UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte CHIH-I WU
and JIHPERNG LEU

Appeal 2008-5338
Application 10/948,046
Technology Center 1700

Decided: December 12, 2008

Before CHARLES F. WARREN, THOMAS A. WALTZ, and CATHERINE Q. TIMM, *Administrative Patent Judges*.

TIMM, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 13-17 and 20-26. We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

STATEMENT OF THE CASE

The invention relates to a microelectronic structure having a dielectric layer, a conductive layer, and a barrier layer disposed only upon the conductive layer and not upon the dielectric layer. In this way, the interface between the dielectric layer and a second dielectric layer is not interrupted by the barrier layer. (Spec. 6, ll. 4-7). Claim 13 is illustrative of the subject matter on appeal:

13. A microelectronic structure comprising:

a first dielectric layer and a conductive layer on a substrate layer, wherein the first dielectric layer comprises a material lacking available negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride; and

a barrier layer disposed only upon the conductive layer and not upon the first dielectric layer, the barrier layer having atomic-level thickness uniformity.

Appellants request review of the sole rejection maintained by the Examiner, namely the rejection of claims 13-17 and 20-26 under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 6,391,785 B1, issued May 21, 2002, to Satta et al. (hereinafter "Satta").

Since no claims are argued separately from the others, we decide this Appeal on the basis of representative independent claim 13. *See* 37 C.F.R. § 41.37(c)(1)(vii) ("When multiple claims subject to the same ground of rejection are argued as a group by appellant, the Board may select a single claim from the group of claims that are argued together to decide the appeal with respect to the group of claims as to the ground of rejection on the basis of the selected claim alone.").

I. FIRST ISSUES

A. ISSUES ON APPEAL

The first issues for our consideration in this case are: (1) have Appellants shown that the Examiner reversibly erred in finding that Satta would have suggested to one of ordinary skill in the art a barrier layer deposited onto a conductive layer and not a dielectric layer, as required by claim 13, or (2) have Appellants sufficiently shown that Satta teaches away from such a structure?

B. FACTUAL FINDINGS

The following Findings of Fact (FF) are directed to the above identified issues on appeal:

1. Conductive layer materials such as copper were known to diffuse or electromigrate into adjacent layers and negatively affect properties. (Spec. 3, ll. 8-10; Satta, col. 1, ll. 43-45).

2. Those of ordinary skill in the art routinely deposited a barrier layer non-selectively, i.e., blanketing all exposed surfaces of the substrate, to inhibit ions from diffusing from the conductive layer. (Satta, col. 1, ll. 45-53 and Fig. 1; Spec. 5, ll. 9-12 and Fig. 1).

3. Satta describes an improvement over the blanket coverage method of the prior art. (Satta, col. 1, l. 51 to col. 2, l. 41).

4. The Satta method involves selectively depositing a barrier layer over a first surface while leaving a second surface of different material exposed. (Satta, col. 2, ll. 37-41).

5. Selective deposition is accomplished by conditioning the layer to be covered to make it susceptible to an atomic layer deposition (ALD) process. (Satta, col. 4, ll. 6-15).

6. As stated by Satta, "[t]he invention has particular utility for depositing selectively on one of insulating and conductive materials, as compared to the other of insulating and conductive materials." (Satta, col. 4, ll. 23-28).

7. The preferred embodiments of Satta are directed to selectively depositing the barrier layer on dielectric layer surfaces and, in particular, on the dielectric sidewalls of an opening to be filled with conductive material. (Satta, col. 2, ll. 46-57 and Fig. 2).

8. In Satta's device, the barrier layer (26) positioned on the sidewalls functions to prevent the metal in the conductive layer (18) from diffusing into the dielectric layer. (Satta, col. 2, ll. 46-57 and col. 4, ll. 54-59).

9. According to Appellants' Specification, it was known in the prior art to place a barrier layer over the top surface of a conductive layer. (Spec. 5, ll. 9-12 and Fig. 1).

