee pursuant to 37 CFR 1.17 will be calculated from the date of the originally set shortened statutory period for response or as set forth in b) above.

- ☐ Appellant's Brief is due two months from the date of the Notice of Appeal filed on _____ (or within any period for response set forth above, whichever is later). See 37 CFR 1.191(d) and 37 CFR 1.192(a).

Applicant's response to the final rejection, filed on Jan 3, 2000 has been considered with the following effect, but is NOT deemed to place the application in condition for allowance:

- ☒ The proposed amendment(s):

☐ will be entered upon filing of a Notice of Appeal and an Appeal Brief.

☒ will not be entered because:

- ☒ they raise new issues that would require further consideration and/or search. (See note below).
- ☐ they raise the issue of new matter. (See note below).
- ☐ they are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal.
- ☐ they present additional claims without cancelling a corresponding number of finally rejected claims.

NOTE: The use of the oxide layer as a barrier to migration of nitrogen atoms from the silicon oxynitride layer was not previously presented therefore it constitutes a new limitation that require further search.

- ☐ Applicant's response has overcome the following rejection(s):

- ☐ Newly proposed or amended claims _____ would be allowable if submitted in a separate, timely filed amendment cancelling the non-allowable claims.

- ☐ The affidavit, exhibit or request for reconsideration has been considered but does NOT place the application in condition for allowance because:

- ☐ The affidavit or exhibit will NOT be considered because it is not directed SOLELY to issues which were newly raised by the Examiner in the final rejection.

- ☒ For purposes of Appeal, the status of the claims is as follows (see attached written explanation, if any):

Claims allowed: _____

Claims objected to: _____

Claims rejected: 1-20

- ☐ The proposed drawing correction filed on _____ ☐ has ☐ has not been approved by the Examiner.

- ☐ Note the attached Information Disclosure Statement(s), PTO-1449, Paper No(s). _____

- ☐ Other

MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

03-12-01

CPA/2825 #51/CPA 3-21-01 Harrison

PTO/SB/29 (10-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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

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

Submit an original, and a duplicate for fee processing.
(Only for Continuation or Divisional applications under 37 CFR 1.53(d))

CHECK BOX, if applicable:
☐ DUPLICATE

Address to: Assistant Commissioner for Patents Box CPA Washington, DC 20231	Attorney Docket No. of Prior Application	AMDSP0211US
	First Named Inventor	Subramanian, et al.
	Examiner Name	R. Rocchegiani
	Group Art Unit	2825
	Express Mail Label No.	EL592220383US

This is a request for a ☒ continuation or ☐ divisional application under 37 CFR 1.53(d),
(continued prosecution application (CPA)) of prior application number 09 / 207,562,
filed on Dec. 8, 1998, entitled USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYER

NOTES

FILING QUALIFICATIONS: The prior application identified above must be a nonprovisional application that is either: (1) complete as defined by 37 CFR 1.51(b), or (2) the national stage of an international application in compliance with 35 U.S.C. 371. Effective May 29, 2000, a CPA may only be filed in a utility or a plant application if the prior nonprovisional application was filed before May 29, 2000. A CPA may be filed in a design application regardless of the filing date of the prior application. See "Request for Continued Examination Practice changes to and Provisional Application Practice," Final Rule, 65 Fed. Reg. 50092 (Aug. 16, 2000); Interim Rule, 65 Fed. Reg. 14865 (Mar. 20, 2000), 1233 Off. Gaz. Pat. Office (Apr. 11, 2000).

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

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

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

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

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

- ☒ Enter the unentered amendment previously filed on January 26, 2001 under 37 CFR 1.116 in the prior nonprovisional application.
- ☐ A preliminary amendment is enclosed.
- This application is filed by fewer than all the inventors named in the prior application, 37 CFR 1.53(d)(4).
 - ☐ DELETE the following inventor(s) named in the prior nonprovisional application:
.....
 - ☐ The inventor(s) to be deleted are set forth on a separate sheet attached hereto.
- ☐ A new power of attorney or authorization of agent (PTO/SB/81) is enclosed.
- Information Disclosure Statement (IDS) is enclosed:
 - ☐ PTO-1449
 - ☐ Copies of IDS Citations

[Page 1 of 2]

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box CPA, Washington, DC 20231.

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c) or (i))	20 -20* =	0	x \$ 0 =	\$ 0
	INDEPENDENT CLAIMS (37 CFR 1.16(b) or (j))	3 -3** =	0	x \$ 0 =	0
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			+ \$ 0 =	0
				BASIC FEE (37 CFR 1.16)	710.00
				Total of above Calculations =	710.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.27).				
	* Reissue claims in excess of 20 and over original patent. ** Reissue independent claims over original patent.				TOTAL = 710.00

6. ☐ Small entity status: Applicant claims small entity status. See 37 CFR 1.27.
7. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 18 - 0988:
- a. ☐ Fees required under 37 CFR 1.16.
- b. ☐ Fees required under 37 CFR 1.17.
- c. ☐ Fees required under 37 CFR 1.18.
8. ☒ A check in the amount of \$ 710.00 is enclosed.
9. ☐ Payment by credit card, Form PTO-2038 is attached.
10. ☐ Applicant requests suspension of action under 37 CFR 1.103(b) for a period of _____ months (not to exceed 3 months) and the fee under 37 CFR 1.17(i) is enclosed.
11. ☐ New Attorney Docket Number, if desired _____
[Prior application Attorney Docket Number will carryover to this CPA unless a new Attorney Docket Number has been provided herein.]
12. a. ☐ Receipt For Facsimile Transmitted CPA (PTO/SB/29A)
- b. ☒ Return Receipt Postcard (Should be specifically itemized, See MPEP 503) **(2)**
13. ☒ Other: Certificate of Express Mailing

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

14. NEW CORRESPONDENCE ADDRESS

☐ Customer Number or Bar Code Label

or ☐ New correspondence address below

(Insert Customer No. or Attach bar code label here)

Name	Thomas W. Adams, Reg. No. 35,047				
	Renner, Otto, Boisselle & Sklar, LLP				
Address	1621 Euclid Avenue				
	Nineteenth Floor				
City	Cleveland	State	Ohio	Zip Code	44115
Country	USA	Telephone	216-621-1113	Fax	216-621-6165

15. SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Name (Print IType)

Thomas W. Adams

Signature

Thomas W. Adams

Registration No. (Attorney/Agent)

Reg. No. 35,047

Date

March 9, 2001

CONTINUED PROSECUTION APPLICATION (CPA) REQUEST TRANSMITTAL Submit an original, and a duplicate for fee processing. (Only for Continuation or Divisional applications under 37 CFR 1.53(d))	
CHECK BOX, if applicable: ☒ DUPLICATE	

Address to: Assistant Commissioner for Patents Box CPA Washington, DC 20231	Attorney Docket No. of Prior Application	AMDSP0211US
	First Named Inventor	Subramanian, et al.
	Examiner Name	R. Rocchegiani
	Group Art Unit	2825
	Express Mail Label No.	EL592220383US

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[Page 1 of 2]

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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
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- b. ☒ Return Receipt Postcard (Should be specifically itemized, See MPEP 503)(2)
13. ☒ Other: Certificate of Express Mailing

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

14. NEW CORRESPONDENCE ADDRESS

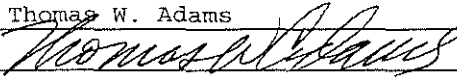
☐ Customer Number or Bar Code Label

or ☐ New correspondence address below

(Insert Customer No. or Attach bar code label here)

Name	Thomas W. Adams, Reg. No. 35,047				
	Renner, Otto, Boisselle & Sklar, LLP				
Address	1621 Euclid Avenue				
	Nineteenth Floor				
City	Cleveland	State	Ohio	Zip Code	44115
Country	USA	Telephone	216-621-1113	Fax	216-621-6165

15. SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Name (Print /Type)	Thomas W. Adams
Signature	
Registration No. (Attorney/Agent)	Reg. No. 35,047
Date	March 9, 2001

EXPRESS MAIL NO. EL592220383US

Date of Deposit: March 9, 2001



I hereby certify that this CPA application (along with any other paper referred to as being attached or enclosed) is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to:

BOX CPA
ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231.

