

The opinion in support of the decision being entered today
is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte KIE Y. AHN and LEONARD FORBES

Appeal 2007-1295
Application 10/109,713
Technology Center 2800

Decided: July 30, 2007

Before BRADLEY R. GARRIS, THOMAS A. WALTZ, and
JEFFREY T. SMITH, *Administrative Patent Judges*.

SMITH, *Administrative Patent Judge*.

DECISION ON APPEAL

Statement of the Case

This is an appeal under 35 U.S.C. § 134 from a final rejection of claims 31-45. We have jurisdiction under 35 U.S.C. § 6.

Appellants' invention relates to the field of semiconductors and, in particular, to a copper damascene structure. Representative independent claim 31, as presented in the Brief, appears below:

31. A dual damascene structure comprising:

- a substrate;
- a metal layer provided within said substrate;
- a methylsilsequiazane layer located over said substrate;
- a via situated within said methylsilsequiazane layer and extending to at least a portion of said metal layer, said via being lined with a tungsten nitride layer and filled with a copper material; and
- a trench situated within said methylsilsequiazane layer and extending to said via, said trench being lined with said tungsten nitride layer and filled with said copper material.

The Examiner relies on the following references in rejecting the appealed subject matter:

Chen	US 6,352,938 B2	Mar. 5, 2002
Lopatin	US 6,368,954 B1	Apr. 9, 2002
Farrar	US 6,395,632 B1	May 28, 2002

T. Kikkawa, *Current and Future Low-K Dielectrics for Cu Interconnects,*" IEDM Tech. Digest, 253-256 (2000).

J.W. Klaus, S.J. Ferro, and S. M. George, *Atomic Layer Deposition of Tungsten Nitride Films Using Sequential Surface Reactions*, Journal of the Electrochemical Society, 2000, 147, no. 3, 1175-1181 (2000).

Claims 31-43 stand rejected under 35 U.S.C. § 103 as unpatentable over Chen in view of Lopatin and the "Admitted Prior Art" or Kikkawa; claims 34 and 40 stand rejected under 35 U.S.C. § 103 as unpatentable over of Lopatin et al. and the "Admitted Prior Art" or Kikkawa, further in view of Klaus; and claims 44 and 45 stand rejected under 35 U.S.C. § 103 as unpatentable over of Lopatin and the "Admitted Prior Art" or Kikkawa, further in view of Farrar or the "Admitted Prior Art."

The issue presented for review is as follows:

Has the Examiner reasonably determined that a person having ordinary skill in the art would have been led to form a dual damascene structure comprising a substrate having a metal layer provided within the substrate, a methylsilsequiazane layer located over the substrate and a via situated within the methylsilsequiazane layer and lined with a tungsten nitride layer and filled with a copper material within the meaning of 35 U.S.C. § 103? On this record, we answer this question in the affirmative.

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) secondary considerations (e.g., the problem solved). *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17-18, 148 USPQ 459, 467(1966). “[A]nalysis [of whether the subject matter of a claim is obvious] need not seek out precise teachings 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. v. Teleflex, Inc.*, 127 S. Ct. 1727, 1740-41, 82 USPQ2d 1385, 1396 (2007) quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336-37 (Fed. Cir. 2006); see also *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1361, 80 USPQ2d 1641, 1645 (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.”); *In re Bozek*, 416 F.2d 1385, 1390, 163 USPQ 545, 549 (CCPA 1969)(“Having established that this

knowledge was in the art, the examiner could then properly rely, as put forth by the solicitor, on a conclusion of obviousness ‘from common knowledge and common sense of the person of ordinary skill in the art without any specific hint or suggestion in a particular reference.’’’); *In re Hoeschele*, 406 F.2d 1403, 1406-07, 160 USPQ 809, 811-812 (CCPA 1969) (“[I]t is proper to take into account not only specific teachings of the references but also the inferences which one skilled in the art would reasonably be expected to draw therefrom...’’). 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 art to combine the elements” in the manner claimed. *KSR*, 127 S.Ct. at 1731, 82 USPQ2d at 1389.

As evidence of obviousness of the claimed subject matter under § 103, the Examiner has relied on the disclosures of Chen in view of Lopatin, the APA and Kikkawa (Answer 3-6).

Chen teaches forming low dielectric layer 204 on copper line 202, forming dual damascene including barrier 212 and copper 214/216. (See col. 3, l. 32 to col. 5, l. 35 and Fig. 2D). Chen discloses the barrier layer 212 is formed using a material that can prevent copper atoms from diffusing into the inter-metal dielectric layer 204 (Col. 3, ll. 47-51). Chen does not describe the use of methylsilsesquiazane as dielectric material and tungsten nitride as the barrier layer.

Lopatin describes an improved interconnect structure including improved barrier and seed layers as well as the method of forming these structures and layers to overcome recognized drawbacks existing in the processing of copper interconnect formation. These drawbacks include difficulties in forming seed and barrier layers in vias and trenches having

high aspect ratios (i.e., deep trenches having narrow trench widths), poor step coverage (non-uniform surface coverage), and void formation in the barrier, seed, and bulk interconnect layers of the damascened process (col. 2, ll. 52-65).

Lopatin teaches the interconnect structure comprising a tungsten nitride barrier layer 401, formed using atomic layer deposition (ALD), which has excellent step coverage and adhesion characteristics to the underlying low dielectric constant layer (col. 5, ll. 19-40). Lopatin discloses that typically, the ALD process is performed using a Chemical Vapor Deposition (CVD) process tool (col. 4, ll. 32-34).

