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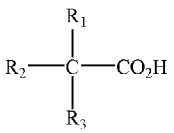
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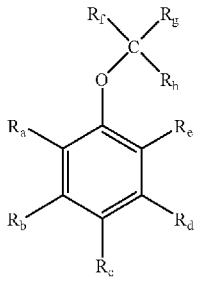
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(54) Title: RINSE AND METHOD OF USE THEREOF FOR REMOVING EDGE PROTECTION LAYERS AND RESIDUAL METAL HARDMASK COMPONENTS



(A)



(B)

(57) Abstract: The disclosed subject matter relates to a rinse and methods of use thereof for removing an edge protection layer and residual hardmask components (e.g., metals) from the edge and at least one proximate surface of a wafer/substrate where the rinse includes acetic acid and/or a halogenated acetic acid of structure (A) wherein R_1 and R_2 are independently hydrogen or a halogen and R_3 is a halogen and (ii) a compound having structure (B) wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and Rh may independently be hydrogen, a substituted or an unsubstituted alkyl group, a substituted or an unsubstituted halogenated alkyl group, a substituted or an unsubstituted alkyl carbonyl group, a halogen, and a hydroxy group.

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RINSE AND METHOD OF USE THEREOF FOR REMOVING EDGE PROTECTION LAYERS AND RESIDUAL METAL HARDMASK COMPONENTS

[0001] BACKGROUND

[0002] Field

[0003] The disclosed subject matter relates to a rinse and the use thereof for removing an edge protection layer in lithographic patterning processes. The novel rinse is formulated to remove both the edge protection layer and residual hardmask components (*e.g.*, metals) from a wafer/substrate surface.

[0004] Related Art

[0005] Multiple antireflective layers and hardmasks are used in advanced lithographic patterning processes. For example, in cases where a photoresist does not provide enough dry etch resistance, underlayers and/or antireflective coatings for the photoresist that act as a hardmask and are highly etch resistant during substrate etching are preferred. One approach has been to incorporate silicon, titanium, zirconium, aluminum or other metallic materials into a layer beneath the organic photoresist layer. Additionally, another high carbon content antireflective or mask layer may be placed beneath the metal containing antireflective layer to create a tri-layer of high carbon film/hard mask film/photoresist. Such layers can be used to improve the lithographic performance of the imaging process. However, metal contamination in the lithographic and etch tools, as well as cross contamination between wafers during manufacturing, can be problems that should be avoided.

[0006] One process and apparatus for reducing metal contamination during the manufacture of integrated circuit components has been described in U.S. Patent No. 8,791,030 ("Iwao"), which is hereby incorporated herein in its entirety. According to Iwao, a masking agent is supplied to an edge of the wafer/substrate and baked to form a masking film (a.k.a. an edge protection layer ("EPL") or edge masking layer) at the edge of the wafer/substrate. A hardmask composition is then coated on the wafer/substrate and the EPL. The portion of the hardmask composition overlying the edge protection layer is removed using an edge bead remover ("EBR") and the hardmask composition is baked to form a hardmask. The EPL is then removed with an EPL removing solution. The result is a hardmask that is spaced away from the edge of the wafer/substrate, thereby reducing contamination.

[0007] Masking agents forming EPLs are described in patent application PCT/EP2018/056322 (published as WO/2018/167112) entitled "Lithographic Compositions and Methods of Use Thereof," which is incorporated herein by reference in its entirety. The compositions disclosed therein prevent metal contamination at substrate/wafer edges during the manufacture of electronic devices. As explained in PCT/EP2018/056322, it is desirable that the applied EPLs be able to be readily removed at rates enabling and/or maintaining commercially acceptable process times without having a negative or damaging effect on the hardmask (such as can occur by wet etching).

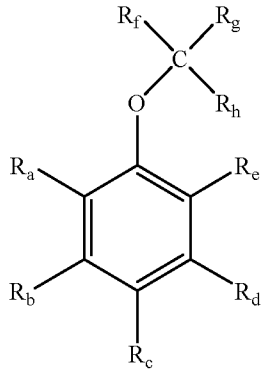
[0008] PCT/EP2018/056322 further sets forth a general process for applying a masking agent to form an EPL in a method for manufacturing an electronic device as is illustrated in FIGs 2 a-f, herein. In such a process, a metal hardmask composition or metal oxide photoresist composition (collectively a "hardmask" or "hardmask composition") is applied onto the substrate and the EPL (*see* FIG. 2c). The EPL and the hardmask composition are then rinsed with an EBR and/or a backside rinse ("BR") material to remove at least a portion of the hardmask composition that is in contact with the EPL (*see* FIG. 2d). A portion or portions of the hardmask composition in contact with the EPL may nevertheless remain even after rinsing with an EBR or BR. The hardmask composition can, for example, partially penetrate through the EPL or undercut the edge thereof. Consequently, some quantity of the hardmask and/or its components in contact with the EPL may not be removed during the EBR rinse. To date, no compositions or processes/method have been identified providing for the simultaneous removal of both the EPL and the remaining residual components (*e.g.*, metals) of the hardmask. Instead, the step of removing the EPL must be followed by a subsequent processing step (*e.g.*, rinsing with additional EBR) in which any remaining residual components of the hardmask are removed from the edge and proximate surfaces of the wafer/substrate. This additional step is both costly and time consuming, and thus inconsistent with enabling and/or maintaining commercially acceptable process times when an EPL is utilized.

[0009] Accordingly, there is a continued need for materials capable of removing EPLs and any remaining residual components of the hardmask at faster rates than the known EPL rinses while avoiding negative or damaging effects on the hardmask. As discussed below, the disclosed subject matter addresses the shortcomings known in the art pertaining to the removal of an EPL and any remaining residual components of the hardmask. The disclosed subject matter provides compositions and manufacturing methods and processes for the quick and efficient removal of an

applied EPL and the remaining hardmask components and residues from the edge and proximate surfaces of the wafer/substrate.

[0010] SUMMARY

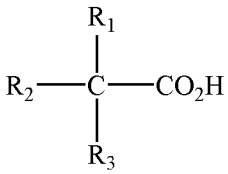
[0011] In one aspect, the disclosed subject matter relates to a rinse for removing an EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) from the edge of a wafer/substrate surface in lithographic processes where the rinse includes (i) between approximately 15% by weight and approximately 35% by weight of acetic acid and (ii) between approximately 85% by weight and approximately 65% by weight of a compound having structure B:



wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted alkyl group, which is preferably a $C_{1\text{-}6}$ alkyl group, a substituted or an unsubstituted halogenated alkyl group, which is preferably a halogenated $C_{1\text{-}6}$ alkyl group, a substituted or an unsubstituted alkyl carbonyl group, which is preferably a $C_{1\text{-}6}$ alkyl carbonyl group, a halogen, and a hydroxy group. In a further aspect, the compound having structure B is anisole (*i.e.*, where each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen).

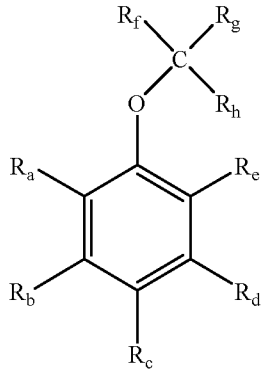
[0012] In another aspect, the disclosed subject matter relates to a rinse for removing an EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) from the edge of a wafer/substrate surface in lithographic processes where the rinse includes:

(i) between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A:



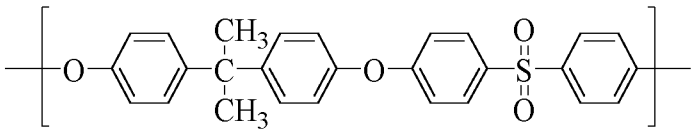
wherein R_1 and R_2 are independently hydrogen or a halogen and R_3 is a halogen; and

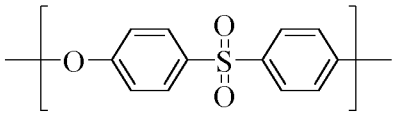
(ii) between approximately 99% by weight and approximately 90% by weight of a compound having structure B:

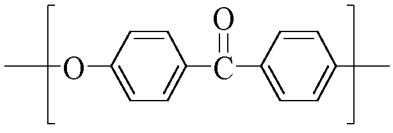


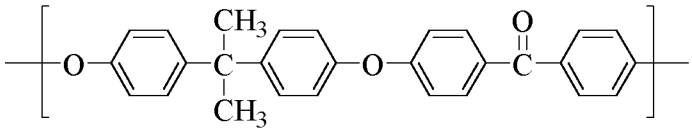
wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h is independently a hydrogen, a substituted or an unsubstituted alkyl group, which is preferably a C_{1-6} alkyl group, a substituted or an unsubstituted halogenated alkyl group, which is preferably a halogenated C_{1-6} alkyl group, a substituted or an unsubstituted alkyl carbonyl group, which is preferably a C_{1-6} alkyl carbonyl group, a halogen, and a hydroxy group. In a further aspect, the compound having structure A is trifluoroacetic acid (*i.e.*, where each of R_1, R_2 and R_3 in structure A is fluorine) or difluoroacetic acid (*i.e.*, where R_3 and one of R_1 and R_2 is fluorine and the other of R_1 and R_2 is hydrogen). In yet a further aspect, the compound having structure B is anisole (*i.e.*, where each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen).

[0013] In another aspect, the rinse is particularly effective at removing an EPL formed from the masking agents described and/or claimed in PCT/EP2018/056322 and residual hardmask components (*e.g.*, metals such as tin or titanium) from the edge and proximate surfaces of a wafer/substrate surface in lithographic processes. In a further aspect, the rinse solution is particularly effective for removing an EPL formed from the masking agents described and/or claimed in PCT/EP2018/056322. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322 where the masking agent includes a polymer unit having one or more of the following formulae:

a. ,

b.  ,

c.  , and

d.  .

[0014] In another aspect, the rinse includes (i) between approximately 15% by weight and approximately 35% by weight of acetic acid and (ii) between approximately 85% by weight and approximately 65% by weight of anisole and/or a compound having structure B. In another aspect, the rinse includes (i) approximately 15% by weight of acetic acid and (ii) preferably approximately 85% by weight of anisole and/or a compound having structure B.

[0015] In another aspect, the rinse includes (i) approximately 20% by weight of acetic acid and (ii) preferably approximately 80% by weight of anisole and/or a compound having structure B. In another aspect, the rinse includes (i) approximately 25% by weight of acetic acid and (ii) preferably approximately 75% by weight of anisole and/or a compound having structure B.

[0016] In another aspect, the rinse includes (i) approximately 30% by weight of acetic acid and (ii) preferably approximately 70% by weight of anisole and/or a compound having structure B.

[0017] In another aspect, the rinse includes (i) approximately 35% by weight of acetic acid and (ii) preferably approximately 65% by weight of anisole and/or a compound having structure B.

[0018] In another aspect, the rinse includes (i) between approximately 1% by weight and approximately 10% by weight of trifluoroacetic acid and/or difluoroacetic acid and (ii) between approximately 99% by weight and approximately 90% by weight of anisole and/or a compound having structure B.

