

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte YOUNGJIN CHOI, HELEN H. ZHU,
SANGHEON LEE, and SEAN S. KANG

Appeal 2008-4341
Application 10/798,456
Technology Center 1700

Decided: September 29, 2008

Before ADRIENE LEPIANE HANLON, THOMAS A. WALTZ, and
CATHERINE Q. TIMM, *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 1-5, 8-15, and 18-26. Claims 6 and 7 have been

cancelled,¹ and claims 16 and 17 have been withdrawn from consideration.²
We have jurisdiction under 35 U.S.C. § 6(b). We AFFIRM.

The Examiner finally rejected claims 1, 2, 4, 5, 13, 14, 18-20, 23, and 24 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem³ and Hineman.⁴ Final 3-5.^{5,6,7}

The Examiner finally rejected claims 3 and 12 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Chen.⁸ Final 5-6.

The Examiner finally rejected claims 8-11 and 15 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Angelopoulos.⁹ Final 6-8.¹⁰

¹ Amendment dated June 9, 2006.

² Office Action mailed March 10, 2006.

³ US 5,846,884 issued to Naeem et al. on December 8, 1998 (“Naeem”).

⁴ US 6,379,872 B1 issued to Hineman et al. on April 30, 2002 (“Hineman”).

⁵ Final Office Action mailed August 24, 2006.

⁶ The Examiner also finally rejected claims 6 and 7 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman. However, claims 6 and 7 were cancelled by the Appellants prior to the Final Office Action. *See* Amendment dated June 9, 2006. Therefore, the Examiner’s inclusion of claims 6 and 7 in the statement of the rejection is harmless error.

⁷ In the Final Office Action, the Examiner did not include claims 23 and 24 in the statement of the rejection but did address the limitations of claims 23 and 24 in the body of the rejection. *See* Final 3-4. Therefore, the Examiner’s omission is harmless error.

⁸ US 6,080,662 issued to Chen et al. on June 27, 2000 (“Chen”).

⁹ US 6,316,167 B1 issued to Angelopoulos et al. on November 13, 2001 (“Angelopoulos”).

¹⁰ The Examiner addresses the limitation of claim 9 in the body of the rejection but has omitted claim 9 from the statement of the rejection. *See* Final 6-8. The Appellants do not argue the patentability of claim 9 separately. Amended Appeal Brief dated February 15, 2007 (“App. Br.”), at 3. Therefore, the Examiner’s omission is harmless error.

The Examiner finally rejected claims 21, 22, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman and Hills.¹¹ Final 8-9.

B. ISSUES¹²

Whether the Appellants have shown that the Examiner reversibly erred in rejecting claims 1, 2, 4, 5, 13, 14, 18-20, 23, and 24 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman.

Whether the Appellants have shown that the Examiner reversibly erred in rejecting claims 3 and 12 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Chen.

Whether the Appellants have shown that the Examiner reversibly erred in rejecting claims 8-11 and 15 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Angelopoulos.

Whether the Appellants have shown that the Examiner reversibly erred in rejecting claims 21, 22, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman and Hills.

C. FINDINGS OF FACT

The following findings of fact (FF) are supported by a preponderance of the evidence. Additional findings of fact as necessary appear in the Analysis portion of the opinion.

¹¹ US 6,217,786 B1 issued to Hills et al. on April 17, 2001 (“Hills”).

¹² The Appellants indicate that “dependent claims 2-5, 8-15, 19-20, and 23-34” are not argued separately. App. Br. 3. We note that claims 27-34 are not pending in this application, and the Appellants argue the patentability of claims 25 and 26 separately. *See* App. Br. 11-12. Therefore, it appears that “23-34” is a typographical error that should read “23-24.”

1. Claimed subject matter

1. Claims 1 and 18 are the only independent claims on appeal. App. Br. 14-18, Claims Appendix.
2. Claim 1 reads as follows:

A method for etching an inorganic dielectric layer through a photoresist mask with an ARC layer between the layer to be etched and the photoresist mask over a substrate, comprising:

- [1] placing the substrate into a processing chamber;
- [2] providing an ARC open gas mixture into the processing chamber, wherein the ARC open gas mixture comprises:
 - an etchant gas, and
 - a polymerization gas comprising CO and CH₃F;
- [3] forming an ARC open plasma from the ARC open gas mixture;
- [4] etching the ARC layer with the ARC open plasma until the ARC layer is opened;
- [5] stopping the ARC open gas mixture before the layer to be etched is completely etched; and
- [6] etching the inorganic dielectric layer.