10. The barrier layer of the prior art discussed in the Specification serves the same purpose as the barrier layer of Satta: to prevent migration of copper ions from the conductive layer to adjacent dielectric layers. (*Compare* Spec. 3, ll. 8-10 and 5, ll. 9-12 to Satta, col. 43-53).

C. PRINCIPLES OF LAW

According to 35 U.S.C. § 103(a), a patent may not be obtained when "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious

at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." In resolving the question of obviousness, we consider (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). *See also KSR Int'l Co. v. Teleflex Inc*., 127 S. Ct. 1727, 1734 (2007)("While the sequence of these questions might be reordered in any particular case, the [*Graham*] factors continue to define the inquiry that controls."). "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.

A reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill in the art, *Merck & Co v. Biocraft Labs.,* 874 F.2d 804, 807 (Fed. Cir. 1989), and preferred embodiments do not constitute a teaching away from a broader disclosure. *In re Susi*, 440 F.2d 442, 446 n.3 (CCPA 1971).

D. ANALYSIS

Barrier layers were conventionally deposited as blanket layers (i.e., non-selectively) over exposed surfaces of microelectronic devices. Satta illustrates a blanket layer deposited along the exposed surfaces of a dielectric layer including on the walls of an opening within the dielectric layer. (FF 2). Appellants' Specification illustrates the conventional deposition of a blanket barrier layer after an opening has been filed with a conductive layer material. (FF 2, 9). In each case, the purpose of the barrier layer is the

same; it prevents ions from migrating out of the conductive layer into adjacent dielectric layers. (FF 1-2, 10).

Satta describes an improvement to the barrier deposition process. (FF 3). In the process of Satta, the deposition is selective. (FF 4). The exposed surface of the device is conditioned so the barrier layer is deposited only on "one of insulating and conductive materials, as compared to the other of insulating and conductive materials." (FF 5-6). While Satta describes a preferred embodiment in which the barrier layer is selectively deposited onto the dielectric material (FF 7), Satta suggests that the barrier layer can be selectively deposited onto conductive layers instead. (FF 6). Given that it was known to place a barrier layer on a conductive layer (FF 9) for the same function, i.e., to prevent migration of ions into a dielectric layer (FF 10), we determine that the evidence supports the Examiner's conclusion that Satta suggests to one of ordinary skill in the art to provide a barrier layer on a conductive layer and not a dielectric layer. *KSR*, 127 S. Ct. at 1739. Moreover, Satta includes a broad disclosure suggesting selective deposition on either the dielectric layer or the conductive layer. (FF 6). Thus, we cannot agree with Appellants that Satta's disclosure of an embodiment of selectively depositing onto the dielectric layer amounts to a teaching away. *Susi*, 440 F.2d at 446 n.3. [1]

We determine that Appellants have not shown that the Examiner reversibly erred in finding that Satta would have suggested to one of

[1] We note our Decision of May 16, 2008, rendered in Appeal No. 2008-1155, for related Application No. 10/335,033. That decision addressed the application of the same prior art reference, but to different claims directed to a method of manufacturing a device having a barrier layer deposited onto a conductive layer and not a dielectric layer.

ordinary skill in the art a barrier layer deposited onto a conductive layer and not a dielectric layer, as required by the claims, nor shown that Satta teaches away from such a structure.

II. SECOND ISSUE

A. ISSUES ON APPEAL

Appellants further contend that the insulating material taught by Satta is not a "dielectric material [that] comprises a material lacking available negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride," as recited in claim 13. (App. Br. 6 and 9-10). The Examiner contends that Satta teaches

> the formation of a barrier layer by utilizing ammonia and titanium tetrachloride as the precursors . . . and that the barrier layer can be selectively provided on either the insulating or the conductive material . . . [, and thus] Satta et al. clearly provide a suggestion to one having ordinary skill in the art to select an insulating material or to modify the insulating material such that it lacks chemical groups capable of reacting with the precursor materials.

