

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* PEIJUN DING, TONY CHIANG,  
TSE-YONG YAO, and BARRY CHIN

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Appeal 2007-4036  
Application 10/931,865  
Technology Center 1700

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Decided: May 8, 2008

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Before THOMAS A. WALTZ, PETER F. KRATZ, and  
JEFFREY T. SMITH, *Administrative Patent Judges*.

KRATZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal from the Examiner's final rejection of claims 1-4, 6-8, 10, 15, 19-22, 24-27, 31, and 34-52. We have jurisdiction pursuant to 35 U.S.C. § 6.

Appellants' invention is directed to a method wherein a copper seed layer is deposited over surfaces outlining an interconnect structure on a substrate followed by a metal electroplating step to fill the interconnect structure. Barrier layers can be deposited prior to the seed layer deposition step. The seed layer deposition is conducted so as to minimize sidewall coverage and maximize bottom coverage of the interconnect structure.

Claim 41 is illustrative and reproduced below:

41. A method for filling an interconnect structure on a substrate, comprising:

providing a substrate comprising surfaces outlining an interconnect structure, wherein the surfaces comprise a sidewalls portion and a bottom portion;

depositing a copper seed layer over the surfaces, wherein the seed layer deposition is minimized on the sidewalls portion and maximized on the bottom portion; and

electroplating a metal to fill the interconnect structure.

The Examiner relies on the following prior art references as evidence in rejecting the appealed claims:

Min	5,487,923	Jan. 30, 1996
Foster	5,610,106	Mar. 11, 1997
Chiang	WO 98/54377	Dec. 3, 1988
Rathore	6,069,068	May 30, 2000
Iacoponi	6,150,268	Nov. 21, 2000
Cooney, III	6,339,258	Jan. 15, 2002
Hautala	6,410,432	Jun. 25, 2002

Nichols et al., "Ionized physical vapor deposition of Co for high aspect ration damascene trench fill applications," J. Vac. Sci. Technol. B 14(5), Sep/Oct 1996, pp. 3270-3275.

The appealed claims stand rejected as follows: I. Claims 1, 20, 22, and 46-52 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Cooney, III in view of Foster, Rathore, and Nichols; II. Claims 2-4, 6-8, 10, 15, 19, 21, 24-27, 31, 34, and 35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Cooney, III in view of Foster, Rathore, Nichols, and Chiang; III. Claims 36 and 37 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Iacononi in view of Hautala, Min, Rathore, and Nichols;<sup>1</sup> IV. Claims 38-40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Iacononi in view of Hautala, Min, Rathore, Nichols, and Chiang; and V. Claims 41-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Rathore in view of Nichols.

We affirm the Examiner's rejections for substantially the reasons set forth by the Examiner in the Answer, which we adopt and incorporate herein, and as further explained below.

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) any secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). “[A]nalysis [of whether the subject matter of a claim is obvious] need not seek out precise teachings

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<sup>1</sup> The first sentence statement of the rejection of claims 36 and 37 does not list Rathore or Nichols as evidence (Final Office Action 9; Ans. 9). However, the Examiner employed these references in the body of the aforementioned rejection in rejecting the involved claims (Final Office Action 10-11; Ans. 10-11). Moreover, Appellants presented an argument against the rejection on the basis that Rathore and Nichol were being applied to claims 36 and 37 by the Examiner (Response to Final Office Action 12; App. Br. 17-18). Thus, the Examiner's omission represents harmless error.

directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR Int’l Co. Teleflex, Inc.*, 127 S. Ct. 1727, 1741 (2007). See *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1361 (Fed. Cir. 2006)(“The motivation need not be found in the references sought to be combined, but may be found in any number of sources, including common knowledge, the prior art as a whole, or the nature of the problem itself.”). The analysis supporting obviousness, however, should be made explicit and should “identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements” in the manner claimed. *KSR*, 127 S. Ct. at 1741. “The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” *KSR*, 127 S. Ct. at 1739.

Starting with the Examiner’s obviousness rejection of claims 41-45 over Rathore in view of Nichols (Rejection V.), we note that Appellants argue these commonly rejected claims as a group. Hence, we select claim 41 as the representative claim, on which we shall decide this appeal as to this ground of rejection with respect to claims 41-45.

Appellants do not dispute the Examiner’s determination that Rathore discloses a method for filling a substrate interconnect structure wherein a copper seed layer is deposited over side and bottom surfaces outlining an interconnect structure followed by metal (copper) electroplating (Ans. 13; App. Br. 21, Reply Br. 4 and 5; Rathore, Abstract, col. 1, l. 66-col. 3, l. 61, col. 7, l. 4-col. 8, l. 62, col. 10, ll. 54-59, and col. 11, ll. 5-8 and 24-31). Indeed, Appellants acknowledge that physical vapor deposition of a seed

layer of a metal, such as copper, followed by copper deposition via electroplating to metallize an interconnect structure is a technique known in the prior art (Specification 4-5; Figs. 1A-1E).<sup>2</sup> Rather, Appellants maintain that Rathore discloses the deposition of a copper seed layer that appears to be of uniform thickness on the trench side walls and bottom but does not suggest minimizing the deposition of seed layer on the trench sidewalls and maximizing the seed layer deposition on the trench bottom.