[0019] In another aspect, the rinse includes (i) approximately 1% by weight of a halogenated acetic acid of structure A and (ii) preferably approximately 99% by weight of anisole and/or a

compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0020] In another aspect, the rinse includes (i) approximately 2% by weight of a halogenated acetic acid of structure A and (ii) preferably approximately 98% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0021] In another aspect, the rinse includes (i) approximately 3% by weight of a halogenated acetic acid of structure A and (ii) approximately 97% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0022] In another aspect, the rinse includes (i) approximately 4% by weight of a halogenated acetic acid of structure A and (ii) preferably approximately 96% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0023] In another aspect, the rinse includes (i) approximately 5% by weight of a halogenated acetic acid of structure A and (ii) approximately 95% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0024] In another aspect, the rinse includes (i) approximately 6% by weight of a halogenated acetic acid of structure A and (ii) approximately 94% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0025] In another aspect, the rinse includes (i) approximately 7% by weight of a halogenated acetic acid of structure A and (ii) preferably approximately 93% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

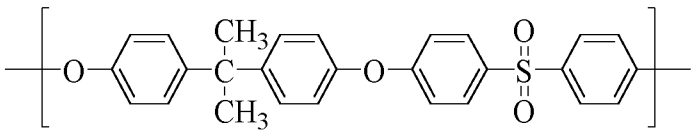
[0026] In another aspect, the rinse includes (i) approximately 8% by weight of a halogenated acetic acid of structure A and (ii) approximately 92% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

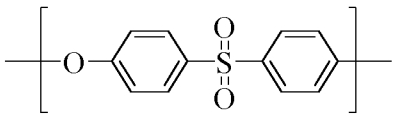
[0027] In another aspect, the rinse includes (i) approximately 9% by weight of a halogenated acetic acid of structure A and (ii) approximately 91% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

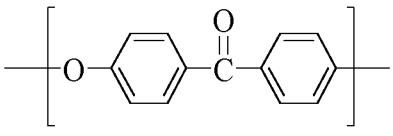
[0028] In another aspect, the rinse includes (i) approximately 10% by weight of a halogenated acetic acid of structure A and (ii) preferably approximately 90% by weight of anisole and/or a compound having structure B. In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

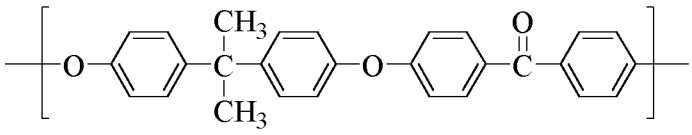
[0029] In another aspect, the disclosed subject matter relates to a method and process of using the rinse for removing an EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) from the edge and proximate surfaces of a wafer/substrate in lithographic processes, including in the manufacture of electronic devices.

[0030] In one aspect, the method and process include the step of removing the EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) by washing the wafer/substrate with the rinse. Thus, the method and process may be referred to as a method of cleaning a wafer or substrate comprising washing the wafer or substrate with the rinse. In a further aspect, the method and process include the step of treating a wafer/substrate edge and proximate surfaces with a masking agent to form an EPL. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322 where the masking agent includes a polymer unit having one or more of the following formulae:

a. ,

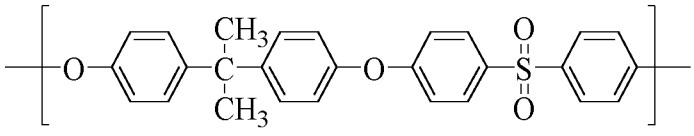
b. ,

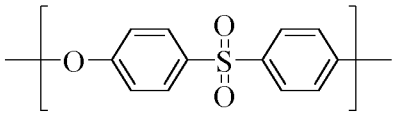
c.  , and

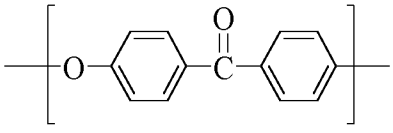
d.  .

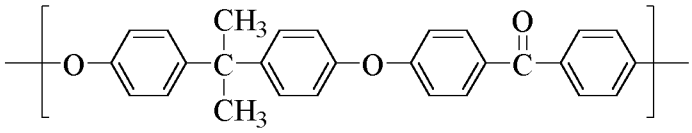
[0031] In another aspect, the method and process include one or more additional steps selected from the group of: (a) heating the masking agent to form the EPL; (b) applying a hardmask composition to the substrate and the EPL; (c) removing at least a portion of the hardmask composition that is in contact with the EPL by rinsing the hardmask composition and EPL with an EBR and/or BR material; (d) heating the hardmask composition to form a hardmask; and (e) performing at least one post applied bake.

[0032] In another aspect, the method and process includes sequentially performing, without intervening steps, the steps of (i) treating a wafer/substrate edge and proximate surfaces with a masking agent; (ii) heating the applied masking agent to form an EPL; (iii) applying a hardmask composition to the substrate and the EPL; (iv) removing at least a portion of the hardmask composition that is in contact with the EPL by rinsing the hardmask composition and EPL with an EBR and/or BR material; (v) heating the hardmask composition to form a hardmask; (vi) removing the EPL and residual hardmask components by washing the wafer/substrate with the rinse; and (vii) optionally performing at least one post applied bake. Those skilled in the art will recognize that the sequential performance of the foregoing steps does not exclude performance of steps prior to or after the sequentially performed steps (*e.g.*, supplying a wafer/substrate). In a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322 where the masking agent includes a polymer unit having one or more of the following formulae:

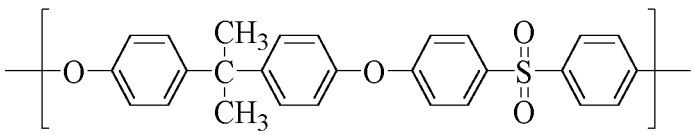
a.  ,

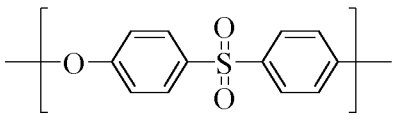
b. ,

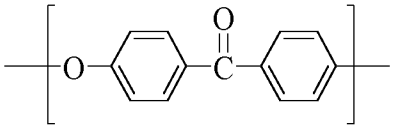
c. , and

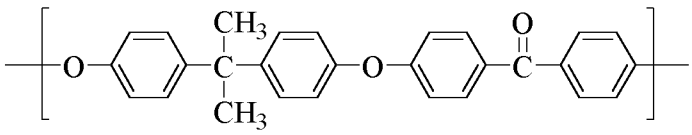
d. .

[0033] In another aspect, the disclosed subject matter relates to the method and process of applying and removing an edge protection layer and residual hardmask components (*e.g.*, metals such as tin or titanium) from a wafer/substrate that includes the steps of: (a) applying a masking agent on an edge and proximate surfaces of the wafer/substrate; (b) heating the masking agent to form the EPL on the edge and proximate surfaces of the wafer/substrate; (c) applying a hardmask composition to the wafer/substrate and the EPL; (d) removing at least a portion of the hardmask composition that is in contact with the EPL by rinsing the hardmask composition with at least one EBR and/or BR material; (e) heating the hardmask composition to form the hardmask; (f) washing the wafer/substrate with a rinse including (i) between approximately 15% by weight and approximately 35% by weight of acetic acid and (ii) between approximately 85% by weight and approximately 65% by weight of anisole and/or a compound having structure B; and (g) optionally performing at least one post applied baking step. In a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322 where the masking agent includes a polymer unit having one or more of the following formulae:

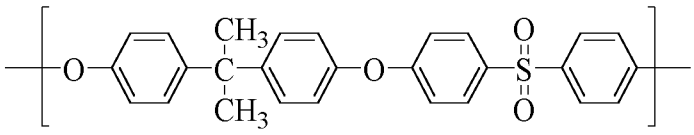
a. ,

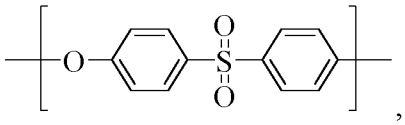
b.  ,

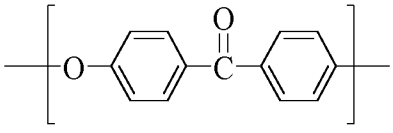
c.  , and

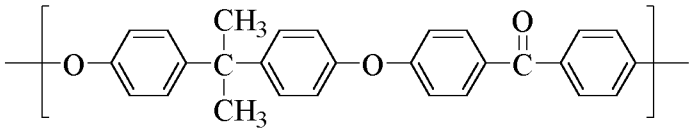
d.  .

[0034] In another aspect, the disclosed subject matter relates to the method and process of applying and removing an edge protection layer and residual hardmask components (*e.g.*, metals such as tin or titanium) from a wafer/substrate that includes the steps of: (a) applying a masking agent on an edge and proximate surfaces of the wafer/substrate; (b) heating the masking agent to form the EPL on the edge and proximate surfaces of the wafer/substrate; (c) applying a hardmask composition to the wafer/substrate and the EPL; (d) removing at least a portion of the hardmask composition that is in contact with the EPL by rinsing the hardmask composition with at least one EBR and/or BR material; (e) heating the hardmask composition to form the hardmask; (f) washing the wafer/substrate with a rinse including (i) between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A and (ii) between approximately 99% by weight and approximately 90% by weight of anisole and/or a compound having structure B; and (g) optionally performing at least one post applied baking step. In a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322. In yet a further aspect, the masking agent is a masking agent described and/or claimed in PCT/EP2018/056322 where the masking agent includes a polymer unit having one or more of the following formulae:

a.  ,

b.  ,

c.  , and

d.  .

In a further aspect, the halogenated acetic acid of structure A is at least one of trifluoroacetic acid and difluoroacetic acid.

[0035] BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The accompanying drawings, which are included to provide a further understanding of the disclosed subject matter and are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosed subject matter and together with the description serve to explain the principles of the disclosed subject matter. In the drawings:

[0037] FIG. 1 illustrates a wafer/substrate upon which an EPL is applied;

[0038] FIGs. 2a-f illustrates a schematic representation of one embodiment of a method and process for using the rinse solutions disclosed herein. In FIG. 2a, a masking agent is applied onto an edge of a substrate. In FIG. 2b, the masking agent is heated to form an EPL. In FIG. 2c, a hardmask composition is applied onto the substrate and the EPL. In FIG. 2d, the hardmask composition and EPL are rinsed with an EBR to remove at least a portion of the hardmask composition that is in contact with the EPL. In FIG. 2e, the hardmask composition is heated to form a hardmask. In FIG. 2f, the EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) are removed from the edge of a wafer/substrate with the rinse;

[0039] FIG. 3 is a graph illustrating residual metal (*i.e.*, titanium) content present on the wafer/substrate surface following removal of the EPL from the edge of a wafer/substrate surface using different formulations of the disclosed rinse that includes acetic acid and anisole; and

[0040] FIG. 4 is a graph illustrating residual metal (*i.e.*, titanium) content present on the wafer/substrate surface following removal of the EPL from the edge of a wafer/substrate surface using different formulations of the disclosed rinse that includes trifluoroacetic acetic acid and anisole.

[0041] **DEFINITIONS**

[0042] Unless otherwise stated, the following terms used in the specification and claims shall have the following meanings for this application.