David Friedman
(Typed or printed name of Sender)


(Signature)

C:\109\Adams-Tom\Client Files\AMD\211\amdsp0211us.express mail cert



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/257,562	12/08/98	SUBRAMANIAN	R 0545

GREGORY TURCOT
RUNNER, UTTO, BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115

MMC2/0411

EXAMINER

ROOCHERIAN, R

ART UNIT

PAPER NUMBER

2825

DATE MAILED:

01/13/01

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

Commissioner of Patents and Trademarks

Office Action Summary	Application No.	Applicant(s)	
	09/207,562	SUBRAMANIAN ET AL.	
	Examiner	Art Unit	
	Renzo N. Rocchegiani	2825	

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

Period for Reply

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

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

Status

1) ☐ Responsive to communication(s) filed on 09 March 2001.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☐ Claim(s) 1-20 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☐ Claim(s) 1-20 is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some * c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

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

Attachment(s)

15) ☒ Notice of References Cited (PTO-892)

16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.

18) ☐ Interview Summary (PTO-413) Paper No(s). _____.

19) ☐ Notice of Informal Patent Application (PTO-152)

20) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

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

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

2. Claims 1-5, 7-13, and 14-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 6,030,541 (Adkisson et al.) in view of U.S. Patent 5,639,687 (Roman et al.) and in further view of U.S. Patent N. 6,156,620 (Puchner et al.).

Adkisson et al. disclose a process to form an ARC layer by depositing a silicon oxynitride layer of a thickness varying between 100 and 2000 angstroms (col. 4, lines 20-25). The silicon oxynitride is deposited by way of low pressure PECVD (col. 4, lines 19-25). An oxide layer is then formed over the silicon oxynitride layer by either oxidizing the silicon oxynitride layer via an oxygen plasma using NO₂ or by way of deposition (col. 4, lines 35-40). The oxide layer formed over the silicon oxynitride layer has a thickness of approximately 50 to 100 angstroms (col. 4, lines 38-40). A deep UV photoresist layer is then deposited over the oxide and silicon oxynitride layer (col. 4, lines 45-50). The photoresist is a positive photoresist that is exposed to UV radiation of up to 320 nm. (col. 4, lines 45-50).

Adkisson et al. do not disclose forming the ARC layer over a metal layer, yet Adkisson et al. teach that the ARC layer may be formed over any substrate (col. 3, lines 52-60). Adkisson et al. also do not specify that the oxide layer formed over the silicon

oxynitride layer may function as barrier layer preventing nitrogen atoms migration from the silicon oxynitride.

Roman et al. teaches a process to form a semiconductor device wherein a metal layer, comprising aluminum or tungsten or an alloy thereof, is deposited over a substrate (col. 2, lines 34-45). An antireflective layer is then deposited over the metal layer (col. 2, lines 46-49) by way of CVD (col. 3, lines 4-6). The thickness of the antireflective layer may be varied depending of a number of factors (col. 2, lines 55-67). A possible thickness for the antireflective coating is 500 (col. 3, lines 20-25). An oxide layer is formed over the antireflective layer (col. 3, lines 50-57). This structure reduces the reflectivity to less than 15% or even 5% at a wavelength of 248 nm (col. 3, lines 25-33). Finally a photoresist is deposited over the oxide layer and used as a patterning mask via lithographic technique (col. 3, lines 34-42).

Puchner et al. teaches that after a silicon oxynitride layer is formed, an oxide layer may be formed over the silicon oxynitride so as to form a barrier layer against nitrogen migration from the oxynitride layer (col. 5, lines 22-34).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Roman et al. to the invention disclosed by Adkisson et al., since Adkisson et al. discloses that the ARC layer may be formed over any substrate. Also, it has been held to be within the general skill of a worker in the specific art to use a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Furthermore, it would have been obvious to one having ordinary skill in the specific art to have the oxide layer function as a barrier layer to the nitrogen atoms, since Puchner et al. teaches that an oxide layer would act as a barrier layer if formed over a silicon oxynitride and since Adkisson et al. forms the oxide over the oxynitride of

the same thickness of the present invention it would be inherent that it would function as a barrier layer.

3. Claims 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 6,030,541 (Adkisson et al.) in view of U.S. Patent 5,639,687 (Roman et al.) and of U.S. Patent N. 6,156,620 (Puchner et al.) and further in view of U.S. Patent N. 4,527,007 (Fuse).

As stated in the preceding paragraph, all the limitations of this claim have been met except for specifying the deposition process for the oxide layer.

Fuse teaches a process to form an oxide capping layer by way of plasma CVD in the presence of silane gas and either NO₂ or O₂ (abstract) at a reduced pressure (col. 4, lines 3-13).

It would have been obvious to one having ordinary skill in the specific art to form an oxide via CVD using silane gas and either NO₂ or O₂, since the process of forming an oxide is a very well known process in the art.

Response to Arguments

4. Applicant's arguments with respect to claims 1-20 have been considered but are moot in view of the new ground(s) of rejection. Upon an update of the search the examiner has found new prior art that reads on the claims and has therefore reformulated the rejections as listed above.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Renzo Rocchegiani whose telephone number is (703) 308-5839. The examiner can normally be reached on Monday through Friday from 8:30 a.m. to 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (703) 308-1323. The fax phone number for the organization where this application or proceeding is assigned is (703) 305-3432.

RNR

April 4, 2001


MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

Notice of References Cited	Application/Control No. 09/207,562	Applicant(s)/Patent Under Reexamination SUBRAMANIAN ET AL.	
	Examiner Renzo N. Rocchegiani	Art Unit 2825	Page 1 of 1

U.S. PATENT DOCUMENTS						
*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification	
	A	US-6,030,541-	02-2000	Adkisson et al.	216	51
	B	US-6,156,620-	12-2000	Puchner et al.	438	400
	C	US- -				
	D	US- -				
	E	US- -				
	F	US- -				
	G	US- -				
	H	US- -				
	I	US- -				
	J	US- -				
	K	US- -				
	L	US- -				
	M	US- -				

FOREIGN PATENT DOCUMENTS						
*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	- -				
	O	- -				
	P	- -				
	Q	- -				
	R	- -				
	S	- -				
	T	- -				

NON-PATENT DOCUMENTS		
*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

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



CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Box NON-FEE AMENDMENT, Washington, D. C. 20231.

Janet Farr

Date: May 9, 2001

(Signature of person mailing paper)

D545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application:

Applicant:	Subramanian, et al.	:	Art Unit:	2825
Serial No.:	09/207,562	:	Examiner:	R. Rocchegiani
Filed:	December 8, 1998	:		

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

REPLY TO OFFICE ACTION MAILED APRIL 11, 2001

Assistant Commissioner for Patents
Box NON-FEE AMENDMENT
Washington, D. C. 20231

Dear Sir:

This paper is responsive to the Office Action mailed April 11, 2001, for which a three (3) month period of response was given. Accordingly, Applicant's Reply is timely filed. Favorable reconsideration of the present application based on the present Reply is respectfully requested.