Kikkawa describes multilevel Cu interconnect including a methylsilsesquiazane (MSZ) layer having a low dielectric constant. MSZ is disclosed to be directly patterned by use of electron beam lithograph or ultraviolet lithography. This lithography permits a small feature size of 50 nm for damascene lines and provides that via holes could be directly patterned without using photoresist and dry etching for interlayer dielectric formation (See p. 253, left column, p. 254, third paragraph).

APA, specification page 8, line 13 to page 9, line 11, teaches the low k dielectric constant material, methylsilsesquiazane (MSZ), which can be conveniently patterned by direct patterning, e.g., by direct EB or UV lithography. Thus, need for using a photoresist and dry etching is eliminated. Appellants assert that the teaching of the APA is the same as Kikkawa (Br. 11).

The Examiner concluded that

“it would have been obvious to one skilled in the art in practicing the Chen invention to have employed the suitable and conventional low-k dielectric materials including MSZ since such is conventional and advantageous as evidenced by APA or Kikkawa wherein the use of MSZ as the low dielectric constant films would have been advantageous in eliminating photoresist coating, dry etching and etchstop layer as delineated in the instant specification page 8 lines 18-20 and as in Kikkawa as delineated above. It would have been obvious to one skilled in the art to have ALD tungsten nitride as the barrier material since such would have good step coverage and adhesion characteristics as taught by Lopatin. The selection of desired and suitable layer thicknesses for the dielectric and nitride barrier is matter of routine optimization well within the purview of one skilled in the art and as such would have been obvious”

(Answer 4-5).

Appellants contend that a person of ordinary skill in the art would not have been motivated to combine Chen, which teaches photoresist removal employing a specific chemistry, with Lopatin, which teaches an ALD/ALE process for copper structure formation (Br. 9).

We do not agree. As stated above, Lopatin describes an improved interconnect structure including improved barrier and seed layers as well as the method of forming these structures and layers to overcome recognized drawbacks existing in the processing of copper interconnect formation. Thus, a person of ordinary skill in the art would have used the process of Lopatin for copper structure formation to overcome the drawbacks recognized in the art. A person of ordinary skill in the art would have

reasonably expected that the process as disclosed by the prior art would have been suitable for the formation of damascene structures.

Appellants contend a person skilled in the art would not have been motivated to combine the teachings of Chen and Lopatin with Kikkawa because Kikkawa teaches the direct patterning of MSZ, without using photoresist and dryetching (See Kikkawa at 2). (Br. 9).

Appellants' contention is not persuasive. As acknowledged by Appellants (Br. 9-10), Kikkawa specifically emphasizes that direct patterning of low-k dielectric films is one of the most promising solutions for reducing the process cost of future Cu interconnects" (Kikkawa at 2). Thus, a person of ordinary skill in the art would have used the process of Kikkawa to gain the advantages disclosed therein. Further, a person of ordinary skill in the art would have recognized that MSZ could serve as the barrier layer as disclosed by Kikkawa (Kikkawa at 2).

Claims 34 and 40 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Chen, Lopatin and APA or Kikkawa as applied to claims 31-43 above, and further in view of Klaus.

The Examiner contends that sequential ALD tungsten nitride would have been obvious over the teachings of over Chen taken with Lopatin and APA or Kikkawa, and alternatively, such would have been further obvious over the teaching of Klaus. According to the Examiner, Klaus describes the application of tungsten nitride using sequential ALD (Answer 5).

Appellants contend that a person of ordinary skill in the art would also not have been motivated to combine the references because of the specific chemistry of each reference (Br. 12).

This is the same contention that Appellants raised in the discussion of the previous rejection. As previously discussed, the Lopatin and APA, Kikkawa references described advances in the formation of damascene structures. This is also the case for the Klaus reference. As previously stated, a person of ordinary skill in the art would have viewed the techniques of the identified prior art references to obtain the advances described therein. A person of ordinary skill in the art would have reasonably expected that the process as disclosed by the prior art would have been suitable for the formation of damascene structures.

Claims 44 and 45 stand rejected under 35 U.S.C. §103(a) as unpatentable over Chen, Lopatin and the APA or Kikkawa and further in view of Farrar or the APA (Specification 14, l. 23 to p. 15, l. 3).

The Examiner cites the APA and the Farrar reference as evidence that it was conventional to couple a damascene structure and an integrated circuit with a processor (Answer 6).

Appellants' argument, Br. 14, regarding the suitability of the Farrar reference as appropriate prior art is noted. The Examiner relied on this reference as further evidence of the position that the APA described that it was known to incorporate damascene structures into integrated circuits. Even assuming the Appellants' argument is correct, the exclusion of this reference from the rejection does not detract from the Examiner's position that a person of ordinary skill in the art would have recognized that damascene structures could be incorporated into integrated circuits. In fact, Lopatin describes, in the Background of the Invention portion of the patent, the suitability of incorporating damascene structures in circuit patterns (See columns 1-2).

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As a final point with respect to the § 103 rejections, we note that Appellants base no argument upon objective evidence of nonobviousness, such as unexpected results.

ORDER

The Examiner's rejection of claims 31-45 under 35 U.S.C. § 103(a) is affirmed.

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)(2006).

AFFIRMED

TLC/lS

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