[0043] In this application, the use of the singular includes the plural, and the words "a," "an" and "the" mean "at least one" unless specifically stated otherwise. Furthermore, the use of the term "including," as well as other forms such as "includes" and "included," is not limiting. Also, terms such as "element" or "component" encompass both elements or components including one unit and elements or components that include more than one unit, unless specifically stated otherwise. As used herein, the conjunction "and" is intended to be inclusive and the conjunction "or" is not intended to be exclusive, unless otherwise indicated. For example, the phrase "or, alternatively" is intended to be exclusive. As used herein, the term "and/or" refers to any combination of the foregoing elements including using a single element.

[0044] The term "about" or "approximately," when used in connection with a measurable numerical variable, refers to the indicated value of the variable and to all values of the variable that are within the experimental error of the indicated value (*e.g.*, within the 95% confidence limit for the mean) or within percentage of the indicated value (*e.g.*, ± 10%, ± 5%), whichever is greater.

[0045] As used herein, "C_{x-y}" designates the number of carbon atoms in a chain. For example, C_{1-6} alkyl refers to an alkyl chain having a chain of between 1 and 6 carbons (*e.g.*, methyl, ethyl, propyl, butyl, pentyl and hexyl). Unless specifically stated otherwise, the chain can be linear or branched.

[0046] Unless otherwise indicated, "alkyl" refers to hydrocarbon groups which can be linear, branched (*e.g.*, methyl, ethyl, propyl, isopropyl, tert-butyl and the like), cyclic (*e.g.*, cyclohexyl, cyclopropyl, cyclopentyl and the like) or multicyclic (*e.g.*, norbornyl, adamantly and the like). These alkyl moieties may be substituted or unsubstituted.

[0047] "Halogenated alkyl" refers to a linear, cyclic or branched saturated alkyl group as defined above in which one or more of the hydrogens has been replaced by a halogen (*e.g.*, F, Cl, Br and I). Thus, for example, a fluorinated alkyl (a.k.a. "fluoroalkyl") refers to a linear, cyclic or

branched saturated alkyl group as defined above in which one or more of the hydrogens has been replaced by fluorine (*e.g.*, trifluoromethyl, pefluoroethyl, 2,2,2-trifluoroethyl, prefluoroisopropyl, perfluorocyclohexyl and the like). Such haloalkyl moieties (*e.g.*, fluoroalkyl moieties), if not perhalogenated/multihalogentated, may be unsubstituted or further substituted.

[0048] "Alkoxy" (a.k.a. "alkyloxy") refers to an alkyl group as defined above which is attached through an oxy (-O-) moiety (*e.g.*, methoxy, ethoxy, propoxy, butoxy, 1,2-isopropoxy, cyclopentyloxy, cyclohexyloxy and the like). These alkoxy moieties may be substituted or unsubstituted.

[0049] "Alkyl carbonyl" refers to an alkyl group as defined above which is attached through a carbonyl group (-C(=O-)) moiety (*e.g.*, methylcarbonyl, ethylcarbonyl, propylcarbonyl, buttylcarbonyl, cyclopentylcarbonyl and the like). These alkyl carbonyl moieties may be substituted or unsubstituted.

[0050] "Halo" or "halide" refers to a halogen (*e.g.*, F, Cl, Br and I).

[0051] "Hydroxy" (a.k.a. "hydroxyl") refers to an –OH group.

[0052] Unless otherwise indicated, the term "substituted" when referring to an alkyl, alkoxy, fluorinated alkyl and the like refers to one of these moieties which also contains one or more substituents including, but not limited, to the following substituents: alkyl, substituted alkyl, unsubstituted aryl, substituted aryl, alkyloxy, alkylaryl, haloalkyl, halide, hydroxy, amino and amino alkyl. Similarly, the term "unsubstituted" refers to these same moieties where no substituents apart from hydrogen are present.

[0053] The section headings used herein are for organizational purposes and are not to be construed as limiting the subject matter described. All documents, or portions of documents, cited in this application, including, but not limited to, patents, patent applications, articles, books, and treatises, are hereby expressly incorporated herein by reference in their entirety for any purpose. In the event that any of the incorporated literature and similar materials defines a term in a manner that contradicts the definition of that term in this application, this application controls.

[0054] **DETAILED DESCRIPTION**

[0055] It is to be understood that both the foregoing general description and the following detailed description are illustrative and explanatory, and are not restrictive of the subject matter, as claimed. The objects, features, advantages and ideas of the disclosed subject matter will be apparent to those skilled in the art from the description provided in the specification, and the disclosed subject

matter will be readily practicable by those skilled in the art on the basis of the description appearing herein. The description of any "preferred embodiments" and/or the examples which show preferred modes for practicing the disclosed subject matter are included for the purpose of explanation and are not intended to limit the scope of the claims.

[0056] It will also be apparent to those skilled in the art that various modifications may be made in how the disclosed subject matter is practiced based on described aspects in the specification without departing from the spirit and scope of the disclosed subject matter disclosed herein.

[0057] As set forth above, the disclosed subject matter relates to a rinse that includes (i) acetic acid and/or halogenated acetic acid of structure A and (ii) anisole and/or derivatives of anisole (*i.e.*, compounds other than anisole falling with the scope of structure B) that can be utilized for removing an EPL and residual hardmask components (*e.g.*, metals such as tin or titanium) from the edge and proximate surfaces of a wafer/substrate surface in lithographic processes.

[0058] **Rinse Components**

[0059] The rinse includes (i) acetic acid (CAS 64-19-7) or halogenated acetic acid of structure A and (ii) anisole (CAS 100-66-3; a.k.a. methoxybenzene or methyl phenyl ether) and/or derivatives of anisole in varying concentrations. The rinse includes, for example, between approximately 15% by weight to approximately 35% by weight of acetic acid and between approximately 85% by weight and approximately 65% by weight of anisole and/or derivatives of anisole. The rinse can alternatively include between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A and between approximately 99% by weight and approximately 90% by weight of anisole and/or a compound having structure B.

[0060] Those skilled in the art will recognize that quantities of acetic acid exceeding approximately 35% by weight or halogenated acetic acid of structure exceeding approximately 10% by weight of A will generally have a deleterious effect on a wafer/substrate and/or other features imprinted thereon despite such compositions being effective at removing an removing an EPL and residual hardmask components. However, to the extent that a wafer/substrate is amenable to exposure to higher weight percentages of acetic acid or halogenated acetic acid of structure A, the disclosed rinse can include amounts of acetic acid exceeding approximately 35% by weight or amounts of halogenated acetic acid of structure A exceeding approximately 10% by weight.

[0061] Those skilled in the art will also readily recognize that the amounts of acetic acid and/or halogenated acetic acid of structure A with anisole and/or the derivatives of anisole can be

adjusted within these ranges and that all such combinations thereof fall within the scope of the disclosed subject matter and the combined relative amounts of acetic acid and/or halogenated acetic acid of structure A with anisole and/or derivatives of anisole do not necessarily need to equal 100% by weight. In one embodiment, for example, the rinse includes approximately 20% by weight of acetic acid and approximately 75% by weight of anisole and/or the derivatives of anisole. In another embodiment, the rinse includes approximately 30% by weight of acetic acid and approximately 70% by weight of anisole and/or the derivatives of anisole. In yet another embodiment, the rinse can include approximately 32.5% by weight of acetic acid and approximately 67% by weight of anisole and/or the derivatives of anisole. In yet another embodiment, the rinse can include approximately 18.5% by weight of acetic acid and approximately 75% by weight of anisole and/or the derivatives of anisole. In further embodiments, the rinse can include approximately 2% by weight of halogenated acetic acid of structure A and approximately 98% by weight of anisole and/or the derivatives of anisole. In further embodiments, the rinse can include approximately 4% by weight of halogenated acetic acid of structure A and approximately 96% by weight of anisole and/or the derivatives of anisole. In yet further embodiments, the rinse can include approximately 10% by weight of halogenated acetic acid of structure A and approximately 90% by weight of anisole and/or the derivatives of anisole.

[0062] Those skilled in the art will further recognize that rinses including between "approximately 15% by weight and approximately 35% by weight" of acetic acid or "approximately 1% by weight and approximately 10% by weight" of halogenated acetic acid of structure A are not strictly bounded ranges and can includes amounts of acetic acid and/or halogenated acetic acid of structure A somewhat outside of those ranges. In one embodiment, for example, a rinse that includes between "approximately 15% by weight and approximately 35% by weight" of acetic acid and/or "approximately 1% by weight and approximately 10% by weight" of halogenated acetic acid of structure A can include ± 10% of the weight percent of acetic acid and/or halogenated acetic acid of structure A. Thus, an embodiment of the rinse including "approximately 15% by weight" of acetic acid can include between 13.5% by weight and 16.5% by weight of acetic acid. An embodiment of the rinse including "approximately 20% by weight of acetic acid" can include between 18% by weight and 22% by weight of acetic acid. An embodiment of the rinse including "approximately 30% by weight" of acetic acid can include between 27% by weight and 33% by weight of acetic acid. Similarly, an embodiment of the rinse including "approximately 2% by

weight" of halogenated acetic acid of structure A can include between 1.8% by weight and 2.2% by weight of halogenated acetic acid of structure A. An embodiment of the rinse including "approximately 4% by weight" of halogenated acetic acid of structure A can include between 3.6% by weight and 4.4% by weight of halogenated acetic acid of structure A. An embodiment of the rinse including "approximately 10% by weight" of halogenated acetic acid of structure A can include between 9% by weight and 11% by weight of halogenated acetic acid of structure A.

[0063] In one embodiment, for example, a rinse that includes between "approximately 15% by weight and approximately 35% by weight" of acetic acid and/or "approximately 1% by weight and approximately 10% by weight" of halogenated acetic acid of structure A can include ± 5% of the weight percent of acetic acid and/or halogenated acetic acid of structure A. Thus, an embodiment of the rinse including "approximately 15% by weight" of acetic acid can include between 14.25% by weight and 15.75% by weight of acetic acid. An embodiment of the rinse including "approximately 20% by weight" of acetic acid can include between 19% by weight and 21% by weight of acetic acid. An embodiment of the rinse including "approximately 30% by weight" of acetic acid can include between 28.5% by weight and 31.5% by weight of acetic acid. Similarly, an embodiment of the rinse including "approximately 2% by weight" of halogenated acetic acid of structure A can include between 1.9% by weight and 2.1% by weight of halogenated acetic acid of structure A. An embodiment of the rinse including "approximately 4% by weight" of halogenated acetic acid can include between 3.8% by weight and 4.2% by weight of halogenated acetic acid of structure A. An embodiment of the rinse including "approximately 10% by weight" of halogenated acetic acid of structure A can include between 9.5% by weight and 10.5% by weight of halogenated acetic acid of structure A.

[0064] Those skilled in the art will further recognize that rinses including between "approximately 85% by weight and approximately 65% by weight" or "approximately 99% by weight and approximately 90% by weight" of anisole and/or derivatives of anisole are not strictly bounded ranges and can include amounts of anisole and/or derivatives of anisole somewhat outside of those ranges. In one embodiment, for example, a rinse that includes between "approximately 85% by weight and approximately 65% by weight" of anisole and/or derivatives of anisole can include ± 10% of the weight percent of anisole and/or derivatives of anisole. Thus, an embodiment of the rinse including "approximately 85% by weight" of anisole and/or derivatives of anisole can include between 93.5% by weight and 76.5% by weight of anisole and/or derivatives of anisole. An

embodiment of the rinse including "approximately 80% by weight" of anisole and/or derivatives of anisole can include between 88% by weight and 72% by weight of anisole and/or derivatives of anisole. An embodiment of the rinse including "approximately 70% by weight" of anisole and/or derivatives of anisole can include between 77% by weight and 63% by weight of anisole and/or derivatives of anisole.

