UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte PADMAPANI C. NALLAN,
AJAY KUMAR, and GUANGXIANG JIN

Appeal 2008-3816
Application 10/418,994
Technology Center 1700

Decided: September 9, 2008

Before ADRIENE LEPIANE HANLON, JEFFREY T. SMITH, and MARK NAGUMO, *Administrative Patent Judges*.

HANLON, *Administrative Patent Judge*.

DECISION ON APPEAL

A. STATEMENT OF THE CASE

This is an appeal under 35 U.S.C. § 134 from an Examiner's final rejection of claims 1-6, 8-15, and 17, all of the claims pending in the application. We have jurisdiction under 35 U.S.C. § 6(b). We AFFIRM.

The Examiner finally rejected claims 1-4, 6, and 9-15 under 35 U.S.C. § 103(a) as unpatentable over Ngai.[1] Final 3-4.[2]

The Examiner finally rejected claim 5 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Yang.[3] Final 4.

The Examiner finally rejected claims 8 and 17 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Hwang.[4] Final 4-5.

B. ISSUE

The dispositive issue in this appeal is whether the Appellants have shown that the Examiner erred in determining that the combination of a fluorine-containing gas and a halogen-containing gas would have been obvious to a person having ordinary skill in the art, in view of the teachings of Ngai.

C. SUBJECT MATTER ON APPEAL

The Appellants claim a method of plasma etching a metal-containing layer formed on a hafnium-based dielectric material. The metal-containing layer is etched using a gas mixture comprising a halogen-containing gas and a fluorine-containing gas. *See* claims 1 and 9; Spec., para. [0008].

The Appellants disclose that the fluorine-containing gas in the gas mixture facilitates a high etch selectivity for the metal-containing material over the hafnium-based dielectric material of about 20:1. Spec., paras. [0026], [0028].

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[1] US 6,518,106 B2 issued to Ngai et al. on February 11, 2003 ("Ngai").
[2] Final Office Action mailed February 5, 2007.
[3] US 6,524,912 B1 issued to Yang et al. on February 25, 2003 ("Yang").
[4] US 6,368,517 B1 issued to Hwang et al. on April 9, 2002 ("Hwang").

The fluorine-containing gas includes gases having the formula C_xF_y, where x and y are integers, and $C_zH_xF_y$, where x, y, and z are integers. For example, the fluorine-containing gas may comprise carbon tetrafluoride (CF_4), fluorobutylene (C_4F_8), trifluoromethane (CHF_3), and the like. Spec., para. [0026].

Halogen-containing gases include chlorine (Cl_2), hydrogen chloride (HCl), and the like. Spec., para. [0029].

Claims 1 and 9 are the only independent claims on appeal.

Claim 1 reads as follows:

> A method for etching a metal-containing layer, comprising:
> providing a substrate having a metal-containing layer formed on a hafnium-based layer; and
> plasma etching the metal-containing layer using a gas mixture comprising a halogen-containing gas and a fluorine-containing gas, wherein the gas mixture has a selectivity for the metal-containing layer over the hafnium-based material of at least 20:1.

App. Br. 9, Claims Appendix.[5]

Claim 9 is directed to a method for forming a gate structure of a field effect transistor and recites, in relevant part:

> . . . (c) plasma etching the gate electrode layer using a gas mixture comprising a halogen-containing gas and a fluorine-containing gas, wherein the gas mixture has a selectivity for the gate electrode layer over the hafnium-based material of at least 20:1 . . . .

App. Br. 10, Claims Appendix.

[5] Appeal Brief dated July 2, 2007.

D. PRINCIPLES OF LAW

A claimed invention is not patentable if the subject matter of the claimed invention would have been obvious to a person having ordinary skill in the art. 35 U.S.C. § 103(a); *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727 (2007); *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966).

Facts relevant to a determination of obviousness include (1) the scope and content of the prior art, (2) any differences between the claimed invention and the prior art, (3) the level of skill in the art, and (4) any relevant objective evidence of obviousness or non-obviousness. *KSR*, 127 S. Ct. at 1734, *Graham*, 383 U.S. at 17-18.

A person of ordinary skill is also a person of ordinary creativity, not an automaton. *KSR*, 127 S. Ct. at 1742. One of ordinary skill in the art is presumed to have skills apart from what the prior art references expressly disclose. *See In re Sovish*, 769 F.2d 738, 742 (Fed. Cir. 1985).

The question under 35 U.S.C. § 103 is not merely what the references teach but what they would have suggested to one of ordinary skill in the art at the time the invention was made. All disclosures of the prior art must be considered. *In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976).

E. ANALYSIS

1. Claims 1-4, 6, and 9-15

The Examiner found that Ngai discloses a process for making a semiconductor device wherein the process includes plasma etching a metal-containing gate layer (50) on a hafnium-based gate dielectric layer (40) using halogen-containing gases such as carbon tetrafluoride (CF_4), hydrogen chloride (HCl), chlorine (Cl_2), or the like. Ans. 3[6]; Ngai 2:45-3:20.

[6] Examiner's Answer mailed October 5, 2007.

The Examiner found that Ngai is silent about using more than one fluorine- or halogen-containing etching gas. The Examiner, however, found that Ngai teaches using both fluorine-containing gases, such as carbon tetrafluoride (CF_4), and other halogen-containing gases, such as hydrogen chloride (HCl), in the disclosed etching process. Ans. 3.

The Examiner concluded that it would have been obvious to use any combination of etching gases disclosed in Ngai, including a combination of fluorine- and halogen-containing gases, because combining two compositions, each of which is taught by the prior art to be useful for the same purpose, to form a third composition which is to be used for the very same purpose is prima facie obvious. The Examiner cites *In re Kerkhoven*, 626 F.2d 846 (CCPA 1980) for support. Ans. 3.