Appellants acknowledge that Nichols discloses directional filling of an interconnect feature with copper, which may effect the resistivity of the interconnect. However, Appellants contend that Nichols does not teach or suggest a method wherein copper seed layer is deposited and deposition of seed layer is minimized on the sidewalls and maximized on the bottom portion of an interconnect structure. Thus, Appellants urge that the Examiner's proposed combination of the teachings of Rathore and Nichols do not teach or suggest all of the limitations of rejected claims 41-45; that is, the argued seed layer depositing step wherein the seed layer deposition is minimized on sidewall portions of an interconnect structure and maximized on the bottom portion of such a structure.

We are not persuaded of reversible error in the Examiner's obviousness rejection by these arguments, as furnished in the Briefs. In particular, Rathore discloses that a thin or reduced thickness seed layer is

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<sup>2</sup> It is axiomatic that admitted prior art in an Applicants' Specification may be used in determining the patentability of a claimed invention and that consideration of the prior art cited by the Examiner may include consideration of the admitted prior art found in an Applicants' Specification. *In re Nomiya*, 509 F.2d 566, 570-571 (CCPA 1975); *In re Davis*, 305 F.2d 501, 503 (CCPA 1962); *In re Hedges*, 783 F.2d 1038, 1039-1040 (Fed. Cir. 1986).

deposited when the interconnect structure or lines have small or narrow dimensions to avoid further narrowing down the opening for the subsequent copper filling operation via electroplating (Rathore, col. 2, ll. 3-29, col. 4, ll. 6-13, col. 5, ll. 51-65, and col. 11, ll. 5-15 and 26-36). In other words, the copper seed layer is deposited in a fashion so as to minimize the deposition of the seed layer on the sidewall portions of the interconnect structure so as not to block lower portions of the interconnect opening to avoid a hollow or unfilled portion. In this regard, we further note that representative claim 41 does not require any particular thickness of seed layer to be deposited on the sidewall portions and the bottom portions of the interconnect construction, much less a non-uniform deposit, by the relative claim terminology minimized and maximized, as employed. In this regard, the subject Specification does not furnish an explicit definition for these claim terms.

After all, during prosecution of a patent application, the claims therein are given the broadest reasonable interpretation consistent with the Specification as it would be understood by one of ordinary skill in the art. *Gechter v. Davidson*, 116 F.3d 1454, 1457, 1460 n.3 (Fed. Cir. 1997); *In re Zletz*, 893 F.2d 319, 321-22 (Fed. Cir. 1989). As pointed out by the court in *In re Morris*, 127 F.3d 1048, 1056 (Fed. Cir. 1997):

Absent an express definition in their specification, the fact that appellants can point to definitions or usages that conform to their interpretation does not make the PTO's definition unreasonable when the PTO can point to other sources that support their interpretation.

Thus, Rathore, in carrying out a thin PVD or CVD seed layer deposit of copper on the sidewalls can be said to be maximizing the bottom deposit

while minimizing the narrowing down of the interconnect opening, that is minimizing the deposit on sidewalls, as broadly recited in claim 41.

Moreover, to the extent that representative claim 41 may be considered to require a thinner deposit of seed layer on sidewall portions than on a bottom portion of an interconnect structure, we agree with the Examiner that it would have been prima facie obvious for one of ordinary skill in the art to employ a directional filling method, such as the HDP-PVD method of Nichols (compare Appellants' dependent claim 45), for depositing the copper seed layer in the interconnect structure of Rathore in such a fashion to obtain the benefits of the lower resistivity of such a technique for depositing the seed layer as suggested by Nichols. In addition, we have no doubt that Nichols' directional copper deposition technique would have been recognized by one of ordinary skill in the art as an available copper deposition method for depositing the copper seed layer of Rathore in a manner that would keep a small-dimensioned interconnect structure opening available (not considerably narrowed or clogged) for subsequent deposit of the electroplating copper as discussed above and in Rathore. In this regard, Appellants' argument with respect to whether Nichols, by itself, suggests using directional deposition for a copper seed layer is not persuasive for reasons set forth by the Examiner in the Answer (Ans. 23 and 24). Moreover, the rejection is not over Nichols alone, but rather the combination of Rathore and Nichols, as discussed above and in the Answer. Thus, the record reflects that ample suggestion and a reasonable expectation of success is present in the prior art teachings that would have directed one of ordinary skill in the art to combine the teachings of Rathore

and Nichols so as to result in the here-claimed method, as proposed by the Examiner in the Answer.

On this record, we affirm the Examiner's obviousness rejection of claims 41 through 45.

Appellants make substantially the same arguments for each of the other grounds of rejection maintained by the Examiner, each of these other grounds includes Rathore and Nichols among the references relied upon in rejecting the claims subject to each respective ground of rejection. Moreover, Appellants argue the claims subject to each separate ground of rejection, as a group. Thus, we select claim 46, as the representative claim on which we decide this appeal as to Rejection I, claim 6, as the representative claim on which we decide this appeal as to Rejection II, claim 36, as the representative claim on which we decide this appeal as to Rejection III, and claim 38 as the representative claim on which we decide this appeal as to Rejection IV.