[0065] In another embodiment, for example, a rinse that includes between "approximately 85% by weight and approximately 65% by weight" of anisole and/or derivatives of anisole can include ± 5% of the weight percent of anisole and/or derivatives of anisole. Thus, an embodiment of the rinse including "approximately 85% by weight" of anisole and/or derivatives of anisole can include between 89.25% by weight and 80.75% by weight of anisole and/or derivatives of anisole. An embodiment of the rinse including "approximately 80% by weight" of anisole and/or derivatives of anisole can include between 84% by weight and 76% by weight of anisole and/or derivatives of anisole. An embodiment of the rinse including "approximately 70% by weight" of anisole and/or derivatives of anisole can include between 76.5% by weight and 73.5% by weight of anisole and/or derivatives of anisole.

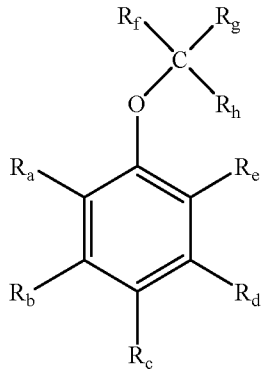
[0066] In a further embodiment, the rinse consists essentially of (i) acetic acid and/or halogenated acetic acid of structure and (ii) anisole and/or derivatives of anisole in varying concentrations. In such an embodiment, the combined amounts of acetic acid and/or halogenated acetic acid of structure A with anisole and/or derivatives of anisole do not equal 100% by weight, and can include other ingredients (*e.g.*, additional solvent(s), including water, common additives and/or impurities) that do not materially change the effectiveness of the rinse. Thus, in other embodiments, the rinse can include acetic acid and/or halogenated acetic acid of structure A acid having different quantities of water. In one such embodiment, the rinse can include acetic acid and/or halogenated acetic acid of structure A having in excess of 1% of water by weight. In another such embodiment, the rinse can include anhydrous (a.k.a. glacial) acetic acid (*i.e.*, acetic acid having less that 1% by weight of water). Such embodiments can also, for example, include different technical grades (*e.g.*, reagent grade, trace grade, ultratrace grade, electronic grade, HPLC grade, etc.) of acetic acid, anhydrous/glacial acetic acid and/or halogenated acetic acid of structure A with varying quantities of impurities.

[0067] In another embodiment, the rinse consists of (i) acetic acid and/or halogenated acetic acid of structure A and (ii) anisole and/or derivatives of anisole in varying concentrations. In such

an embodiment, the combined amounts of acetic acid and/or halogenated acetic acid of structure A and anisole and/or derivatives of anisole equal approximately 100% by weight but may include other small and/or trace amounts of impurities that are present in such small quantities that they do not materially change the effectiveness of the rinse. For example, in one such embodiment, the rinse can contain 2% by weight or less of total impurities and/or other ingredients (*e.g.*, additional solvent(s), including water). In another embodiment, the rinse can contain 1% by weight or less than of total impurities and/or other ingredients (*e.g.*, additional solvent(s), including water). In a further embodiment, the rinse can contain 0.05% by weight or less than of total impurities and/or other ingredients (*e.g.*, additional solvent(s), including water). Such embodiments can, for example, include anhydrous/glacial acetic acid. Such embodiments can also, for example, include different technical grades (*e.g.*, reagent grade, trace grade, ultratrace grade, electronic grade, HPLC grade, etc.) of acetic acid, anhydrous/glacial acetic acid and/or halogenated acetic acid of structure A with varying quantities of impurities. Such embodiments can also include, for example, trace amounts of metal impurities present at quantities well-below 0.05% by weight (*e.g.*, at the ppb level).

[0068] Those skilled in the art will further recognize that the halogenated acetic acid of structure A that can be used in the disclosed rinse include (i) those halogenated acetic acid compounds of structure A where R_1 and R_2 are each hydrogen and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine, (ii) those halogenated acetic acid compounds of structure A where two or more of R_1, R_2 and R_3 are the same halogen selected from among fluorine, bromine, iodine and chlorine, and (iii) those halogenated acetic acid compounds of structure A where two or more of R_1, R_2 and R_3 are a different halogen selected from among fluorine, bromine, iodine and chlorine. Examples of such compounds include, but are not limited to, fluoroacetic acid, iodoacetic acid, bromo acetic acid, chloroacetic acid, difluoracetic acid, trifluoracetic acid, diiodoracetic acid, triiodoracetic acid, dibromoracetic acid, tribromoracetic acid, dichlororacetic acid, trichlororacetic acid as well as halogenated acetic acids including two or more different halogens (*e.g.*, where two or more of R_1, R_2 and R_3 in structure A are each a different halogen). The rinse can further include a mixture of two or more halogenated acetic acids of structure A.

[0069] Those skilled in the art will further recognize that derivatives of anisole, including variously substituted anisole compounds, can also be used in the disclosed rinse. In this regard, the disclosed rinse includes mixtures of acetic acid or halogenated acetic acid of structure A and anisole and/or derivatives of anisole of structure B:



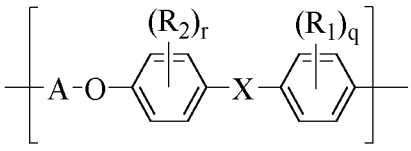
Structure B

wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted alkyl group, a substituted or an unsubstituted halogenated alkyl group, a substituted or an unsubstituted alkyl carbonyl group, a halogen, and a hydroxy group as described above. Examples of specific derivatives of anisole suitable for use in the described and/or claimed rinse include, but are not limited to, halogenated anisole compounds (*e.g.*, where one or more of R_a, R_b, R_c, R_d and R_e is each independently a fluorine, iodine, bromine or chlorine).

[0070] EPL Masking Agent

[0071] The disclosed rinses are suitable for removing an EPL formed on the edge and proximate surfaces of a wafer/substrate. In one embodiment, the disclosed rinses are adapted for removing an EPL formed from the masking agents or compositions described and/or claimed in PCT/EP2018/056322, including those having the following components:

a. a polymer including a unit having structure (I):

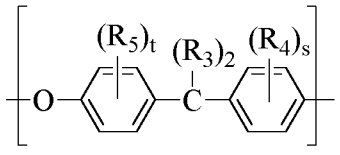


(I),

wherein

X is selected from the group of $–SO_2–$, –C(=O)- and –O–;

A is a direct bond or A is selected from the group of structure (II):



(II);

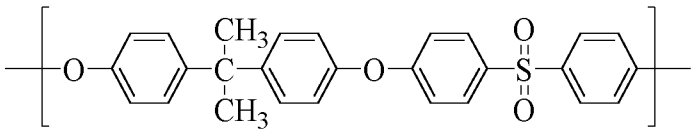
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

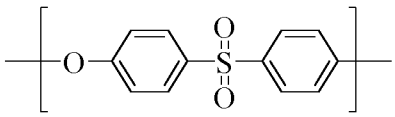
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

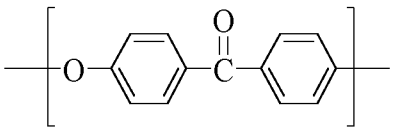
b. an organic solvent,

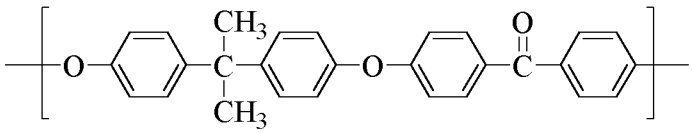
wherein the polymer has an average molecular weight of less than 50000.

[0072] In a further embodiment, where the EPL is formed from the compositions disclosed and/or claimed in PCT/EP2018/056322, the rinses are particularly effective where the polymer unit having structure (I) shown above includes one of, and preferably is one of:

a. ,

b. ,

c. , and

d. .

[0073] When applied, the EPL can for example be applied at a width of at least approximately 0.5 mm. Alternatively, the EPL can be applied at a width of at least approximately 0.75 mm. Further, the EPL can be applied at a width of not more than approximately 2.0 mm. Alternatively, the EPL can be applied at a width of not more than approximately 1.0 mm.

[0074] Referring to FIG. 1, when the EPL is applied to a wafer/substrate **1**, the EPL is applied to the edge **2** of the wafer/substrate, as well as on one or more surfaces proximate to the edge of the wafer/substrate (*i.e.*, the top surface **3** and/or bottom surface **4**) of the wafer/substrate.

Thus, the EPL can be positioned to cover the edge of the substrate and to extend over the front and/or backside of the substrate. For example, the EPL can be applied on the proximate surfaces of the edge and extend from approximately 0.5 mm to approximately 2.0 mm in width on the top surface of the wafer/substrate, over the edge and then approximately 2.5 mm in width on the backside of the wafer/substrate edge.

[0075] Hardmask

[0076] As noted above, the disclosed rinses advantageously provide for the simultaneous removal of an applied EPL and remaining hardmask components from the edge and proximate surfaces of the wafer/substrate (*e.g.*, where the hardmask has penetrated or undercut the EPL). Examples of residual hardmask components that can be removed with the disclosed rinses include the ingredients of both metal hardmask compositions and metal oxide photoresist compositions used in lithographic manufacturing processes. Suitable metal hardmask and metal oxide photoresist compositions include, but are not limited to, those described in US Patent Nos. 9,315,636; 8,568,958, 9,201,305; 9,296,922; 9,409,793; and 9,499,698 and US Patent Application Nos. 62/437,449 (filed December 21, 2016) and 14/978,232 (filed December 22, 2015), which are hereby incorporated herein by reference in their entireties. The hardmask components removed or that can be removed by the disclosed rinses include different metals, including tin, titanium, zirconium, tantalum, lead, antimony, thallium, indium, ytterbium, gallium, hafnium, aluminum, magnesium, molybdenum, germanium, iron, cobalt, nickel, copper, zinc, gold, silver, cadmium, tungsten and platinum.

[0077] The rinses are effective at removing residual hardmask components regardless of the methodology used for applying the hardmask. In this regard, any of a variety of techniques can be used to apply the hardmask composition onto the wafer/substrate surface to form the hardmask in the disclosed methods/processes. Suitable techniques include, but are not limited to, spin-on coating, chemical vapor deposition (CVD) and atomic layer deposition (ALD). When spin coating is utilized, preferably at least one casting solvent is used, wherein the solvent used should not deleteriously affect the EPL. Accordingly, suitable casting solvents for the hardmask composition include, but are not limited to, propylene glycol monomethyl ether acetate (PGMEA), propylene glycol methyl ether (PGME), ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

[0078] In the disclosed methods/processes any of a variety of techniques can be used to remove a portion of the hardmask composition that is in contact with the EPL. It would be understood by those skilled in the art that removal of a portion of the hardmask composition that is in contact with the EPL should not deleteriously affect that part of the hardmask composition that is not in contact with the EPL. Suitable techniques include, but are not limited to, chemical mechanical polishing (CMP), plasma etching, and wet etching. When wet etching is utilized, any of a variety of solvents (such as EBRs) can be used provided that the solvent does not deleteriously affect the EPL or hardmask. Suitable EBRs include, but are not limited to, PGMEA, PGME, ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

[0079] In the disclosed methods/processes the hardmask composition can be treated by a variety of techniques to form the hardmask. For example, the hardmask composition can be treated by heating at a temperature between approximately 150 °C and approximately 450 °C and/or for a time between approximately 60 seconds and approximately 120 seconds.