(Ans. 7).

Thus, a second issue for our consideration in this case is: would the teachings of Satta have suggested to one of ordinary skill in the art a microelectronic structure having a dielectric layer "lacking available negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride," as recited in claim 13?

We answer this question in the affirmative.

B. FACTUAL FINDINGS

The following additional Findings of Fact are directed to the above identified issue on appeal:

11. The conditioning taught by Satta specifically includes the formation of ligands on the surface of the conditioned layer, whereby the barrier layer is only deposited on the conditioned surface "while avoiding depositing on the second [unconditioned] surface." (Satta, col. 2, ll. 40-45; col. 4, ll. 6-10).

12. Satta teaches that a conditioning step can comprise a chemical reaction on sidewalls comprising conductive material and an appropriate atmosphere such that ligands on the sidewalls are formed. (Satta, col. 3, ll. 12-16).

13. Conditioning "prepares the surface for further deposition" and makes "the surface susceptible to an atomic layer deposition (ALD) process to form the desired barrier layer." (Satta, col. 4, ll. 10-14).

14. Satta teaches deposition of a titanium nitride (TiN) barrier layer by ALD. (Satta, col. 12, ll. 23-25).

15. The deposition includes chemisorbing titanium tetrachloride ($TiCl_4$) upon an OH- or NH_x-terminated surface, followed by reacting ammonia (NH_3) with the chloride-terminated surface, in a ligand exchange reaction, to form a monolayer of TiN. (Satta, col. 12, ll. 28-30).

16. Satta states that "the non-conditioned surface is substantially insensitive to the ALD process for the desired barrier layer. The 'non-conditioned' surface can be achieved by failure to condition this surface or by further modification of conditioning on this surface." (Satta, col. 4, ll. 14-19).

17. Satta teaches that "the lack of conditioning, or modification of conditioning, on the second surface 10 prevents adsorption or reaction of the $TiCl_4$ with the second surface." (Satta, col. 12, ll. 35-38).

18. Satta also states that "the NH_3 reactant under these conditions does not react with the second surface 10, which, as noted, has no conditioning or has modified conditioning (e.g., blocking layer or sacrificial layer)." (Satta, col. 12, ll. 64-67).

C. ANALYSIS

As discussed above, we determined that it would have been obvious to one of ordinary skill in the art to apply a barrier layer to a conductive layer and not a dielectric layer based on the teachings of Satta. Satta further instructs to provide the barrier layer by conditioning the surface to have ligands (for example hydroxyl tails or NH_x-terminated ligands) that react with $TiCl_4$ during an ALD process, which subsequently reacts with NH_3. (FF 11-15). Satta also clearly instructs that no barrier layer is deposited on a non-conditioned surface and that such a non-conditioned surface (i.e., a surface that lacks conditioning) does not react with $TiCl_4$ or NH_3 under such conditions. (FF 16-18).

One of ordinary skill in the art would have understood that a non-conditioned surface, as taught by Satta, necessarily lacks available negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride. Therefore, it would have been obvious to one of ordinary skill in the art to provide a dielectric layer lacking negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride by merely providing a non-conditioned dielectric layer.

Therefore, the teachings of Satta would have suggested to one of ordinary skill in the art a microelectronic structure having a dielectric layer "lacking available negative polar groups reactive with precursors comprising ammonia and titanium tetrachloride," as recited in claim 13.

IV. CONCLUSION

For the reasons discussed above, we sustain the Examiner's rejection of claims 13-17 and 20-26 under 35 U.S.C. § 103(a) as being obvious over Satta.

V. DECISION

We affirm the Examiner's decision.

VI. TIME PERIOD FOR RESPONSE

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

AFFIRMED

cam

MICHAEL A. BERNADICOU
BLAKELY, SOKOLOFF, TAYLOR
& ZAFMAN LLP
SEVENTH FLOOR
12400 WILSHIRE BLVD.
LOS ANGELES, CA 90025