App. Br. 14, Claims Appendix (paragraph numbering added).

3. Claim 18 reads as follows:

A method for forming a semiconductor device, comprising:

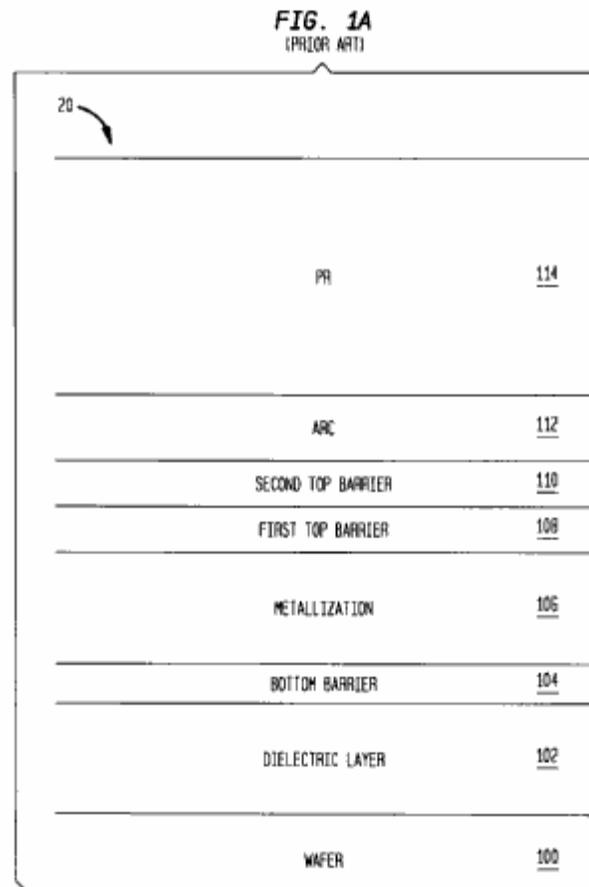
- [1] placing an inorganic dielectric layer to be etched over a substrate;
- [2] forming an organic ARC layer over the layer to be etched;
- [3] forming a photoresist mask over the ARC layer;
- [4] placing the substrate into a processing chamber;
- [5] providing an ARC open gas mixture into the processing chamber, wherein the ARC open gas mixture comprises:
 - an etchant gas; and
 - a polymerization gas comprising CO and CH₃F;
- [6] forming an ARC open plasma from the ARC open gas mixture;

- [7] etching the ARC layer with the ARC open plasma until the ARC layer is opened;
- [8] stopping the ARC open gas mixture, so that none of the layer to be etched is etched by the ARC open plasma;
- [9] providing an etch plasma different than the ARC open plasma; and
- [10] etching the inorganic dielectric layer to be etched with the etch plasma.

App. Br. 16-17, Claims Appendix (paragraph numbering added).

2. Naeem

- 4. Naeem discloses a method for etching through a selected portion of an integrated circuit (IC) layer stack in a plasma processing chamber. Naeem 1:6-11, 3:27-29.
- 5. Naeem Figure 1A illustrates a cross-section view of a layer stack, representing the layers that are formed during the fabrication of a typical semiconductor IC. Naeem 4:3-5. Figure 1A is reproduced below:



Naeem Figure 1A depicts an IC layer stack.

6. According to Naeem, the dielectric layer **102** is typically formed of silicon dioxide. Naeem 1:25-28.
7. In the first step of the disclosed method, etching is performed at least partially through the top barrier layer using a high-sputter component etch. This first high-sputter component etch is employed to “break through” the barrier layer(s) and is referred to as the break-through etch. Naeem 6:4-8.
8. In the context of Figure 1A, the top barrier layer comprises first and second top barrier layers **108** and **110**. Naeem 6:8-10.

9. According to Naeem, if ARC layer **112** is organic, it may be useful to break through this ARC layer first with gases such as N₂, Ar, O₂, CHF₃, CF₄, CH₃F, CO, CO₂, C₄F₈ and/or other suitable chemistry. Naeem 6:10-13.
10. In one embodiment, the high sputter component etch is terminated before the metallization layer is etched through. More preferably, the high sputter component break through etch is ended substantially as the barrier layer(s) is etched through. Naeem 7:13-17.
11. To etch through the remainder of the layer stack, a low sputter component main etch step is provided in accordance with one embodiment of the invention. Naeem 7:20-22.
12. Figure 3 shows layer stack **20** of Figure 1A after being etched into interconnect line **216** in accordance with the inventive etch technique. Naeem 8:25-27.
13. Naeem discloses that the inventive etch process may be performed using any suitable etch technique, such as reactive ion etching. Naeem 5:21-23.
14. Etchant source chemicals include, Cl₂ and BCl₃ when etching through aluminum or one of its alloys, as in the metallization layer. Other chlorine-based etchant chemicals may also be used, such as CH₄, HI, HBr, HCl, CHCl₃, which may be employed along with optional inert and/or nonreactive gases. Naeem 5:39-45, 1:41-43.