[0080] Typical electronic devices that can be manufactured using the compositions and methods of the disclosed subject matter include, but are not limited to, computer chips, integrated circuits, and semiconductor devices.

[0081] **EXAMPLES**

[0082] Reference will now be made to more specific embodiments of the present disclosure and experimental results that provide support for such embodiments. The examples are given below to more fully illustrate the disclosed subject matter and should not be construed as limiting the disclosed subject matter in any way.

[0083] It will be apparent to those skilled in the art that various modifications and variations can be made in the disclosed subject matter and specific examples provided herein without departing from the spirit or scope of the disclosed subject matter. Thus, it is intended that the disclosed subject matter, including the descriptions provided by the following examples, covers the modifications and variations of the disclosed subject matter that come within the scope of any claims and their equivalents.

[0084] **Materials and Methods:**

[0085] MHM 082 is a metal hardmask composition containing titanium available from EMD Performance Material Corp.

[0086] EPL 003 is a polysulfone in anisole available from EMD performance Materials Corp..

[0087] U98 polymer is a high carbon-containing polymer available from EMD Performance Materials Corp.

[0088] ArF Thinner is a 70/30 (by weight) mixture of PGMEA/PGME available from EMD Performance Materials Corp.

[0089] Metal content was determined by ICP-MS on an Elan DRC II using the following operating parameters:

Condition	Setting
Ti 48	DRc Mode
Aqueous Standard	0.2, 1.0, 2.5, 5.0 and 10.0 ppb
Replicates Scans	3
Sweeps/Reading	5
Scan Mode	Peak Hopping
Dwell Time	50 ms
Integration Time	250 ms
DRC Neb Flow	1.12 mL/minute
DRC Gas	0.1 mL/minute
ICP Power	1600 watts
Plasma Flow	19 L/minute
Aux Flow	1.2 mL/minute
Detector Mode	Dual
Sample Flush Time	70 seconds
Read Delay	20 seconds
Sample Prep.	1 to 10 in deionized water
Report Units	Parts-per-billion (ppb)

[0090] **Metal Hard Mask ("MHM") Formulation:** In order to evaluate the effectiveness of removing any remaining residual components of a hardmask, an MHM formulation containing a

masking agent for application to a wafer/substrate (the "MHM formulation") was prepared by combining MHM 082 (2514.285 g), triethanolamine (314.285 g), and U-98 polymer (78.57 g) were dissolved in ArF Thinner (12,092.857 g) and filtered through 0.2 micron filter.

[0091] **Example 1:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in 100% anisole on a lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 89.14 ppb as described above.

[0092] **Example 2:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 5% (by weight) of acetic acid and 95% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 89.14 ppb as described above.

[0093] **Example 3:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 10% (by weight) of acetic acid and 90% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 90.33 ppb as described above.

[0094] **Example 4:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 20% (by weight) of acetic acid and 80% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 58.73 ppb as described above.

[0095] **Example 5:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 30% (by weight) of acetic acid and 70% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 58.84 ppb as described above.

[0096] **Example 6:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 2% (by weight) of trifluoro acetic acid and 98% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 49.2 ppb as described above.

[0097] **Example 7:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 4% (by weight) of trifluoro acetic acid and 96% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 50.89 ppb as described above.

[0098] **Example 8:** The MHM formulation was spin coated (7500 rpm) without any bake on a wafer and the wafer was soaked in a mixture of 10% (by weight) of trifluoro acetic acid and 90% (by weight) of anisole on lab hotplate until all the film was removed. The wafer was then washed with an acid solution of HCl and hydrogen peroxide for 6 minutes that was prepared by adding approximately 30.4 g of water to a flask to which 35.7 g of hydrogen peroxide (30%) and 33.9 g of HCl (37%) were added with stirring (approximately 1 hour). The titanium content of the extracted solution was determined by ICP-MS to be 49.13 ppb as described above.

[0099] **Results**

[0100] As shown in Table 1 below, a significant and unexpected drop in residual quantities of the applied hardmask (*i.e.*, the amount of metal residue) is observed for rinses including between

approximately 15% by weight and 35% by weight of acetic acid and between approximately 85% by weight and 65 %by weight of anisole.

Acetic Acid/Anisole Ratio (wt%)	Metal Residue (ppb)
0/100	89.14
5/95	89.14
10/90	90.33
20/80	58.73
30/70	58.84

Table 1

[0101] As shown in Table 1, for example, the rinses including between approximately 20% by weight and 30% by weight of acetic acid and between approximately 80% by weight and 70% by weight of anisole unexpectedly reduced residual metal content by approximately 35% compared to other mixtures of acetic acid and anisole.

[0102] As shown in Table 2 below, the use of trifluoracetic acid (*i.e.*, a halogenated acetic acid compounds of structure A) also evidences a significant and unexpected drop in residual quantities of the applied hardmask (*i.e.*, the amount of metal residue). In particular, drop in residual quantities of titanium was observed when using rinses including between approximately 1% by weight and 10% by weight of trifluoroacetic acid and between approximately 99% by weight and 90% by weight of anisole.

Trifluroacetic Acid/Anisole Ratio (wt%)	Metal Residue (ppb)
0/100	89.14
2/98	49.2
4/96	50.89
10/90	49.13

Table 2

[0103] As shown in Table 2, for example, the rinses including between approximately 2% by weight and 10% by weight of trifluoroacetic acid and between approximately 98% by weight and

90% by weight of anisole were unexpectedly somewhat more effective at removing residual metal content than the acetic acid formulations on Table 1. In particular, the trifluoroacetic acid-containing rinses were demonstrated to be approximately 15% more effective at removing residual quantities of the applied hardmask based upon the average remaining metal residue (58.76 ppb) of the most effective acetic acid/anisole rinses of Table 1 (*i.e.*, 20/80 and 30/70) compared to the average remaining metal residue (49.74 ppb) of the trifluoroacetic acid/anisole rinses of Table 2.

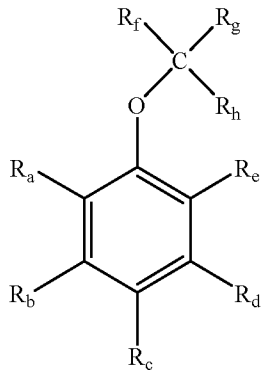
[0104] Although the disclosed and claimed subject matter has been described and illustrated with a certain degree of particularity, it is to be understood that the disclosure has been made only by way of example, and that numerous changes in the conditions and order of steps can be resorted to by those skilled in the art without departing from the spirit and scope of the disclosed and claimed subject matter.

What is claimed is:

1. A rinse comprising

(i) between approximately 15% by weight and approximately 35% by weight of acetic acid and

(ii) between approximately 85% by weight and approximately 65% by weight of a compound having structure B:



wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted (C_{1-6}) alkyl group, a substituted or an unsubstituted halogenated (C_{1-6}) alkyl group, a substituted or an unsubstituted (C_{1-6}) alkyl carbonyl group, a halogen, or a hydroxy group.

2. The rinse of claim 1, wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen.

3. The rinse of any of claims 1-2, wherein the rinse contains approximately 15% by weight of acetic acid.

4. The rinse of any of claims 1-2, wherein the rinse contains approximately 20% by weight of acetic acid.

5. The rinse of any of claims 1-2, wherein the rinse contains approximately 25% by weight of acetic acid.

6. The rinse of any of claims 1-2, wherein the rinse contains approximately 30% by weight of acetic acid.

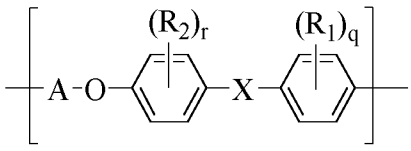
7. The rinse of any of claims 1-2, wherein the rinse contains approximately 35% by weight of acetic acid.

8. The rinse of any of claims 1-7, wherein the rinse consists essentially of acetic acid and the compound having structure B.

9. The rinse of any of claims 1-7, wherein the rinse consists of acetic acid and the compound having structure B.

10. The rinse of any of claims 1-9, wherein the rinse is adapted for removing an edge protection layer formed from a masking composition comprising

a. a polymer comprising a unit having structure (I):

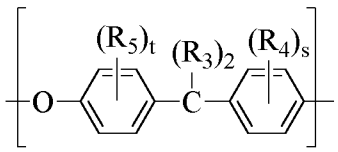


(I),

wherein

X is selected from the group consisting of $–SO_2$-, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

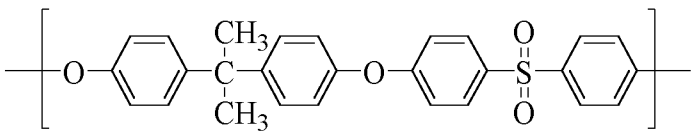
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

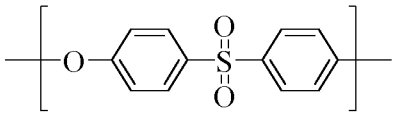
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

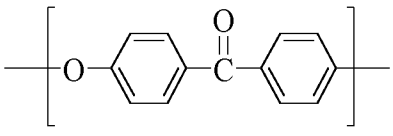
b. an organic solvent,

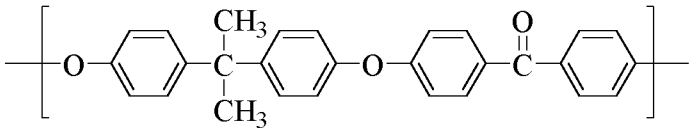
wherein the polymer has an average molecular weight of less than 50000.

11. The rinse of claim 10, wherein the polymer unit having structure (I) includes one of:

a. ,

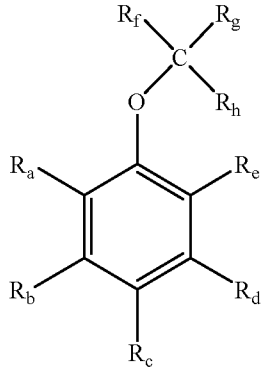
b. ,

c.  , and

d.  .

12. A method of cleaning a wafer or substrate comprising:

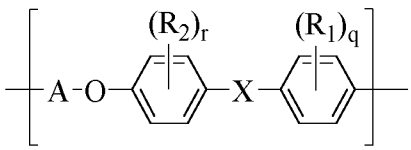
washing the wafer or substrate with a rinse comprising between approximately 15% by weight and approximately 35% by weight of acetic acid and between approximately 85% by weight and approximately 65% by weight of a compound having structure B:



wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted alkyl group, a substituted or an unsubstituted halogenated alkyl group, a substituted or an unsubstituted alkyl carbonyl group, a halogen, and a hydroxy group.