AMENDMENTS

Please amend claims 1, 8 and 15 so as to read as follows:

B¹

1. (Twice Amended) A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:

- providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;
- depositing a silicon oxynitride layer on the metal layer having a thickness from about 100Å to about 1500Å; and
- forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

B²

8. (Twice Amended) A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating on the metal layer; wherein the silicon oxynitride antireflection coating formed over the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

15. (Twice Amended) A method of processing a semiconductor substrate, comprising:

providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%;

forming a silicon oxynitride antireflection coating on the metal layer having a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating comprising an oxide layer having a thickness from about 5Å to about 50Å over a silicon oxynitride layer;

depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating;

selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and

developing the deep ultraviolet photoresist,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

A version of the above amended claims marked to indicate the specific amendments may be found in the attached Appendix, in accordance with 37 CFR 1.121(c)(1).

REMARKS

Claims 1-20 are pending in the application. Claims 1, 8 and 15 have been amended herein. The amendment of these claims is supported, for example, in Figs. 1-4 of the drawings. Favorable reconsideration in light of the amendments and the remarks which follow is respectfully requested.

Rejection over Adkisson in view of Roman and further in view of Puchner:

Claims 1-5 and 7-20 stand rejected under 35 U.S.C. § 103(a) as obvious over Adkisson et al (U.S. Patent No. 6,030,541) in view of Roman et al (U.S. Patent No. 5,639,687) and further in view of Puchner et al (U.S. Patent No. 6,156,620). Claim 6 stands rejected as obvious over these references and further in view of Fuse et al (U.S. Patent No. 4,527,007).

Applicants respectfully traverse these rejections for the following reasons.

In the Office action, the Examiner asserted that Adkisson et al disclose a process including forming an oxide film over an antireflective coating ("ARC"), but admitted that Adkisson et al do not disclose forming the ARC layer over a metal layer. However, the Examiner asserted that "Adkisson et al teach that the ARC layer may be formed over any substrate". The Examiner also admitted that Adkisson et al fail to disclose that the oxide layer formed over the silicon oxynitride layer may function as a barrier layer to prevent nitrogen atoms from migrating out of the silicon oxynitride layer. Apparently on the basis that Adkisson et al suggest other substrates, the Examiner cited Roman et al as showing an ARC layer over a metal layer.

With respect to the assertion that Adkisson et al teach that the ARC layer may be formed over "any substrate", Applicants respectfully point out that Adkisson et al in fact disclose only that "the present invention may be used to define a pattern in a variety of surfaces". This is not the same as "any substrate" and it is not the kind of suggestion which would lead a person to think that the method also would be applicable to a metal surface, when taken together with the whole of the Adkisson et al disclosure. Consistent with this point, at col. 3, lines 62-65, Adkisson et al state:

The semiconductor substrate is typically silicon but can be any other semiconductor material such as group III-V semiconductor. (Emphasis added.)

That Adkisson et al contemplate only a semiconductor substrate such as silicon is further emphasized by the disclosure at col. 5, lines 36-39:

It is crucial to the success of the present invention that after patterning the hard mask, both the remaining photoresist layer 18 and anti-reflective coating 16 be removed to allow for silicidization of the underlying polysilicon film. (Emphasis added.)

While the foregoing disclosures do not exclude metals, when taken in conjunction with disclosure as a whole, and in particular with the above-quoted reference to semiconductor materials, the term "variety of surfaces", at col. 3, line 54, appears to be quite limited. Certainly, when Adkisson et al is considered as a whole (as it must), the reference would not suggest that metal is among the substrates to which the method might be applied.

Furthermore, there is nothing in Adkisson et al which would lead a person to conclude that the method is applicable to a metal surface. In fact, it appears that the term "metal" does not appear in Adkisson et al. Thus, the Adkisson et al disclosure might constitute, at best, an invitation to experiment, i.e., an "obvious-to-try" situation, but "obvious-to-try" is not sufficient to support a motivation to combine references or to reach a conclusion of obviousness. See, *In re O'Farrell*, 7 USPQ2d 1673, 1681 (Fed. Cir. 1988). Certainly there is no suggestion in Adkisson et al that the method would be applicable to metal surfaces.

Applicants' claims are amended herein to specify that the ARC layer is formed on the metal layer, rather than "over" the metal layer. This amendment distinguishes the present invention from that of Adkisson et al, which requires the presence of a hard mask layer between the substrate and the ARC layer. See Adkisson et al, col. 3, lines 60-62.

As Applicants have previously noted, Roman et al teach that an oxide layer may optionally above or below the ARC layer. Thus, a person considering both Adkisson et al and Roman et al would conclude that an oxide layer (one example of the Adkisson et al hard mask layer) should be applied between the ARC and the underlying layer. Therefore, if one were to combine the disclosures of Adkisson et al and Roman et al, one might attempt to apply an ARC layer over a metal layer and, if so, one would first cover the metal layer with a hard mask layer, as taught by Adkisson et al and consistent with Roman et al. As noted above, Applicants' claims exclude such an embodiment. Thus, even if the combination of Adkisson et al and Roman et al were attempted, it would still not lead to Applicants' claimed invention.

Puchner et al disclose forming a barrier region in an STI structure to prevent migration of dopants out of an adjacent semiconductor region. Puchner et al add an oxide barrier layer to prevent a reverse migration of nitrogen from the barrier layer into the semiconductor region, which might change the doping of the semiconductor. Puchner et al does not remedy the shortcomings of the primary and secondary references, i.e., it does not suggest that an ARC layer could be applied as presently claimed, in contradistinction to the teachings of Adkisson et al and Roman et al.

For the foregoing reasons, Applicants respectfully assert that the presently claimed invention would not have been obvious over the asserted combination of Adkisson et al, Roman et al and Puchner et al. There is neither suggestion nor motivation in either reference to make the presently claimed combination. The only way one would know to make the presently claimed combination is after reading Applicants' claims and/or specification. That is, the asserted obviousness of Applicants' claimed invention must have been based on a hindsight reconstruction of Applicants' invention.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Adkisson et al, Roman et al and Puchner et al.

Rejection of Claim 6 Over the Above References and further in view of Fuse:

Claim 6 stands rejected as obvious over the above combination of Adkisson et al, Roman et al and Puchner et al, further in view of Fuse. Applicants respectfully traverse this rejection for the above reasons with respect to the primary, secondary and tertiary references, and for the following additional reasons with respect to the asserted combination including Fuse.

Fuse fails to remedy the deficiencies of the primary, secondary and tertiary references. Fuse provides only a method for making a silicon oxide layer by use of silane gas and oxygen or nitrous oxide (N₂O). Fuse forms this silicon oxide layer on ITO, not on silicon oxynitride. Like the primary, secondary and tertiary references, Fuse provides no suggestion or motivation that an ARC layer should be applied as presently claimed, on an underlying metal layer. Fuse does not remedy the shortcomings of the primary, secondary and tertiary references, and, even if combined with the teachings of those references, still fails to lead one unambiguously to Applicants' claimed invention, particularly as recited in pending claim 6.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Adkisson et al, Roman et al and Puchner et al and further in view of Fuse.

Conclusion

For the foregoing reasons, Applicants respectfully assert that the presently claimed invention patentably distinguishes over the cited prior art references. There is no suggestion in the references to provide an antireflective coating such as that presently claimed. The Examiner is requested to reconsider and withdraw the asserted rejections and to allow the claims. Notice to such effect is respectfully requested.

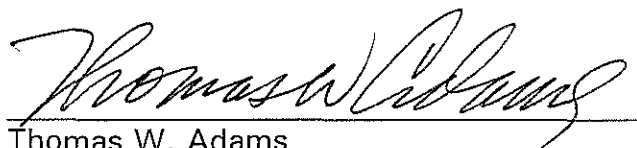
Application No. 09/207,562

Attorney Docket No.: D545

Should the Examiner consider that a further telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact the Applicant's undersigned attorney at the telephone number listed below.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 18-0988 under Attorney Docket No. AMDSP211US/D545.