D. PRINCIPLES OF LAW

A claimed invention is not patentable if the subject matter of the invention would have been obvious to a person having ordinary skill in the art at the time the invention was made. 35 U.S.C. § 103(a); *KSR Int'l Co. v.*

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Teleflex Inc., 127 S. Ct. 1727, 1734 (2007); *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 13 (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 not an automaton but is a person of ordinary creativity. *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. *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).

During patent examination, the pending claims must be interpreted as broadly as their terms reasonably allow. The reason is simply that during patent prosecution when claims can be amended, ambiguities should be recognized, scope and breadth of language explored, and clarification imposed. *In re Zletz*, 893 F.2d 319, 321 (Fed. Cir. 1989).

The term “comprises” permits the inclusion of steps, elements, and materials not expressly recited in a claim. *In re Baxter*, 656 F.2d 679, 686 (CCPA 1981).

E. ANALYSIS

1. Claims 1, 2, 4, 5, 13, 14, 18-20, 23 and 24

The Examiner found that Naeem teaches steps [1]-[4] and [6] recited in claim 1 and steps [1]-[7], [9], and [10] recited in claim 18. Ans. 3-5.¹³ As for step [5] recited in claim 1 and step [8] recited in claim 18, we find that these steps are also taught or suggested by Naeem.

After the step of “etching the ARC layer with the ARC open plasma until the ARC layer is opened,”¹⁴ claim 18 recites the step of “stopping the ARC open gas mixture, so that none of the layer to be etched is etched by the ARC open plasma” (step [8]), and claim 1 recites the step of “stopping the ARC open gas mixture before the layer to be etched is completely etched” (step [5]). We interpret “the layer to be etched” as the dielectric layer.

As for step [8] in claim 18, we find that Naeem suggests that etching of the ARC layer with the ARC open plasma is completed before the dielectric layer is etched. *See, e.g.*, FF 7, 9-11. As for step [5] in claim 1, we likewise find that Naeem suggests that etching of the ARC layer with the ARC open plasma is completed before any portion of the dielectric layer is etched. *See, e.g.*, FF 7, 9-11. We note that claim 1 does not require any portion of the dielectric layer to be etched with the ARC open plasma.

The Appellants do not point to any error in the Examiner’s findings that Naeem teaches steps [1]-[4] recited in claim 1 and steps [2]-[7] and [9] recited in claim 18. Rather, the Appellants argue that Naeem does not teach or suggest “[a] method for etching an inorganic dielectric layer” or “etching the inorganic dielectric layer” (step [6]) as recited in claim 1. Similarly, the Appellants argue that Naeem does not teach or suggest “placing an inorganic

¹³ Examiner’s Answer mailed June 27, 2007.

¹⁴ Step [7] in claim 18 and step [4] in claim 1.

dielectric layer to be etched over a substrate” (step [1]) or “etching the inorganic dielectric layer to be etched with the etch plasma” (step [10]) as recited in claim 18. App. Br. 7.

The Appellants’ arguments are not persuasive. Naeem discloses a method for etching through a selected portion of an IC layer stack that includes the step of etching an inorganic dielectric layer with an etch plasma that is different than the ARC open plasma. *See, e.g.*, FF 6, 9, 11, 12, 14; Naeem Figure 3.

The Appellants also argue:

Naemm [*sic*, Naeem] describes altering the sputter in the etch from a high sputter to a low sputter prior to the metallization layer being penetrated. Col. 7, lines 4-20. Naemm’s [*sic*, Naeem’s] concern is the prevention of a high sputter during etching of the metallization layer. . . . Naemm [*sic*, Naeem] does not teach or suggest trying to protect an inorganic dielectric layer during the etch that penetrates the ARC layer, or any other etch for that matter, despite Naemm [*sic*, Naeem] clearly teaching a dielectric layer (see FIG. 1B). The presently claimed invention, on the other hand, describes a method for etching an inorganic dielectric layer, which is a process that does not occur in Naemm [*sic*, Naeem] until long after the inventive process in Naemm [*sic*, Naeem] is completed.