13. The method of claim 12, wherein the edge protection layer is formed from a masking composition comprising

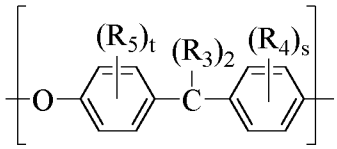
a. a polymer comprising a unit having structure (I):

 (I),

wherein

X is selected from the group consisting of $-SO_2-$, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

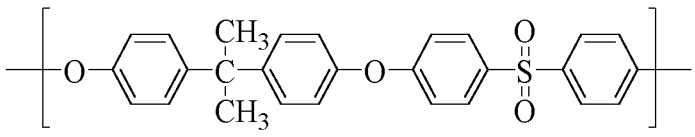
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

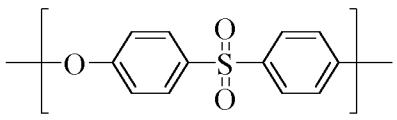
b. an organic solvent,

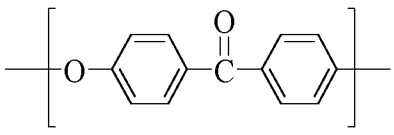
wherein the polymer has an average molecular weight of less than 50000.

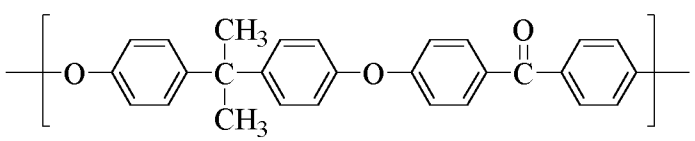
14. The method of any of claims 12-13, wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen.

15. The method of any of claims 13-14, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. .

16. The method of any of claims 12-15, wherein the rinse contains approximately 15% by weight of acetic acid.

17. The method of any of claims 12-15, wherein the rinse contains approximately 20% by weight of acetic acid.

18. The method of any of claims 12-15, wherein the rinse contains approximately 25% by weight of acetic acid.

19. The method of any of claims 12-15, wherein the rinse contains approximately 30% by weight of acetic acid.

20. The method of any of claims 12-15, wherein the rinse contains approximately 35% by weight of acetic acid.

21. The method of any of claims 12-20, wherein the rinse consists essentially of acetic acid and the compound having structure B.

22. The method of any of claims 12-20, wherein the rinse consists of acetic acid and the compound having structure B.

23. The method of any of claims 12-22, further comprising one or more steps selected from the group of:

(a) applying a masking agent on an edge and at least one proximate surface of the wafer or substrate;

(b) heating the applied masking agent to form the edge protection layer on the edge and at least one proximate surface of the wafer or substrate;

(c) applying a hardmask composition to the wafer or substrate and the edge protection layer;

(d) removing at least a portion of the applied hardmask composition that is in contact with the edge protection layer, wherein the removing comprises rinsing the hardmask composition with at least one edge bead remover material;

(e) heating the applied hardmask composition to form the hardmask; and

(f) performing at least one post applied bake.

24. A method of applying and removing an edge protection layer and residual hardmask components from a wafer or substrate comprising:

(a) applying a masking agent on an edge and at least one proximate surface of the wafer or substrate;

(b) heating the masking agent to form the edge protection layer on the edge and the at least one proximate surface of the wafer or substrate;

(c) applying a hardmask composition to the wafer or substrate and the edge protection layer;

(d) removing at least a portion of the hardmask composition that is in contact with the edge protection layer, wherein the removing comprises rinsing the hardmask composition with at least one edge bead remover material;

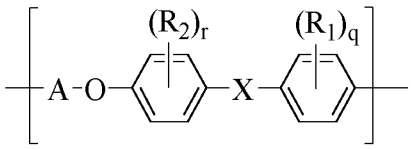
(e) heating the hardmask composition to form the hardmask; and

(f) washing the wafer or substrate with a rinse comprising between approximately 15% by weight and approximately 35% by weight of acetic acid and between approximately 85% by weight and approximately 65% by weight of anisole.

25. The method of claim 24 further compromising performing at least one post applied baking step.

26. The method of any of claims 24-25, wherein the edge protection layer is formed from a masking composition comprising

a. a polymer comprising a unit having structure (I):

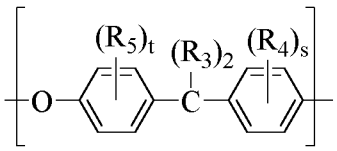


(I),

wherein

X is selected from the group consisting of $–SO_2$-, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

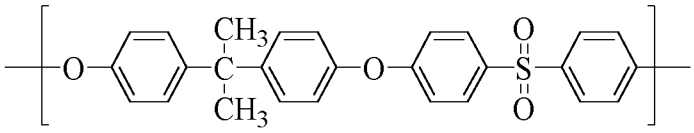
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

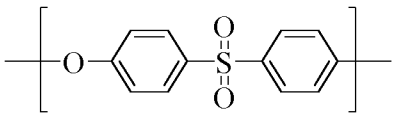
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

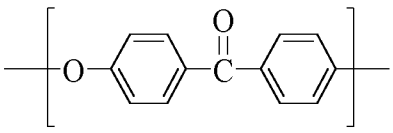
b. an organic solvent,

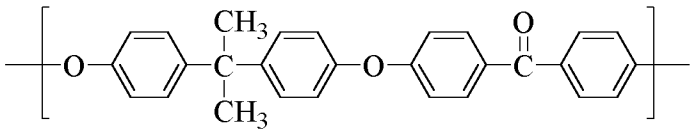
wherein the polymer has an average molecular weight of less than 50,000.

27. The method of claim 26, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. .

28. The method of any of claims 24-27, wherein the rinse contains approximately 15% by weight of acetic acid.

29. The method of any of claims 24-27, wherein the rinse contains approximately 20% by weight of acetic acid.

30. The method of any of claims 24-27, wherein the rinse contains approximately 25% by weight of acetic acid.

31. The method of any of claims 24-27, wherein the rinse contains approximately 30% by weight of acetic acid.

32. The method of any of claims 24-27, wherein the rinse contains approximately 35% by weight of acetic acid.

33. The method of any of claims 24-32, wherein the rinse consists essentially of acetic acid and anisole.

34. The method of any of claims 24-32, wherein the rinse consists of acetic acid and anisole.

35. The method of any of claims 24-34, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises a spin-on coating process.

36. The method of claim 35, wherein the spin-on coating process utilizes at least one casting solvent.

37. The method of claim 36, wherein the at least one casting solvent includes at least one of PGMEA, PGME, ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

38. The method of any of claims 24-34, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises a chemical vapor deposition process.

39. The method of any of claims 24-34, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises an atomic layer deposition process.

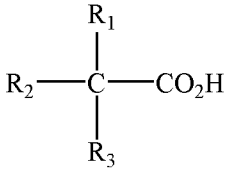
40. The method of any of claims 24-39, wherein the at least one edge bead remover material is at least one of PGMEA, PGME, ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

41. The method of any of claims 24-40, wherein the heating the hardmask composition to form the hardmask comprises heating at a temperature between approximately 150 °C and approximately 450 °C.

42. The method of any of claims 24-41, wherein the heating the hardmask composition to form the hardmask comprises heating for a time between approximately 60 seconds and approximately 120 seconds.

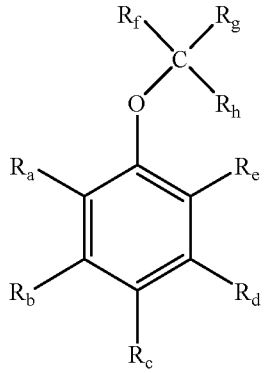
43. A rinse comprising

(i) between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A:



wherein R_1 and R_2 are independently hydrogen or a halogen and R_3 is a halogen; and

(ii) between approximately 99% by weight and approximately 90% by weight of a compound having structure B:



wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted (C_{1-6}) alkyl group, a substituted or an unsubstituted halogenated (C_{1-6}) alkyl group, a substituted or an unsubstituted (C_{1-6}) alkyl carbonyl group, a halogen, or a hydroxy group.

44. The rinse of claim 43, wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen.

45. The rinse of any of claims 43-44, wherein the rinse contains approximately 1% by weight of the halogenated acetic acid of structure A.

46. The rinse of any of claims 43-44, wherein the rinse contains approximately 2% by weight of the halogenated acetic acid of structure A.

47. The rinse of any of claims 43-44, wherein the rinse contains approximately 4% by weight of the halogenated acetic acid of structure A.

48. The rinse of any of claims 43-44, wherein the rinse contains approximately 7% by weight of the halogenated acetic acid of structure A.

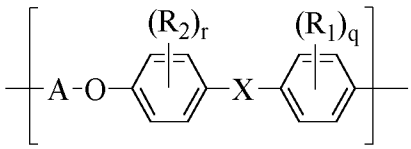
49. The rinse of any of claims 43-44, wherein the rinse contains approximately 10% by weight of the halogenated acetic acid of structure A.

50. The rinse of any of claims 43-49, wherein the rinse consists essentially of the halogenated acetic acid of structure A and the compound having structure B.

51. The rinse of any of claims 43-49, wherein the rinse consists of the halogenated acetic acid of structure A and the compound having structure B.

52. The rinse of any of claims 43-51, wherein the rinse is adapted for removing an edge protection layer formed from a masking composition comprising

a. a polymer comprising a unit having structure (I):

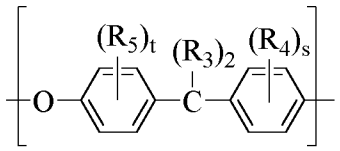


(I),

wherein

X is selected from the group consisting of $–SO_2$-, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

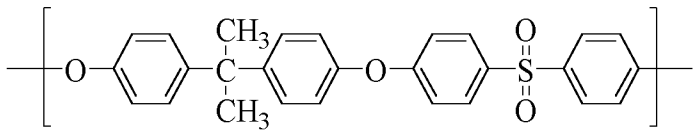
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

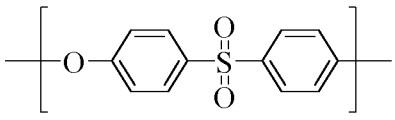
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

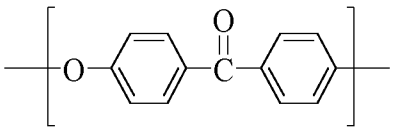
b. an organic solvent,

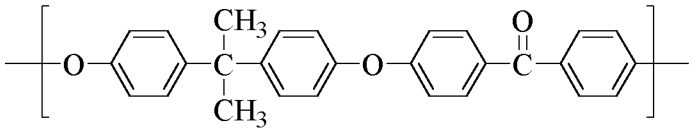
wherein the polymer has an average molecular weight of less than 50,000.

53. The rinse of claim 52, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. 

54. The rinse of any of claims 43-53, wherein in the halogenated acetic acid of structure A R_1 and R_2 are each hydrogen and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine

55. The rinse of any of claims 43-53, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine.

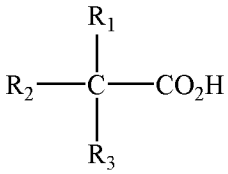
56. The rinse of any of claims 43-53, wherein the halogenated acetic acid of structure A is difluoroacetic acid.

57. The rinse of any of claims 43-53, wherein the halogenated acetic acid of structure A is trifluoroacetic acid.

58. The rinse of any of claims 43-53, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a different halogen selected from among fluorine, bromine, iodine and chlorine.