Respectfully submitted,
RENNER, OTTO, BOISSELLE & SKLAR, LLP



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APPENDIX

The claims as shown above have been amended in the following manner:

1. (Twice Amended) A method of forming a silicon oxynitride antireflection coating over a metal layer, comprising:

providing a semiconductor substrate comprising the metal layer over at least part of the semiconductor substrate;

depositing a silicon oxynitride layer [over] on the metal layer having a thickness from about 100Å to about 1500Å; and

forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride layer to provide the silicon oxynitride antireflection coating,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

8. (Twice Amended) A method of reducing an apparent reflectivity of a metal layer having a first reflectivity in a semiconductor structure, comprising forming a silicon oxynitride antireflection coating over the metal layer; wherein the silicon oxynitride antireflection coating formed [over] on the metal layer has a second reflectivity and is formed by depositing silicon oxynitride on the metal layer by chemical vapor deposition and forming an oxide layer having a thickness from about 5Å to about 50Å over the silicon oxynitride, and the difference between the first reflectivity and the second reflectivity is at least about 60%,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.

15. (Twice Amended) A method of processing a semiconductor substrate, comprising:

providing a semiconductor substrate comprising a metal layer having a reflectivity of at least 80%;

forming a silicon oxynitride antireflection coating [over] on the metal layer having a thickness from about 100Å to about 1500Å, the silicon oxynitride antireflection coating comprising an oxide layer having a thickness from about 5Å to about 50Å over a silicon oxynitride layer;

depositing a deep ultraviolet photoresist over the silicon oxynitride antireflection coating;

selectively irradiating the deep ultraviolet photoresist with electromagnetic radiation having a wavelength of about 248 nm or less; and

developing the deep ultraviolet photoresist,

wherein the oxide layer forms a barrier to migration of nitrogen atoms from the silicon oxynitride layer.



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TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	09/207,562
	Filing Date	December 8, 1998
	First Named Inventor	Subramanian et al.
	Group Art Unit	2825
	Examiner Name	R. Rocchegiani
Total Number of Pages in This Submission	Attorney Docket Number	D545

ENCLOSURES (check all that apply)		
☐ Fee Transmittal Form ☐ Fee Attached ☒ Amendment / Response ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Response to Missing Parts/ Incomplete Application ☐ Response to Missing Parts under 37 CFR 1.52 or 1.53	☐ Assignment Papers (for an Application) ☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition Routing Slip (PTO/SB/69) and Accompanying Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation Change of Correspondence Address ☐ Terminal Disclaimer ☐ Small Entity Statement ☐ Request for Refund	☐ After Allowance Communication to Group ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to Group (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☒ Additional Enclosure(s) (please identify below): Postcard
Remarks		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT	
Firm or Individual name	Thomas W. Adams, Reg. No. 35,047
Signature	
Date	May 9, 2001

CERTIFICATE OF MAILING			
I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on this date: 05/09/01			
Typed or printed name	Janet Farr		
Signature		Date	May 9, 2001

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/207,562	12/08/98	SUBRAMANIAN	R D545

MMC1/0731

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EXAMINER

ROCCHESIANI, R

ART UNIT

PAPER NUMBER

2825

DATE MAILED: 07/31/01

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

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/207,562

Applicant(s)

SUBRAMANIAN ET AL.

Examiner

Renzo N. Rocchegiani

Art Unit

2825

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

Period for Reply

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

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

Status

- 1) ☒ Responsive to communication(s) filed on 14 May 2001.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☐ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

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

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

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

Attachment(s)

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

DETAILED ACTION

Claim Rejections - 35 USC § 103

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

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

2. Claims 1-5, 7-13, and 14-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 6,030,541 (Adkisson et al.) in view of U.S. Patent 5,639,687 (Roman et al.) and in further view of U.S. Patent N. 6,156,620 (Puchner et al.).

Adkisson et al. disclose a process to form an ARC layer by depositing a silicon oxynitride layer of a thickness varying between 100 and 2000 angstroms (col. 4, lines 20-25). The silicon oxynitride is deposited by way of low pressure PECVD (col. 4, lines 19-25). An oxide layer is then formed over the silicon oxynitride layer by either oxidizing the silicon oxynitride layer via an oxygen plasma using NO₂ or by way of deposition (col. 4, lines 35-40). The oxide layer formed over the silicon oxynitride layer has a thickness of approximately 50 to 100 angstroms (col. 4, lines 38-40). A deep UV photoresist layer is then deposited over the oxide and silicon oxynitride layer (col. 4, lines 45-50). The photoresist is a positive photoresist that is exposed to UV radiation of up to 320 nm. (col. 4, lines 45-50).

Adkisson et al. do not disclose forming the ARC layer over a metal layer, yet Adkisson et al. teach that the ARC layer may be formed over any substrate (col. 3, lines 52-60). Adkisson et al. also do not specify that the oxide layer formed over the silicon

oxynitride layer may function as barrier layer preventing nitrogen atoms migration from the silicon oxynitride.

Roman et al. teaches a process to form a semiconductor device wherein a metal layer, comprising aluminum or tungsten or an alloy thereof, is deposited over a substrate (col. 2, lines 34-45). An antireflective layer is then deposited over the metal layer (col. 2, lines 46-49) by way of CVD (col. 3, lines 4-6). The thickness of the antireflective layer may be varied depending of a number of factors (col. 2, lines 55-67). A possible thickness for the antireflective coating is 500 (col. 3, lines 20-25). An oxide layer is formed over the antireflective layer (col. 3, lines 50-57). This structure reduces the reflectivity to less than 15% or even 5% at a wavelength of 248 nm (col. 3, lines 25-33). Finally a photoresist is deposited over the oxide layer and used as a patterning mask via lithographic technique (col. 3, lines 34-42).

Puchner et al. teaches that after a silicon oxynitride layer is formed, an oxide layer may be formed over the silicon oxynitride so as to form a barrier layer against nitrogen migration from the oxynitride layer (col. 5, lines 22-34).

It would have been obvious to one having ordinary skill in the specific art to combine the teachings of Roman et al. to the invention disclosed by Adkisson et al., since Adkisson et al. discloses that the ARC layer may be formed over any substrate. Also, it has been held to be within the general skill of a worker in the specific art to use a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Furthermore, it would have been obvious to one having ordinary skill in the specific art to have the oxide layer function as a barrier layer to the nitrogen atoms, since Puchner et al. teaches that an oxide layer would act as a barrier layer if formed over a silicon oxynitride and since Adkisson et al. forms the oxide over the oxynitride of

the same thickness of the present invention it would be inherent that it would function as a barrier layer.

3. Claims 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent N. 6,030,541 (Adkisson et al.) in view of U.S. Patent 5,639,687 (Roman et al.) and of U.S. Patent N. 6,156,620 (Puchner et al.) and further in view of U.S. Patent N. 4,527,007 (Fuse).

As stated in the preceding paragraph, all the limitations of this claim have been met except for specifying the deposition process for the oxide layer.

Fuse teaches a process to form an oxide capping layer by way of plasma CVD in the presence of silane gas and either NO₂ or O₂ (abstract) at a reduced pressure (col. 4, lines 3-13).

It would have been obvious to one having ordinary skill in the specific art to form an oxide via CVD using silane gas and either NO₂ or O₂, since the process of forming an oxide is a very well known process in the art.