App. Br. 7-8.

According to the method disclosed in Naeem, the ARC layer is etched with an ARC open plasma until the ARC layer is opened or broken through. *See, e.g.*, FF 9. Subsequently, the inorganic dielectric layer is etched with an etch plasma that is different than the ARC open plasma. *See, e.g.*, FF 11, 12, 14. Although not expressly disclosed in Naeem, we find that the dielectric layer would be “protected” during at least the etch that penetrates the ARC layer.

Nonetheless, to the extent that Naeem may not be concerned about protecting the dielectric layer, the Appellants have failed to point to any step in the process of claim 1 or claim 18 that distinguishes the claimed process from the process disclosed in Naeem. *See In re Hiniker Co.*, 150 F.3d 1362, 1369 (Fed. Cir. 1998) (“the name of the game is the claim”).

For the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claims 1 and 18 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman.¹⁵

The Appellants argue that claims 2, 4, 5, 13, 14, and 20, as well as claim 19, are allowable for the same reasons that the claims from which they depend, claims 1 and 18, respectively, are allowable. App. Br. 8. The Appellants do not otherwise dispute the Examiner’s findings or conclusion of obviousness as to claims 2, 4, 5, 13, 14, 19, and 20.

The Appellants have also indicated that dependent claims 19, 23, and 24 are not argued separately. App. Br. 3.

For the reasons set for the above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claims 1 and 18 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman. Therefore, the Appellants have likewise failed to show that the Examiner reversibly erred in rejecting claims 2, 4, 5, 13, 14, 19, 20, 23, and 24 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman.

¹⁵ It is not necessary to address the Appellants’ arguments with respect to Hineman since the teachings of Naeem alone render the claimed method unpatentable. *See In re Fracalossi*, 681 F.2d 792, 794 (CCPA 1982) (“lack of novelty is the ultimate of obviousness”).

2. Claims 3 and 12

The Appellants indicate that claims 3 and 12 are not argued separately from claim 1. App. Br. 9.

For the reasons set for the above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claim 1 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman. Therefore, the Appellants have likewise failed to show that the Examiner reversibly erred in rejecting claims 3 and 12 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Chen.

3. Claims 8-11

The Appellants indicate that claims 8-11 are not argued separately from claim 1. App. Br. 3, 9.

For the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claim 1 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman. Therefore, the Appellants have likewise failed to show that the Examiner reversibly erred in rejecting claims 8-11 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Angelopoulos.

4. Claim 15

The Appellants argue that the Examiner has failed to provide any basis for the rejection of claim 15. Therefore, the Appellants argue that claim 15 is in condition for allowance. App. Br. 12; *but see* App. Br. 3 (dependent claim 15 is not argued separately from independent claim 1).

In the Final Office Action, the Examiner found that the combination of Naeem and Hineman does not teach the limitations of claim 15. Final 6. The Examiner found that “Angelopoulos illustrates that an ARC of an

organic material having a photoresist mask of 193 nm or higher and the layer to be etching [*sic*, etched] is silicon oxide is known.” Final 7; *see also* Ans. 7-8.

The Appellants have not directed us to any error in these findings. Therefore, the Appellants have not shown that the Examiner reversibly erred in rejecting claim 15 under 35 U.S.C. § 103(a) as unpatentable over Naeem, Hineman, and Angelopoulos.

5. Claim 21

Claim 21 reads as follows:

The method, as recited in claim 1, wherein said substrate sits atop a lower electrode providing power of 0-1000 Watts at 27 MHz and 100-1000 Watts at 2 MHz.

App. Br. 17, Claims Appendix.

The Examiner found that the combined teachings of Naeem and Hineman do not teach providing power of 0-1000 Watts at 27 MHz and 100-1000 Watts at 2 MHz. Ans. 8. The Examiner, however, found that Hills discloses a bottom electrode frequency of 1-4 MHz, with 2 MHz being exemplary, and a bottom power of 0-2500 Watts at 2 MHz. Ans. 9.

The Appellants recognize that Hills discloses operating the bottom electrode at a frequency of 1-4 MHz. Nonetheless, the Appellants argue that Hills fails to teach or suggest a lower electrode providing power of 0-1000 Watts at 27 MHz. App. Br. 10.