Concerning Rejection I and the Examiner's application of Cooney III, Foster, Rathore and Nichols therein, we observe that Appellants do not dispute that the applied references teach or suggest a method corresponding to the representative claim 46 method including the formation of a barrier layer as claimed, but for the representative claim 46 requirement for a seed layer deposition step that includes deposition being minimized on sidewall portions of an interconnect structure and maximized on the bottom portion of such a structure. For the reasons set forth above and in the Answer, however, these arguments are not persuasive in light of the teachings of Rathore and Nichols, which teachings reasonably suggest such a metal (copper) seed layer deposition technique followed by copper electroplating

that would be useful in forming the copper metallization of the interconnect of Cooney III.

Accordingly, we shall affirm the Examiner's obviousness rejection of claims 1, 20, 22, and 46-52 over Cooney, III in view of Foster, Rathore, and Nichols.

Similarly, for Rejection II and the Examiner's application of Cooney III, Foster, Rathore and Nichols therein as set forth in Rejection I together with the additional teachings of Chiang, we observe that Appellants do not dispute that the applied references teach or suggest a method corresponding to the representative claim 6 method including the formation of the required first and second barrier layers as claimed, but for the representative claim 6 requirement for a copper seed layer deposition step that includes deposition being minimized on sidewall portions of an interconnect structure and maximized on the bottom portion of such a structure prior to electroplating copper to fill the interconnect structure. For the reasons set forth above and in the Answer, however, these arguments are not persuasive in light of the teachings of Rathore and Nichols, which teachings reasonably suggest such a metal (copper) seed layer deposition technique followed by copper electroplating that would be useful in forming the copper metallization of the interconnect of Cooney III.

It follows that we shall affirm the Examiner's obviousness rejection of claims 2-4, 6-8, 10, 15, 19, 21, 24-27, 31, 34, and 35 over Cooney, III in view of Foster, Rathore, Nichols, and Chiang.

Also, for Rejection III and the Examiner's application of Iacoponi, Hautala, Min, Rathore, and Nichols therein, we observe that Appellants do not dispute that the applied references teach or suggest a method

corresponding to the representative claim 36 method including the formation of the required first and second barrier layers thereof, but for the representative claim 36 requirement for a copper seed layer deposition step that includes deposition being minimized on sidewall portions of an interconnect structure and maximized on the bottom portion of such a structures high conductance barrier layer prior to electroplating copper to fill the interconnect structure. For the reasons set forth above and in the Answer, however, these arguments are not persuasive in light of the teachings of Rathore and Nichols, which teachings reasonably suggest such a metal (copper) seed layer deposition technique followed by copper electroplating, which steps would have been recognized as advantageous and obvious to employ to one of ordinary skill in the art in forming the copper conductive metallization layers that overlay the barrier layers of the interconnect (channels and vias) of Iacoponi for reasons stated above and in the Answer.

Thus, we affirm the Examiner's separate obviousness rejection of claims 36 and 37, on this record.

Finally, for Rejection IV and the Examiner's application of Iacoponi, Hautala, Min, Rathore, and Nichols therein as set forth in Rejection III together with the additional teachings of Chiang, we observe that Appellants do not dispute that the applied references teach or suggest a method corresponding to the representative claim 38 method including the formation of the required first and second barrier layers thereof, but for the representative claim 38 requirement for a copper seed layer deposition step that includes deposition being minimized on sidewall portions of an interconnect structure and maximized on the bottom portion of such a

structures high conductance barrier layer prior to electroplating copper to fill the interconnect structure. For the reasons set forth above and in the Answer, however, these arguments are not persuasive in light of the teachings of Rathore and Nichols, which teachings reasonably suggest such a metal (copper) seed layer deposition technique followed by copper electroplating, which steps would have been recognized as advantageous and obvious to employ to one of ordinary skill in the art in forming the copper conductive metallization layer(s) that overlay the barrier layers of the interconnect (channels and vias) of Iacoponi for reasons stated above and in the Answer.

Therefore, we affirm the Examiner's separate obviousness rejection of claims 38-40, on this record.

#### ORDER

The Examiner's decision to reject claims 1, 20, 22, and 46-52 under 35 U.S.C. § 103(a) as being unpatentable over Cooney, III in view of Foster, Rathore, and Nichols; to reject claims 2-4, 6-8, 10, 15, 19, 21, 24-27, 31, 34, and 35 under 35 U.S.C. § 103(a) as being unpatentable over Cooney, III in view of Foster, Rathore, Nichols, and Chiang; to reject claims 36 and 37 under 35 U.S.C. § 103(a) as being unpatentable over Iacoponi in view of Hautala, Min, Rathore, and Nichols; to reject claims 38-40 under 35 U.S.C. § 103(a) as being unpatentable over Iacoponi in view of Hautala, Min, Rathore, Nichols, and Chiang; and to reject claims 41-45 under 35 U.S.C. § 103(a) as being unpatentable over Rathore in view of Nichols is affirmed.

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No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

PL Initial:  
sld

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