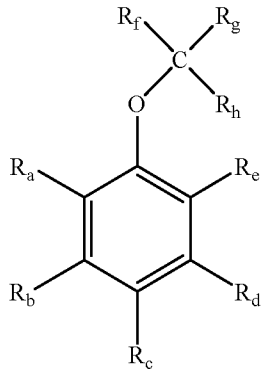
59. A method of cleaning a wafer or substrate comprising:

washing the wafer or substrate with a rinse comprising (i) between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A:



wherein R_1 and R_2 are independently hydrogen or a halogen and R_3 is a halogen; and

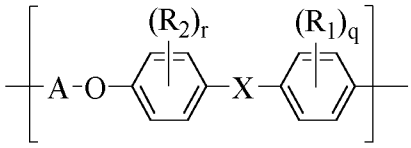
(ii) between approximately 99% by weight and approximately 90% by weight of a compound having structure B:



wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h may independently be hydrogen, a substituted or an unsubstituted (C_{1-6}) alkyl group, a substituted or an unsubstituted halogenated (C_{1-6}) alkyl group, a substituted or an unsubstituted (C_{1-6}) alkyl carbonyl group, a halogen, or a hydroxy group.

60. The method of claim 59, wherein the edge protection layer is formed from a masking composition comprising

a. a polymer comprising a unit having structure (I):

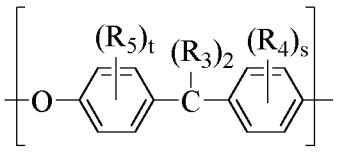


(I),

wherein

X is selected from the group consisting of $-SO_2-$, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

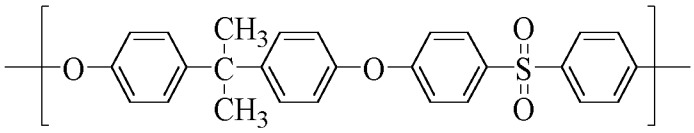
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

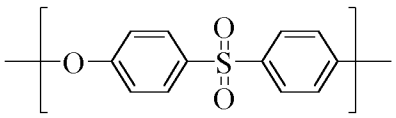
b. an organic solvent,

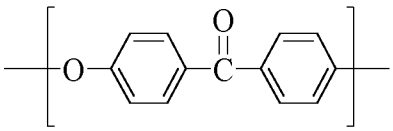
wherein the polymer has an average molecular weight of less than 50,000.

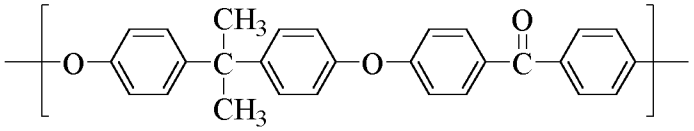
61. The method of any of claims 59-60, wherein each of R_a, R_b, R_c, R_d, R_e, R_f, R_g and R_h in structure B is hydrogen.

62. The method of any of claims 60-61, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. .

63. The method of any of claims 59-62, wherein the rinse contains approximately 1% by weight of the halogenated acetic acid of structure A.

64. The method of any of claims 59-62, wherein the rinse contains approximately 2% by weight of the halogenated acetic acid of structure A.

65. The method of any of claims 59-62, wherein the rinse contains approximately 4% by weight of the halogenated acetic acid of structure A.

66. The method of any of claims 59-62, wherein the rinse contains approximately 7% by weight of the halogenated acetic acid of structure A.

67. The method of any of claims 59-62, wherein the rinse contains approximately 10% by weight of the halogenated acetic acid of structure A.

68. The method of any of claims 59-67, wherein the rinse consists essentially of the halogenated acetic acid of structure A and the compound having structure B.

69. The method of any of claims 59-67, wherein the rinse consists of the halogenated acetic acid of structure A and the compound having structure B.

70. The method of any of claims 59-69, further comprising one or more steps selected from the group of:

(a) applying a masking agent on an edge and at least one proximate surface of the wafer or substrate;

(b) heating the applied masking agent to form the edge protection layer on the edge and at least one proximate surface of the wafer or substrate;

(c) applying a hardmask composition to the wafer or substrate and the edge protection layer;

(d) removing at least a portion of the applied hardmask composition that is in contact with the edge protection layer, wherein the removing comprises rinsing the hardmask composition with at least one edge bead remover material;

(e) heating the applied hardmask composition to form the hardmask; and

(f) performing at least one post applied bake.

71. The method of any of claims 59-70, wherein in the halogenated acetic acid of structure A R_1 and R_2 are each hydrogen and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine

72. The method of any of claims 59-70, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine.

73. The method of any of claims 59-70, wherein the halogenated acetic acid of structure A is difluoroacetic acid.

74. The method of any of claims 59-70, wherein the halogenated acetic acid of structure A is trifluoroacetic acid.

75. The method of any of claims 59-70, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a different halogen selected from among fluorine, bromine, iodine and chlorine.

76. A method of applying and removing an edge protection layer and residual hardmask components from a wafer or substrate comprising:

(a) applying a masking agent on an edge and at least one proximate surface of the wafer or substrate;

(b) heating the masking agent to form the edge protection layer on the edge and the at least one proximate surface of the wafer or substrate;

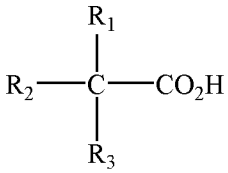
(c) applying a hardmask composition to the wafer or substrate and the edge protection layer;

(d) removing at least a portion of the hardmask composition that is in contact with the edge protection layer, wherein the removing comprises rinsing the hardmask composition with at least one edge bead remover material;

(e) heating the hardmask composition to form the hardmask; and

(f) washing the wafer or substrate with a rinse comprising

(i) between approximately 1% by weight and approximately 10% by weight of halogenated acetic acid of structure A:



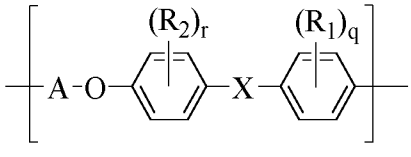
wherein R_1 and R_2 are independently hydrogen or a halogen and R_3 is a halogen, and

(ii) between approximately 99% by weight and approximately 99% by weight of anisole.

77. The method of claim 76 further compromising performing at least one post applied baking step.

78. The method of any of claims 76-77, wherein the edge protection layer is formed from a masking composition comprising

a. a polymer comprising a unit having structure (I):

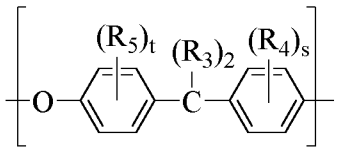


(I),

wherein

X is selected from the group consisting of $-SO_2-$, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

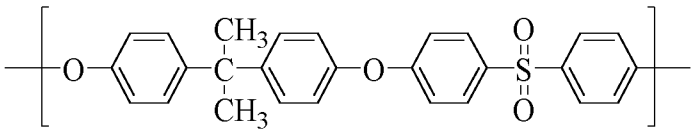
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

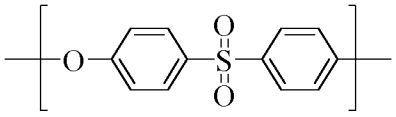
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

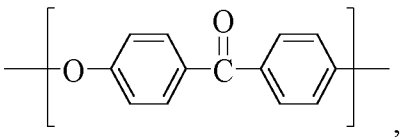
b. an organic solvent,

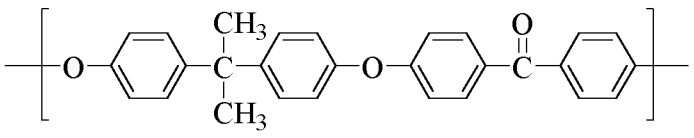
wherein the polymer has an average molecular weight of less than 50000.

79. The method of claim 78, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. .

80 The method of any of claims 76-79, wherein the rinse contains approximately 1% by weight of the halogenated acetic acid of structure A.

81 The method of any of claims 76-79, wherein the rinse contains approximately 2% by weight of the halogenated acetic acid of structure A.

82. The method of any of claims 76-79, wherein the rinse contains approximately 4% by weight of the halogenated acetic acid of structure A.

83. The method of any of claims 76-79, wherein the rinse contains approximately 7% by weight of the halogenated acetic acid of structure A.

84. The method of any of claims 76-79, wherein the rinse contains approximately 10% by weight of the halogenated acetic acid of structure A.

85. The method of any of claims 76-84, wherein the rinse consists essentially of the halogenated acetic acid of structure A and anisole.

86. The method of any of claims 76-84, wherein the rinse consists of the halogenated acetic acid of structure A and anisole.

87. The method of any of claims 76-86, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises a spin-on coating process.

88. The method of claim 87, wherein the spin-on coating process utilizes at least one casting solvent.

89. The method of claim 88, wherein the at least one casting solvent includes at least one of PGMEA, PGME, ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

90. The method of any of claims 76-86, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises a chemical vapor deposition process.

91. The method of any of claims 76-86, wherein the applying a hardmask composition to the wafer or substrate and the edge protection layer comprises an atomic layer deposition process.

92. The method of any of claims 76-91, wherein the at least one edge bead remover material is at least one of PGMEA, PGME, ethyl lactate, methoxyethanol, ethoxypropanol, ethoxyethanol, 1-pentanol, 4-methyl-2-pentanol and mixtures thereof.

93. The method of any of claims 76-92, wherein the heating the hardmask composition to form the hardmask comprises heating at a temperature between approximately 150 °C and approximately 450 °C.

94. The method of any of claims 76-93, wherein the heating the hardmask composition to form the hardmask comprises heating for a time between approximately 60 seconds and approximately 120 seconds.

95. The method of any of claims 76-94, wherein in the halogenated acetic acid of structure A R_1 and R_2 are each hydrogen and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine

96. The method of any of claims 76-94, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a halogen selected from among fluorine, bromine, iodine and chlorine.

97. The method of any of claims 76-94, wherein the halogenated acetic acid of structure A is difluoroacetic acid.

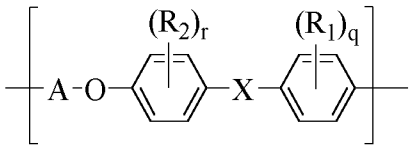
98. The method of any of claims 76-94, wherein the halogenated acetic acid of structure A is trifluoroacetic acid.

99. The method of any of claims 76-94, wherein in the halogenated acetic acid of structure A two or more of R_1, R_2 and R_3 is a different halogen selected from among fluorine, bromine, iodine and chlorine.

100. The use of a rinse according to any one of claims 1 to 11 or 43 to 58 for removing an edge protection layer and/or residual hardmask components.