Response to Arguments

4. Applicant's arguments filed May 14, 2001 have been fully considered but they are not persuasive. Applicant argues that there would be no motivation to combine the Adkisson et al. reference to the Roman et al. reference because Adkisson et al. only suggests that it would be obvious to try to form the ARC layer on other surfaces. Applicant also opines that even if Adkisson et al. and Roman et al. were combinable they would not render applicant's invention obvious because a worker in the art would form a hard mask before forming the ARC layer. Furthermore, applicant argues that the

further combination of the other prior art with Adkisson et al. and Roman et al. not only does not remedy these deficiencies but they also do not render the additional limitations of the dependent claims obvious. The examiner disagrees with the applicant on all the points. Examiner disagrees that Adkisson et al. only suggests that it be obvious to try, no where in the patent Adkisson et al. says that it would be "obvious to try". Adkisson et al. clearly states that his process can be applied to any surface, interpreted broadly as it must be, this includes a metal surface. Furthermore, it has been held that non-preferred embodiments can be indicative of obviousness. *Merck & Co. v. Biocraft*

Laboratories Inc. 10 USPQ 2d 1843 (Fed. Cir. 1989). Adkisson et al. does not suggest to try, it discloses a non-preferred embodiment. Applicant argues that Adkisson et al. only refers to the use of semiconductor substrate that is the working embodiment of Adkisson et al.. Yet, a reference is not limited to working examples. *In re Fracalossi* 215 USPQ 569 (CCPA 1982). Finally, the examiner is convinced that a reference is good not only for what it teaches by direct anticipation but also for what one of ordinary skill might reasonably infer from the teachings. *In re Opprecht* 12 USPQ 2d 1235, 1236 (Fed. Cir. 1989). Thus, the Adkisson et al. reference provides enough motivation to be combined with the Roman et al. reference and render the present invention obvious by meeting the limitation of forming an ARC layer over a metal layer. The applicant also argues that even if the combination were obvious it would encourage the formation of a hard mask prior to the deposition of the ARC layer. The examiner disagrees in that Adkisson et al. disclose the formation of an hard mask to improve the etch step after the ARC layer is removed, hence it is a separate feature that does not

affect the ARC layer. In combination with Roman et al., where it is taught that the ARC layer may be formed right on the metal layer, a worker in the art would be able to determine that the hard mask is really an extra layer that would be optional. Hence, it would be obvious for a worker in the art to form the ARC layer on a metal layer.

Furthermore, the hard mask disclosed by Adkisson et al. may be made of silicon oxynitride which is the same material of the ARC layer, thus there would be no reason why a worker in the art would not deposit a silicon oxynitride layer directly on a metal layer. Applicant also argues that the combination with Puchner and Fuse do not render the present invention obvious. The examiner again disagrees with the applicant on this issue. Puchner teaches that an oxide layer works as a diffusion barrier, hence this is a property that the layer has. Since the main reference already teaches the formation of an oxide over the oxynitride layer it would be obvious that such oxide layer will act as a nitride barrier. Hence, the combination of Puchner is more than obvious. As for the Fuse reference, it teaches a well known method of depositing a silicon oxide layer. Independently on what surface the oxide layer is being deposited, the method taught by Fuse is so readily known that a worker in the art would not hesitate in using it. Hence, the fact that Fuse may not teach the deposition of an oxide over an oxynitride layer is not necessary for the combination to be made, besides that limitation is already covered by the main reference. Thus, there is enough motivation to combine Fuse as well. Thus, the examiner has not been persuaded by applicant's arguments and has decided to maintain the rejections as presented in the previous action.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Renzo Rocchegiani whose telephone number is (703) 308-5839. The examiner can normally be reached on Monday through Friday from 8:30 a.m. to 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (703) 308-1323. The fax phone number for the organization where this application or proceeding is assigned is (703) 305-3432.

RNR

July 16, 2001



MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
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Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
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09/207,562

EXAMINER

ART UNIT	PAPER NUMBER
----------	--------------

DATE MAILED:

EXAMINER INTERVIEW SUMMARY RECORD

All participants (applicant, applicant's representative, PTO personnel):

(1) Renzo Rocchegiani (3) Matthew Smith M.D.
(2) Thomas Adams M.D. (4) _____

Date of interview 8/16/2001

Type: ☐ Telephonic ☒ Personal (copy is given to ☐ applicant ☐ applicant's representative).

Exhibit shown or demonstration conducted: ☐ Yes ☒ No. If yes, brief description: _____

Agreement ☐ was reached with respect to some or all of the claims in question. ☒ was not reached.

Claims discussed: All

Identification of prior art discussed: US Patent N. 5,639,687 & US Patent N. 6,030,541

Description of the general nature of what was agreed to if an agreement was reached, or any other comments: Applicant will file a request for reconsideration. Examiner will review of prior art.

(A fuller description, if necessary, and a copy of the amendments, if available, which the examiner agreed would render the claims allowable must be attached. Also, where no copy of the amendments which would render the claims allowable is available, a summary thereof must be attached.)

☐ 1. It is not necessary for applicant to provide a separate record of the substance of the interview.

Unless the paragraph below has been checked to indicate to the contrary, A FORMAL WRITTEN RESPONSE TO THE LAST OFFICE ACTION IS NOT WAIVED AND MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW (e.g., items 1-7 on the reverse side of this form). If a response to the last Office action has already been filed, then applicant is given one month from this interview date to provide a statement of the substance of the interview.

☐ 2. Since the examiner's interview summary above (including any attachments) reflects a complete response to each of the objections, rejections and requirements that may be present in the last Office action, and since the claims are now allowable, this completed form is considered to fulfill the response requirements of the last Office action. Applicant is not relieved from providing a separate record of the substance of the interview unless box 1 above is also checked.

Renzo N. Rocchegiani
Examiner's Signature



AF/2325

AF

16/Response
8/2001
A. Waller

CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Box AF, Washington, D. C. 20231.

Date: August 23, 2001

JANET FARR
Janet Farr
(Signature of person mailing paper)

TECHNICAL STAFF (C) 11/25/99
RECEIVED

D545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application:

Applicant:	Subramanian, et al.	:	Art Unit:	2825
Serial No.:	09/207,562	:	Examiner:	R. Rocchegiani
Filed:	December 8, 1998	:		

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

REPLY TO FINAL OFFICE ACTION MAILED JULY 31, 2001

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

**RESPONSE AFTER FINAL--
EXPEDITED HANDLING
REQUESTED**

Dear Sir:

This paper is responsive to the final Office Action mailed July 31, 2001, for which a three (3) month period of response was given. Accordingly, Applicant's Reply is timely filed. The Examiner is requested to reconsider the rejections of

Applicants' claims, which are considered allowable over the prior art of record. Favorable reconsideration of the present application is respectfully requested in light of both the matters discussed in the personal interview held on August 16, 2001, and on the following remarks.

Interview Summary

Applicants' undersigned attorney wishes to thank both the Examiner and the Examiner's SPE, Mr. Matthew Smith, for granting and conducting the personal interview on August 16, 2001, and for the courteous and helpful discussion of the claims of the present application. During the interview, the rejections of the independent claims in particular, over the Adkisson et al and Roman et al references in particular, were discussed. Applicants' attorney pointed out features of the invention not consistent with the teachings of the applied prior art, and explained why a person of skill in the art would not make the asserted combination of prior art. No proposed claim amendments were discussed.

The Examiner and Mr. Smith requested Applicant's undersigned attorney to submit the present Reply to Office Action so that the points raised in the interview could be further considered. Accordingly, the contents of the present Reply are in accordance with the substance of the interview. This statement constitutes Applicants' interview summary, in accordance with 37 CFR 1.133 and MPEP 713.04.

REMARKS

Claims 1-20 are pending in the application. Favorable reconsideration in light of the amendments and the remarks which follow is respectfully requested.