We determine that 0-1000 Watts is a range of power at 27 MHz. *See* Spec. 9-10, Table 1 (specifying a range of power of 0-1000 Watts, 0-500 Watts, and 0-200 Watts at 27 MHz). This range includes no power, i.e., 0 Watts, at 27 MHz. *See* Spec. 7:23-24 (in one example, “[t]he power provided by the lower electrode is 0 Watts at 27 MHz and 600 Watts at 2

MHz.”). Thus, the method of claim 21 includes a lower electrode that provides no power at 27 MHz. For this reason, we find that the teachings of Hills satisfy the limitations of claim 21. *See* Ans. 16 (Hills discloses a bottom power within a range of 0-2500 Watts at 2 MHz which suggests as well as comprises Appellants’ power at 0 Watts).

The Appellants have failed to show that the Examiner reversibly erred in rejecting claim 21 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Hills.

6. Claim 22

Claim 22 reads as follows:

The method, as recited in claim 21, wherein the temperature within said chamber is between -20 degrees and 40 degrees C.

App. Br. 17, Claims Appendix.

The Examiner found that the combined teachings of Naeem and Hineman do not teach that the temperature within the chamber is between -20° and 40°C. Ans. 8. The Examiner, however, found that Hills discloses a top electrode temperature of 0-60°C and an electrostatic chuck temperature of -20-40°C. Ans. 9; *see also* Naeem, Tables 1, 2, and 3.

The Appellants agree that Hills discloses a temperature within the claimed range during etching of an inorganic dielectric layer. The Appellants, however, argue that Hills does not teach a temperature within the claimed range during etching of the ARC layer. App. Br. 10.

Neither claim 22, nor any of the claims from which it depends, identifies when, during the claimed method, the temperature of the chamber must be within the range recited in claim 22. The Appellants argue that “[t]he wording of claim 22 implies that the temperature is kept within the

desired range for each of the steps performed in claim 1, not just the final step.” App. Br. 10. We disagree. Interpreting claim 22 as broadly as its terms reasonably allow, we conclude that claim 22 does not require the chamber temperature to be within the claimed range during etching of the ARC layer. *See Zletz*, 893 F.2d at 321.

For the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claim 22 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Hills.

7. Claims 25 and 26

Claim 25 reads as follows:

The method of claim 1, further comprising:
setting the pressure within said processing chamber at between
200 and 300 mTorr.

App. Br. 18, Claims Appendix.

Claim 26 depends from claim 18 and also recites “setting the pressure within said processing chamber at between 200 and 300 mTorr.” App. Br. 18, Claims Appendix.

The Examiner found that the combined teachings of Naeem and Hineman do not teach setting the pressure within the processing chamber at between 200 and 300 mTorr. The Examiner, however, found that Hills discloses a chamber pressure between 10 and 250 mTorr. Ans. 9.

The Appellants agree that Hills discloses pressures within the claimed range during etching of an inorganic dielectric layer. The Appellants, however, argue that Hills does not teach a chamber pressure within the claimed range during etching of the ARC layer. App. Br. 11.

None of claims 1, 18, 25, or 26 identify when, during the claimed method, the pressure within the chamber must be within the range recited in claims 25 and 26. The Appellants argue that “[t]he wording of claims 25 and 26 implies that the pressure is kept within the desired range for each of the steps performed in claims 1 and 18, respectively, not just the final step.” App. Br. 11. We disagree. Interpreting claims 25 and 26 as broadly as their terms reasonably allow, we conclude that claims 25 and 26 do not require the chamber pressure to be within the claimed range during etching of the ARC layer. *See Zletz*, 893 F.2d at 321.

For the reasons set forth above, the Appellants have failed to show that the Examiner reversibly erred in rejecting claims 25 and 26 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Hills.

8. Improper Final Office Action

The Appellants argue that the Office Action mailed August 24, 2006, was improperly made final. Reply Br. 3¹⁶; *see also* App. Br. 6-7. This matter is petitionable rather than appealable. *See* MPEP § 1002.02(c) (8th ed., Rev. 5, Aug. 2006). Thus, the matter is not properly decided in this appeal.

F. DECISION

The rejection of claims 1, 2, 4, 5, 13, 14, 18-20, 23, and 24 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem and Hineman is affirmed.

¹⁶ Reply Brief dated August 23, 2007.

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The rejection of claims 3 and 12 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Chen is affirmed.

The rejection of claims 8-11 and 15 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman, and Angelopoulos is affirmed.

The rejection of claims 21, 22, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combination of Naeem, Hineman and Hills 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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BEYER LAW GROUP LLP
P.O. BOX 1687
CUPERTINO, CA 95015-1687