101. The use according to claim 101, wherein the edge protection layer comprises

a. a polymer comprising a unit having structure (I):

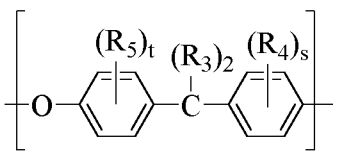


(I),

wherein

X is selected from the group consisting of $-SO_2-$, -C(=O)- and –O-;

A is a direct bond or A is selected from the group consisting of structure (II):



(II);

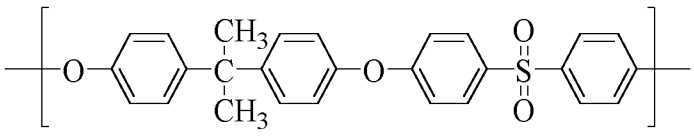
R_1, R_2, R_3, R_4 and R_5 are each independently selected from the group consisting of H, halo, (C_{1-3}) alkyl, (C_{1-3}) fluorinated alkyl, hydroxy, (C_{1-3}) alkoxy, and (C_{1-3}) alkyl carbonyl; and

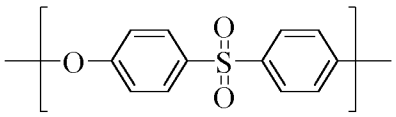
q, r, s and t are each independently selected from the group consisting of 0, 1, 2, 3 and 4; and

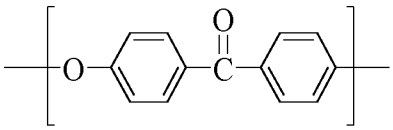
b. an organic solvent,

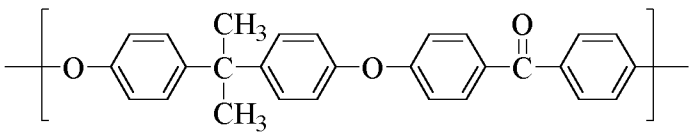
wherein the polymer has an average molecular weight of less than 50000.

102. The use according to claim 102, wherein the polymer unit having structure (I) includes one of:

a. ,

b. ,

c. , and

d. .

DRAWINGS

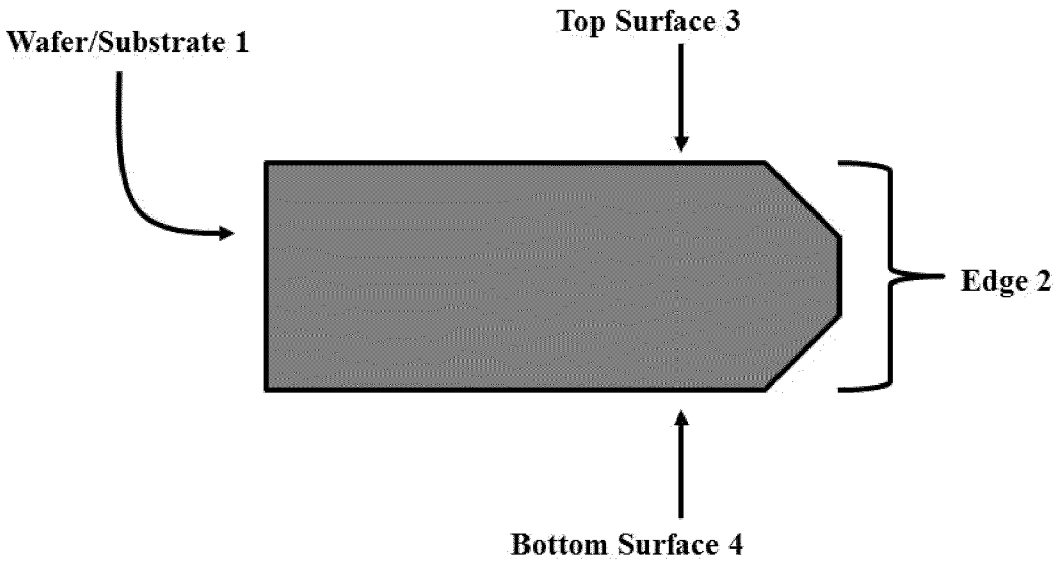
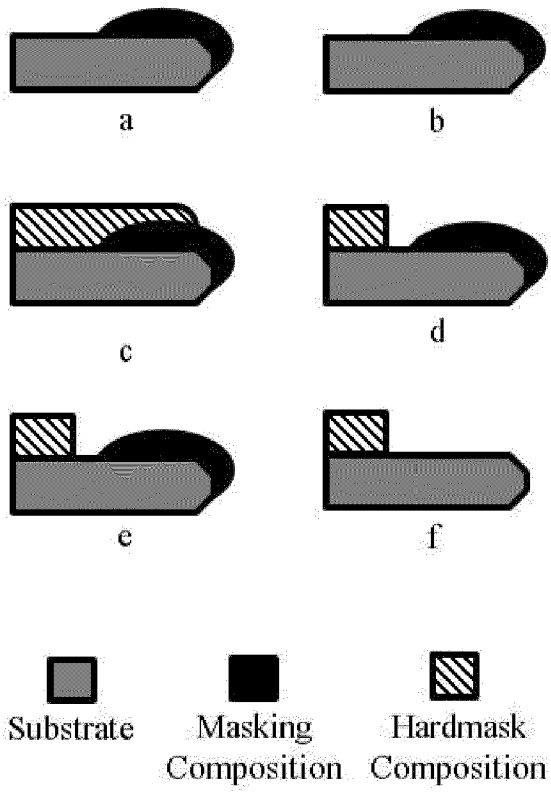


Figure 1.



Figures 2a-f.

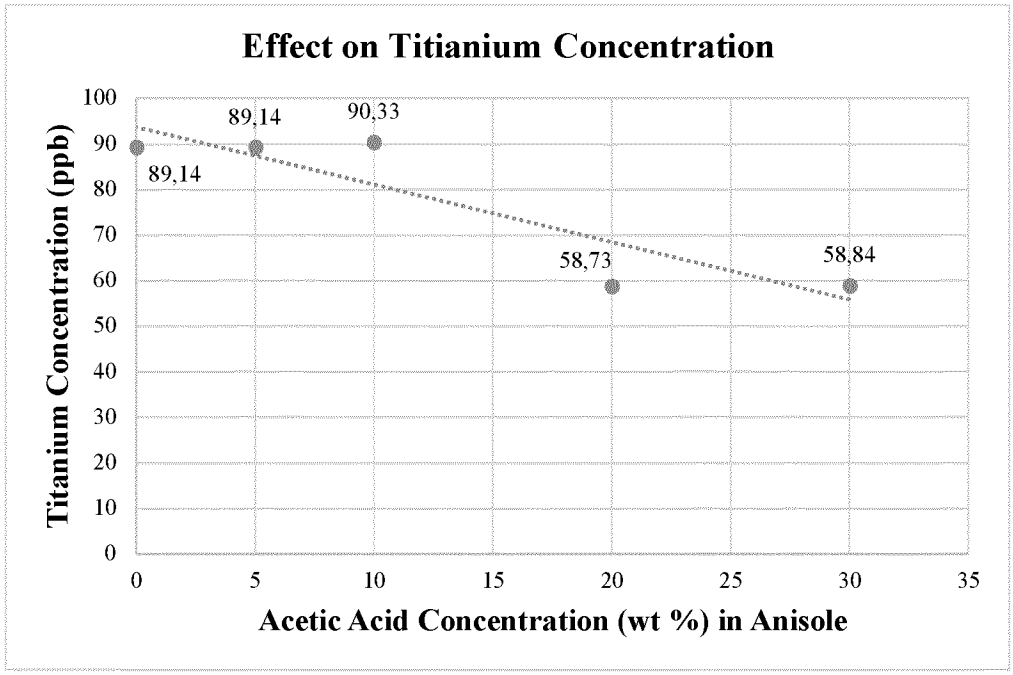


Figure 3.

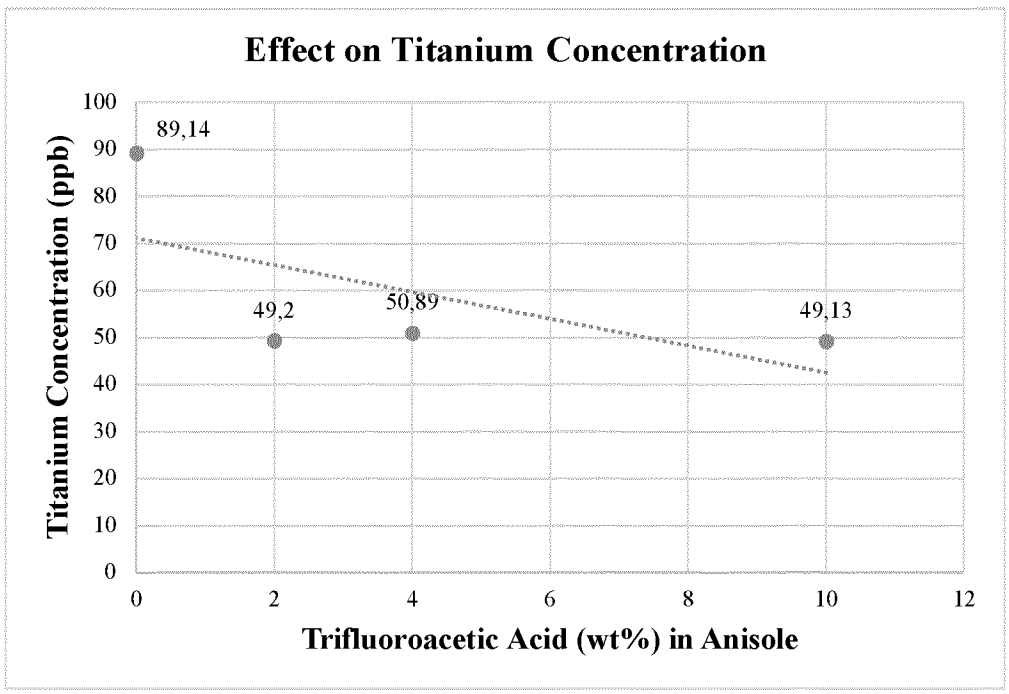


Figure 4.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/068936

A. CLASSIFICATION OF SUBJECT MATTER
INV. G03F7/42 G03F7/09 H01L21/02 H01L21/027 H01L21/311
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G03F H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2018/167112 A1 (MERCK PATENT GMBH [DE]) 20 September 2018 (2018-09-20) cited in the application abstract; claims; figures paragraph [0052] paragraph [0054] - paragraph [0076]; tables	1-102
A	EP 0 566 286 A1 (AMERICAN TELEPHONE & TELEGRAPH [US]) 20 October 1993 (1993-10-20) abstract; claims 1,5 page 3, line 19 - line 27	1-102

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 October 2020	16/11/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Paisdor, Bernd

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/029893 A1 (KOSHIYAMA JUN [JP] ET AL) 29 January 2009 (2009-01-29) abstract; claim 9; table 1 paragraph [0014] - paragraph [0026] paragraph [0028] - paragraph [0053] -----	1-102
A	WO 00/33140 A1 (SILICON VALLEY CHEMLABS INC [US]; SAHBARI JAVAD J [US]) 8 June 2000 (2000-06-08) abstract; claims 1,14-16 page 3, line 16 - line 19 page 4, line 10 - page 6, line 2; tables 1-2 -----	1-102
A	NILESH A. MALI ET AL: "Vapor-Liquid Equilibrium Data for Binary Mixtures of Acetic Acid + Anisole, Acetone + Anisole, and Isopropanol + Anisole at Pressure 96.15 kPa", JOURNAL OF CHEMICAL AND ENGINEERING DATA., vol. 62, no. 3, 14 February 2017 (2017-02-14), pages 947-953, XP055741067, US ISSN: 0021-9568, DOI: 10.1021/acs.jced.6b00700 figure 3; table 6 -----	1-102

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/068936

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