The Examiner also concluded that the claimed etch selectivity would have been obvious because Ngai's gas mixture and the material to be etched are similar to the claimed subject matter, and thus, would have been expected to have a similar result. Ans. 4.

The Appellants argue that the Examiner has failed to show where the prior art teaches or suggests plasma etching a metal-containing layer using a gas mixture comprising a halogen-containing gas and a fluorine-containing gas, wherein the gas mixture has a selectivity for the metal-containing layer over the hafnium-based layer of at least 20:1. App. Br. 4. The Appellants argue that the Examiner's reliance on *Kerkhoven* is insufficient to establish a prima facie case of obviousness. App. Br. 5. Specifically, the Appellants argue:

> *Ngai* fails to teach or suggest any gas for etching a metal-containing layer formed on a hafnium-based layer having a selectivity for the metal-containing layer over the hafnium-

> based material of at least 20:1, as recited in independent claims 1 and 9. Accordingly, combining any of the individual gases disclosed by *Ngai* would still fail to teach or suggest all the limitations recited in the claims, as required to establish a *prima facie* case of obviousness.

App. Br. 5.

Claim 1 is representative of the issue on appeal. Claim 1 recites a method comprising two steps. The first step is providing a substrate having a metal-containing layer formed on a hafnium-based layer. The second step is plasma etching the metal-containing layer using a gas mixture comprising a halogen-containing gas and a fluorine-containing gas.

Since fluorine is a halogen, the gas mixture recited in claim 1 includes mixtures of two fluorine-containing gases as well as mixtures of a fluorine-containing gas and a nonfluorine halogen-containing gas. According to the Appellants' specification, the fluorine-containing gas mixture has a selectivity for the metal-containing layer over the hafnium-based material of at least 20:1.

Ngai discloses that halogen-based chemistries such as carbon tetrafluoride (CF_4), hexafluoroethane (C_2F_6), hydrogen bromide (HBr), sulfur hexafluoride (SF_6), hydrogen chloride (HCl), molecular chlorine (Cl_2), or the like can be used to etch the metal-containing gate layer. Ngai 3:14-21. Although Ngai does not expressly disclose that mixtures of these gases may be used to etch the metal-containing layer, Ngai also does not exclude the use of gas mixtures. We find that one of ordinary skill in the art would have understood that the disclosed gases could be used either individually or as mixtures in the Ngai process. *See, e.g.,* Yang 10:42-52 (disclosing dry

etching a metal-containing layer and an insulative or dielectric layer using a gas mixture of CF_4, CHF_3, and argon).

As for the claimed selectivity, we recognize that Ngai does not identify the etch selectivity of the disclosed gases. Nonetheless, the Appellants disclose that fluorine-containing gases, such as carbon tetrafluoride (CF_4) and other C_xF_y gases, have a selectivity for a metal-containing layer over a hafnium-based material of about 20:1. Spec., para. [0026]. The Appellants do not argue or direct us to any portion of the Specification disclosing that the selectivity recited in claims 1 and 9 is based on specific process conditions. Moreover, claims 1 and 9 do not recite any process conditions.

Based on the record before us, we find that the etch selectivity recited in claims 1 and 9 is an inherent property of a fluorine-containing gas. Thus, we find that any mixture of gases disclosed in Ngai containing at least one of carbon tetrafluoride (CF_4) or hexafluoroethane (C_2F_6), would have a selectivity for the metal-containing layer over the hafnium-based material of at least 20:1. *See In re Papesch*, 315 F.2d 381, 391 (CCPA 1963) (a chemical compound and its properties are inseparable).

In sum, the claimed "providing" and "plasma etching" steps would have been obvious to one of ordinary skill in the art in view of the teachings in Ngai, and the claimed etch selectivity is met by any mixture of gases disclosed in Ngai containing at least one of carbon tetrafluoride (CF_4) or hexafluoroethane (C_2F_6).

For the reasons set forth above, the Appellants have not shown that the Examiner reversibly erred in rejecting claims 1 and 9 under 35 U.S.C. § 103(a) as unpatentable over Ngai.

The Appellants do not argue the patentability of dependent claims 2-4, 6, and 10-15 separately. App. Br. 6. Therefore, the Appellants have likewise failed to show that the Examiner reversibly erred in rejecting claims 2-4, 6, and 10-15 under 35 U.S.C. § 103(a) as unpatentable over Ngai.

2. Claim 5

The Appellants argue that claim 5 is allowable for the same reasons that the claim from which it depends, claim 1, is allowable. The Appellants do not otherwise dispute the Examiner's findings or conclusion of obviousness as to claim 5. App. Br. 6-7.

Therefore, for the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claim 5 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Yang.

3. Claims 8 and 17

The Appellants argue that claims 8 and 17 are allowable for the same reasons that the claims from which they depend, claims 1 and 9, respectively, are allowable. The Appellants do not otherwise dispute the Examiner's findings or conclusion of obviousness as to claims 8 and 17. App. Br. 7-8.

Therefore, for the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claims 8 and 17 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Hwang.

F. DECISION

The rejection of claims 1-4, 6, and 9-15 under 35 U.S.C. § 103(a) as unpatentable over Ngai is affirmed.

The rejection of claim 5 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Yang is affirmed.

The rejection of claims 8 and 17 under 35 U.S.C. § 103(a) as unpatentable over the combination of Ngai and Hwang is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 35 U.S.C. § 1.136(a) (2008).

AFFIRMED

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MOSER IP LAW GROUP/APPLIED MATERIALS, INC.
1030 Broad Street
2nd Floor
Shrewsbury, NJ 07702