Rejection over Adkisson et al in view of Roman et al:

Claims 1-5 and 7-20 stand rejected under 35 U.S.C. § 103(a) as obvious over Adkisson et al (U.S. Patent No. 6,030,541) in view of Roman et al (U.S. Patent No. 5,639,687), and further in view of Puchner et al, (U.S. Patent No. 6,156,620). Claim 6 is rejected over the same references further in view of Fuse (U.S. Patent No. 4,527,007). Applicants traverse these rejections for the reasons of record and for the following additional reasons, as pointed out in the interview of August 16, 2001.

Applicants respectfully submit that the Examiner's position in making the asserted rejection is in error with respect to at least the following four points. Since the rejections are based primarily on Adkisson et al and Roman et al, the following remarks are directed to these references.

First, in both the Office actions and the interview, the Examiner asserted that Adkisson et al teaches the method may be applied to "any surface", and that the Examiner is entitled to interpret this disclosure broadly. In fact, the disclosure of Adkisson at column 3, line 54, states that the patented method may be applied to "a variety of surfaces", and then goes on to consistently identify only semiconductor materials as the surfaces to which the method may be applied. Applicants note that at least the following disclosures indicate that Adkisson et al contemplates only semiconductor substrates:

Col. 3, lines 54-57 (i.e., immediately following "a variety of surfaces"):

the present invention is especially suitable for defining a pattern in a semiconductor substrate;

Col. 3, lines 62-65:

The semiconductor substrate is typically silicon but can be any other semiconductor material such as group III-V semiconductor.

Col. 5, lines 36-39:

It is crucial to the success of the present invention that after patterning the hard mask, both the remaining photoresist layer 18 and anti-reflective coating 16 be removed to allow for silicidization of the underlying polysilicon film.

and, Col. 5, lines 50-53:

The hard mask 14 is then used as the etch mask for etching the underlying surface such as a polysilicon surface in the case of preferred structures according to the present invention.

The Examiner is required to consider the teachings of the reference as a whole. The Adkisson et al reference as a whole would suggest the ARC be applied to a semiconductor substrate, and would not suggest it be applied to a metal substrate.

The Examiner must consider the reference for all it teaches, and cannot select portions which, in hindsight, may broadly encompass a single element of Applicants' invention. The Examiner asserted that the "variety of surfaces" of Adkisson et al would suggest a metal surface, since the metal surface is a "non-preferred embodiment". In fact, a metal surface is a non-disclosed embodiment, not a "non-preferred" embodiment. The term "metal" simply does not appear in Adkisson et al. Furthermore, Applicants did not argue that disclosure of metals was lacking from "working examples" as opposed to some other disclosure. Thus, the reference as a whole would not suggest a metal substrate.

Second, the Examiner asserted that the hard mask is "a separate feature that does not affect the ARC layer." To the contrary, the hard mask is an essential feature of the Adkisson et al disclosure. In fact, as pointed out by Applicants' attorney at the interview, the hard mask appears to be the sole feature distinguishing Adkisson et al from the prior art. The hard mask is used to protect the underlying layers and to form

a mask for patterning the underlying semiconductor layer. To dispense with the hard mask of Adkisson et al would be to destroy the intended function of the disclosure.

Third, Applicants' claims specify that the ARC is deposited on the metal layer, thus obviating a hard mask layer between the metal layer and the ARC. The Examiner has taken the position that the hard mask layer of Adkisson et al can be omitted. This is erroneous. The hard mask layer of Adkisson et al simply cannot be omitted, as noted above and as follows.

As pointed out by the Examiner, one of the alternative hard mask materials disclosed by Adkisson et al is silicon oxynitride. Applicants note that Adkisson et al also discloses a number of alternative ARC materials, in addition to the preferred silicon oxynitride. It is Applicants' position that the hard mask and the ARC of Adkisson et al must be different. It is Applicants' position that an embodiment in which the hard mask is silicon oxynitride would include one of the alternative ARC materials, and would not include silicon oxynitride as the ARC.

The Examiner asserted that since Adkisson et al teaches that silicon oxynitride may be used as the hard mask and as the ARC, if silicon oxynitride is used for both layers at the same time, there would only be one layer applied. Applicants disagree. To do so would destroy the intended function of Adkisson et al, since this would essentially be the same as not applying a hard mask. Furthermore, to apply two silicon oxynitride layers (or any two layers of the same material for the hard mask and the ARC) would destroy the selectivity necessary to removal of the ARC selective to the hard mask layer. As Adkisson et al disclose at col. 6, lines 36-49, the photoresist and ARC are removed, and the hard mask remains. If the ARC and the hard mask were the same material, there would be no selectivity between these layers, and it would be virtually impossible to remove only the portion of the silicon oxynitride which constitutes the ARC while retaining the portion thereof which constitutes the hard mask.

As an apparent alternative argument, the Examiner asserted that the hard mask of Adkisson et al is "really an extra layer that would be optional." This is erroneous for the same reason set forth above with respect to the use of the same material for both the hard mask and the ARC - the hard mask is essential to Adkisson et al. As noted above, the difference between Adkisson et al and the prior art is the hard mask, and this element is so important that it is applied in the first step of the method of claim 1 of Adkisson et al.

Fourth, Roman et al is not properly combinable with Adkisson et al in the manner asserted by the Examiner. While Roman et al does apply an ARC to a metal surface, the ARC of Roman et al is silicon-rich silicon nitride. Roman et al teaches that an important advantage of silicon-rich silicon nitride is that it is low in hydrogen (col. 4, ll. 21-22). As taught in the previously-cited Ionov et al reference (U.S. Patent No. 6,013,582), silicon oxynitride has a formula of $\text{SiO}_x\text{N}_y\text{H}_z$, where x ranges up to about 2, and y and z each range up to about 1 (col. 1, ll. 55-58). Thus, silicon oxynitride contains hydrogen, which is antithetical to the teachings of Roman et al. This would be particularly true in the present case, since Adkisson et al teach applying silicon oxynitride from SiH_4 (col. 4, line 20). Thus, a person of skill in the art would not substitute H-containing silicon oxynitride for the silicon-rich silicon nitride of Roman et al, based on the teachings of these references. For this reason, the combination of Adkisson et al with Roman et al is not proper, and would not have rendered obvious Applicants' claimed invention.

Finally, Applicants want to clarify the "obvious to try" argument previously submitted. Applicants note that in the Office Action mailed July 31, 2001, the Examiner stated: "Applicant argues that there would be no motivation to combine the Adkisson et al. reference to the Roman et al. reference because Adkisson et al only suggests that it would be obvious to try to form the ARC layer on other surfaces". Office Action mailed July 31, 2001, page 4. This is an erroneous attribution.

Applicants made no such statement. In the Reply to Office Action, Applicants asserted:

Thus, the Adkisson et al disclosure might constitute, at best, an invitation to experiment, i.e., an "obvious-to-try" situation, but "obvious-to-try" is not sufficient to support a motivation to combine references or to reach a conclusion of obviousness. See, *In re O'Farrell*, 7 USPQ2d 1673, 1681 (Fed. Cir. 1988).

See page 5 of the "Reply to Office Action Mailed April 11, 2001". Applicants' point is that, at best, the teachings of the prior art might constitute an invitation to experiment, which would create an "obvious to try" situation. An "obvious to try" situation is one in which the prior art may suggest a general direction of study or research, but falls short of suggesting the claimed invention, as is required for obviousness. As noted in *In re O'Farrell* and elsewhere, "obvious to try" is not the standard for obviousness.

Accordingly, the Examiner is requested to reconsider and withdraw the asserted rejections over the combination of Adkisson et al and Roman et al, with or without the additional disclosures of Puchner et al and Fuse.

Conclusion

For the foregoing reasons, Applicants respectfully assert that the presently claimed invention patentably distinguishes over the cited prior art references. The Examiner is requested to reconsider and withdraw the asserted rejections and to allow the claims. Notice to such effect is respectfully requested.

Should the Examiner consider that a further telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact the Applicant's undersigned attorney at the telephone number listed below.

Application No. 09/207,562

Attorney Docket No.: D545

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 18-0988 under Attorney Docket No. AMDSP0211US (D545).

Respectfully submitted,
RENNER, OTTO, BOISSELLE & SKLAR, LLP

Date:

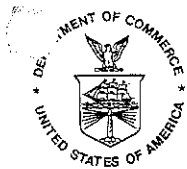
August 23, 2001

Thomas W. Adams

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/207,562 12/08/98 SUBRAMANIAN R D545

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115

MM21/0917

EXAMINER

ROCCHEGIANI, R

ART UNIT	PAPER NUMBER
----------	--------------

2625

DATE MAILED: 09/17/01

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

Commissioner of Patents and Trademarks

Notice of Allowability	Application No.	Applicant(s)	
	09/207,562	SUBRAMANIAN ET AL.	
	Examiner	Art Unit	
	Renzo N. Rocchegiani	2825	

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

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

1. ☒ This communication is responsive to the response filed on 8/27/2001.

2. ☒ The allowed claim(s) is/are 1-20.

3. ☒ The drawings filed on 08 December 1998 are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some* c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

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

(a) ☐ The translation of the foreign language provisional application has been received.

6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

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

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

8. ☐ CORRECTED DRAWINGS must be submitted.

(a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached

1) ☐ hereto or 2) ☐ to Paper No. _____.

(b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.

(c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

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

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

Attachment(s)

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

DETAILED ACTION

Allowable Subject Matter

1. Claims 1-20 are allowed.
2. The following is an examiner's statement of reasons for allowance: after reviewing the cited prior art in light of the arguments presented by applicant, the examiner has decided that the presented prior art does not render the present invention obvious because the words "a variety of surfaces", that appear in the statement found in Adkisson et al., under column 3, lines 53-56, "*Although the present invention may be used to define a pattern in a variety of surfaces, the present invention is especially suitably for defining a pattern in a semiconductor substrate and especially a substrate having a non-planar topology*", are assumed to refer to the topology of the surface as opposed to the material composition of the surface. Thus, the prior art does not teach a process wherein an antireflective coating (ARC) layer is formed directly on a metal layer, wherein the ARC layer is a silicon oxynitride layer, that is not also a hard mask layer, with an oxide layer formed directly on it so as to form a barrier to the nitrogen out-diffusion of the silicon oxynitride layer as well as lowering the reflectivity even further. The ARC layer to be used in conjunction with a photolithographic process that utilizes a photoresist layer and wherein no hard masks are used.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Application/Control Number: 09/207,562
Art Unit: 2825

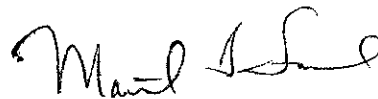
Page 3

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Renzo Rocchegiani whose telephone number is (703) 308-5839. The examiner can normally be reached on Monday through Friday from 8:30 am. to 4:30 pm..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached at (703) 308-1323. The fax phone number for the organization where this application or proceeding is assigned is (703) 305-3432.

RNR

September 12, 2001



MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

NM2170917

SPECKY TURKEY
BENNER CITY BOTSELLE & SKLAR
1621 BIRCH AVE
19TH FLOOR
CLEVELAND OH 44115

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
09/207,562	12/08/98	020	RUCCHIGIANI, R	2825 09/17/00
First Named Applicant	SUBRAMANIAN, 35 USC 154(b) term ext. = 0 Days.			

TITLE OF INVENTION USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
1 D545	438-072.000	M08	UTILITY	NO	\$1240.00	12/17/00

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

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

HOW TO RESPOND TO THIS NOTICE:

- Review the SMALL ENTITY status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:
 - If the status is changed, pay twice the amount of the FEE DUE shown above and notify the Patent and Trademark Office of the change in status, or
 - If the status is the same, pay the FEE DUE shown above.
- If the SMALL ENTITY is shown as NO:
 - Pay FEE DUE shown above, or
 - File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.
- Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.
- All communications regarding this application must give application number and batch number.
Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

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

PATENT AND TRADEMARK OFFICE COPY

RT B—ISSUE FEE TRANSMITTAL

Complete and mail this form, together with applicable fees, to: **Box ISSUE FEE**
Assistant Commissioner for Patents
Washington, D.C. 20231

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Issue Fee Receipt, the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

MM21/0917

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND OH 44115

Note: The certificate of mailing below can only be used for domestic mailings of the Issue Fee Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

Certificate of Mailing

I hereby certify that this Issue Fee Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above on the date indicated below.

Janet Farr (Depositor's name)

(Signature)

October 9, 2001 (Date)

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP	ART UNIT	DATE MAILED
09/207,562	12/08/98	020	ROCCHIGIANI, R	2825	09/17/01
First Named Applicant	SUBRAMANIAN, 35 USC 154(b) term ext. = 0 Days.				

TITLE OF INVENTION **USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS**

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
1 D545	438-072.000	M03	UTILITY	NO	\$1240.00	12/17/01

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

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

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

1 Renner, Otto, Boisselle & Sklar, LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)
PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE **Advanced Micro Devices, Inc.**

(B) RESIDENCE (CITY & STATE OR COUNTRY) **Sunnyvale, California**

Please check the appropriate assignee category indicated below (will not be printed on the patent)

☐ Individual ☐ corporation or other private group entity ☐ government

4a. The following fees are enclosed (make check payable to Commissioner of Patents and Trademarks):

- ☒ Issue Fee
☒ Advance Order - # of Copies **4**

4b. The following fees or deficiency in these fees should be charged to:

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(ENCLOSE AN EXTRA COPY OF THIS FORM)

- ☐ Issue Fee
☐ Advance Order - # of Copies

The COMMISSIONER OF PATENTS AND TRADEMARKS IS requested to apply the Issue Fee to the application identified above.

(Authorized Signature) *Monash* (Date) **09 Oct 2001**

NOTE: The Issue Fee will not be accepted from anyone other than the applicant, a registered attorney or agent, or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

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

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

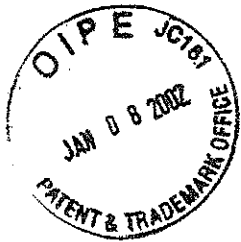
10/15/2001 IFM0011 0000077 09207562

01 FC:142
02 FC:561

1200.00 IP
12.00 IP

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BH



CERTIFICATE OF MAILING (37 CFR 1.8(a))

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Date: December 4, 2001

JANET FARR
Janet Farr
(Signature of person mailing paper)

D545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application:

Applicant:	Subramanian, et al.	:	Art Unit:	2825
Serial No.:	09/207,562	:	Examiner:	R. Rocchegiani
Filed:	December 8, 1998	:	Confirmation No.	6966

Title: USE OF SILICON OXYNITRIDE AS AN ARC FOR METAL LAYERS

REPLY TO NOTICE OF PUBLICATION FEE DUE MAILED NOVEMBER 14, 2001

Assistant Commissioner for Patents
Box ISSUE FEE
Washington, D. C. 20231

Dear Sir:

This paper is responsive to the NOTICE OF PUBLICATION FEE DUE mailed November 14, 2001, for which a three (3) month period of response was given. Accordingly, Applicant's Reply is timely filed. For the reasons set forth herein, no publication fee is due, since the patent was issued on December 4, 2001.

Application No. 09/207,562

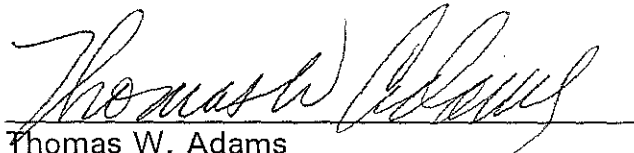
Attorney Docket No.: D545

In accordance with 37 CFR 1.211(e), no publication fee is due, because the patent on this application issued on December 4, 2001, as U.S. Patent No. 6,326,231.

A copy of the Notice of Publication Fee Due, and a copy of the Issue Notification, both relating to the above-identified application, are included herewith.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 18-0988 under Attorney Docket No. AMDSP211US/D545.

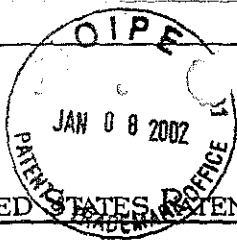
Respectfully submitted,
RENNER, OTTO, BOISSELLE & SKLAR, LLP



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UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/207,562	12/08/1998	RAMKUMAR SUBRAMANIAN	D545 Amdspool JS

CONFIRMATION NO. 6966



0C000000007065676

GREGORY TUROCY
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND, OH 44115

Title: USE OF SILICON OXYNITRIDE ARC FOR METAL LAYERS

Date Mailed: 11/14/2001

NOTICE OF PUBLICATION FEE DUE

The above-identified application was filed (including as a Continued Prosecution Application) on or after November 29, 2000 and a non-publication request in compliance with 37 CFR 1.213 was not included with the application on filing. Since the application has been allowed, a publication fee is due.

The fee due is \$300.00. No small entity discount is available. See 37 CFR 1.18(d).

The reply to this notice should be mailed to:
Box ISSUE FEE
Commissioner for Patents
Washington D.C. 20231.

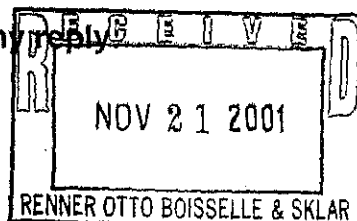
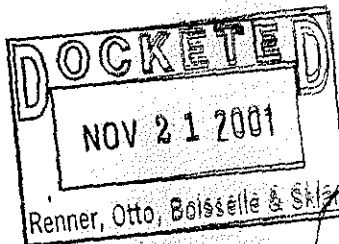
The publication fee must be submitted within **THREE MONTHS** from the mailing date of this notice or the application may be regarded as abandoned. No extensions of time under 37 CFR 1.136(a) or (b) are available. A reply must be filed to this notice, even if applicant does not anticipate that the application will be published (e.g., because the patent has issued and the projected publication date is more than a month after the issue date of the patent). A proper reply to this notice in such a situation would be a statement that no fee is now due, citing 37 CFR 1.211(e). If publication of the application does not occur, any publication fee paid will be refunded, if applicant requests a refund. See 37 CFR 1.211(e).

Questions relating to this Notice should be directed to the Office of Patent Publication at (703) 305-8283.

A copy of this notice should be returned with any reply

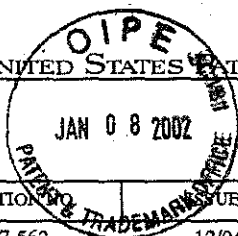
01/14/2002 BNGUYEN2 00000070 180988 09207562

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UNITED STATES PATENT AND TRADEMARK OFFICE



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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/207,562	12/04/2001	6326231	D545	6966

7590 11/16/2001
GREGORY TUROCY TWA/WAS/MDS
RENNER OTTO BOISSELLE & SKLAR
1621 EUCLID AVENUE
19TH FLOOR
CLEVELAND, OH 44115

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

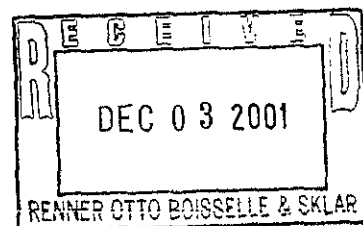
Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The patent term adjustment is 0 day(s), and will be printed on the front page of the patent.

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

APPLICANT(S):

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BHARATH RANGARAJAN, SANTA CLARA, CA;
MICHAEL K. TEMPLETON, ATHERTON, CA;





UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
09/207,562	6326231	2825	9200 L 10022 1021 114

Change of Address/Power of Attorney

The following fields have been set to Customer Number 45305 on

- Correspondence Address
- Power of Attorney

The address of record for Customer Number 45305 is:

RENNER, OTTO, BOISSELLE & SKLAR, LLP (AMDS)
1621 EUCLID AVE - 19TH FLOOR
CLEVELAND, OH 44115-2191

The Practitioners of record for Customer Number 45305 are:

PTO INSTRUCTIONS:

Please take the following action when the correspondence address has been changed to a customer number:

- 1) Add 'ADDRESS CHANGE TO CUSTOMER NUMBER' on the next available content line of the File Jacket.
- 2) Put a line through the old address on the File Jacket and enter the Customer Number as the new address.
- 3) File this Notice in the File Jacket.

Please take the following action when the correspondence address has NOT been changed:

- 1) File this Notice in the File Jacket

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2000

Application or Docket Number

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	*
INDEPENDENT CLAIMS	minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT ☐		

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

CLAIMS AS AMENDED - PART II

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	* 20	Minus ** 20	=
Independent	* 3	Minus *** 3	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐			

SMALL ENTITY TYPE ☐

OR

OTHER THAN SMALL ENTITY

RATE	FEE
BASIC FEE	355.00
X\$ 9=	
X40=	
+135=	
TOTAL	*

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SMALL ENTITY

OR

OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

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RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

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OR

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

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OR

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

OR

OR

OR

OR

OR

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

OR

OR

OR

OR

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL	
ADDIT. FEE	

OR

OR

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

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 2000

Application or Docket Number

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	20	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	20 minus 20 =	*
INDEPENDENT CLAIMS	3 minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT ☐		

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

CLAIMS AS AMENDED - PART II

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	* 20	Minus ** 20	=
Independent	* 3	Minus *** 3	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐			

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

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SMALL ENTITY TYPE ☐

OR

OTHER THAN SMALL ENTITY

RATE	FEE
BASIC FEE	355.00
X\$ 9=	
X40=	
+135=	
TOTAL	

RATE	FEE
BASIC FEE	710.00
X\$18=	
X80=	
+270=	
TOTAL	710

SMALL ENTITY

OR

OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X80=	
+270=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X80=	
+270=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$ 9=	
X40=	
+135=	
TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE
X\$18=	
X80=	
+270=	
TOTAL ADDIT. FEE	

PATENT APPLICATION FEE DETERMINATION RECORD

Effective November 10, 1998

Application or Docket Number

09/207562

CLAIMS AS FILED - PART I

(Column 1)

(Column 2)

FOR	NUMBER FILED	NUMBER EXTRA
BASIC FEE		
TOTAL CLAIMS	20 minus 20= *	
INDEPENDENT CLAIMS	3 minus 3= *	
MULTIPLE DEPENDENT CLAIM PRESENT		

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

CLAIMS AS AMENDED - PART II

(Column 1)

(Column 2)

(Column 3)

AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	* 20	Minus	** 20	=
	Independent	* 3	Minus	*** 3	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

(Column 1)

(Column 2)

(Column 3)

AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	*	Minus	**	=
	Independent	*	Minus	***	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

(Column 1)

(Column 2)

(Column 3)

AMENDMENT C		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	*	Minus	**	=
	Independent	*	Minus	***	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SMALL ENTITY

TYPE ☐

OR

OTHER THAN
SMALL ENTITY

RATE	FEE		RATE	FEE
	380.00	OR		760.00
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL		OR	TOTAL	1100

SMALL ENTITY

OR

OTHER THAN
SMALL ENTITY

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	