

The opinion in support of the decision being entered today was not written for publication in a law journal and is not binding precedent of the Board.

Paper No. 44

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte MITSURU TAGUCHI and KEIICHI MAEDA

Appeal No. 1998-2987
Application No. 08/250,332

HEARD: January 9, 2001

Before THOMAS, GROSS, and BARRY, Administrative Patent Judges.
BARRY, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the rejection of claims 22, 25, 27, and 32-35. We reverse.

BACKGROUND

The invention at issue in this appeal relates to forming metal wirings in electronic materials such as semiconductor devices. Wirings for semiconductor devices are sometimes manufactured by forming films at a high temperature. For

instance, aluminum (Al) series materials have often been used in view of their low resistivity and easy fabricability, and Al series alloys have been generally used therefor. The Al series alloys have usually been formed by a sputtering method.

When sputtering aluminum alloys such as aluminum-silicon (Al-Si) wiring, however, Si nodules occur. The nodules have a large cross section and, with the reduced size of semiconductor devices, can be detrimental to the electrical characteristics of the wiring and also cause problems in forming the wiring structure.

The appellants' process of forming metal wirings begins with a semiconductor substrate having diffusion regions. An insulating layer is deposited on the substrate. At least one contact hole is formed by removing a portion of the insulating layer to expose a selected portion of the surface of the substrate. An underlying metal layer is then deposited on both the interlayer and exposed portions of the substrate. An electrically conductive layer of an aluminum material

containing silicon is deposited on the metal layer by sputtering at a temperature no greater than 150°C so that silicon nodules are deposited at a boundary between the conductive layer and the underlying metal layer. A rapid thermal annealing treatment is applied so that the silicon nodule are absorbed from the boundary layer into the intermediate layer to form an alloy of aluminum, silicon, and a metal of the underlying layer between the conductive layer and the underlying layer.

Claim 22, which is representative for our purposes, follows:

22. A method of forming wirings for semiconductor devices comprising the steps of:

providing a semiconductor substrate having a diffusion region contained therein;

depositing an interlayer insulating layer on the semiconductor substrate;

forming at least one contact hole by removing a portion of the interlayer insulating layer to expose a selected portion of a surface of the semiconductor substrate;

depositing an underlying metal layer over both the interlayer insulating layer and the exposed surface of the semiconductor substrate;

depositing an electrically conductive layer of aluminum material containing silicon on the underlying metal layer by sputtering at a temperature, said temperature being # 150°C so that silicon nodules are deposited at a boundary between the conductive layer and the underlying metal layer; and

then absorbing the silicon nodule from the boundary into an intermediate layer by applying a heat

treatment by rapid thermal annealing to form the intermediate layer of an alloy of aluminum, silicon, and a metal of the underlying metal layer between the conductive layer and underlying metal layer.

The references relied on in rejecting the claims follow:

Howard et al. (Howard) 1979	4,154,874	May 15,
Gardner et al. (Gardner) 16, 1987	4,673,623	June
Inoue 1990	4,976,839	Dec. 11,
Yamaha	5,036,382	July 30, 1991
Thomas et al. (Thomas) 1992	5,117,276	May 26,
		(filed Nov. 8, 1990)
Chen et al. (Chen) 1993	5,270,254	Dec. 14,
		(filed Mar. 27, 1991)

Mori et al. (Mori), Japanese Published Application No. 62-113421, May 1987¹

Ho et al. (Ho), Sputtered Metallurgy Process for Electromigration Improvement of Al-Cu Interconnections, IBM Technical Disclosure Bulletin, Vol. 21, No. 11, Apr. 1979, at 4527-28.

Hoffman et al. (Hoffman), Individual Wafer Metallization Utilizing Load-Locked, Close-Coupled Conical Magnetron Sputtering, Solid State Technology, Feb. 1981, at 105-111

Wolf et al. (Wolf), Silicon Processing for the VLSI Era, Volume 1: Process Technology, 56-58 and 365-74 (1986).

Claims 22 and 33 stand rejected under 35 U.S.C. § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman. Claims 25 and 34 stand rejected under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Howard. Claims 27 and 35 stand rejected under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Chen or Ho. Claim 32 stands rejected under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in

¹A copy of the translation prepared by the U.S. Patent and Trademark Office is attached.

view of Wolf and Hoffman, and further in view of Inoue or Mori. Rather than repeat the arguments of the appellants or examiner in toto, we refer the reader to the briefs and answer for the respective details thereof.

OPINION

In deciding this appeal, we considered the subject matter on appeal and the rejection advanced by the examiner. Furthermore, we duly considered the arguments and evidence of the appellants and examiner. After considering the totality of the record, we are persuaded that the examiner erred in rejecting claims 22, 25, 27, and 32-35. Accordingly, we reverse.

We begin by noting the following principles from In re Rijckaert, 9 F.3d 1531, 1532, 28 USPQ2d 1955, 1956 (Fed. Cir. 1993).

In rejecting claims under 35 U.S.C. Section 103, the examiner bears the initial burden of presenting a prima facie case of obviousness. In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992).... "A prima facie case of obviousness is established when the teachings from the prior art itself would appear to have suggested the claimed

subject matter to a person of ordinary skill in the art." In re Bell, 991 F.2d 781, 782, 26 USPQ2d 1529, 1531 (Fed. Cir. 1993) (quoting In re Rinehart, 531 F.2d 1048, 1051, 189 USPQ 143, 147 (CCPA 1976)).

With these principles in mind, and for all the reasons expressed by the appellants, we reverse the rejections.

In particular, we find the appellants' following argument particularly persuasive.

In Item 11 *Response to Arguments*, starting on page 9, the Examiner discusses the teachings of Yamaha [sic] and maintains that absorption of silicon nodules would take place to form the trinary compound given the barrier layer of Ti as employed with the Al-Si wiring and states that despite numerous holdings in the various Office Actions, no evidence has been provided to prove that the Examiner's holding of inherent absorption would not take place. However, as pointed out in the Brief and previously, it is noted that there is nothing in the reference to suggest the absorption and, in fact, Yamaha specifically states that the precipitation occurs with recrystallization and mentions nothing about absorption of the silicon nodules. Yamaha uses the two titanium layers on each side of the aluminum layer so that even with the nodules' formation, this does not destroy the electrical circuit. It is submitted that there is nothing in the record to support the Examiner's holding of inherent absorption other than his own opinion, which is not suggested by any evidence.

(Reply Br. at 2.)

We also find the appellants' following argument particularly persuasive.

Yamaha does not state what type of sputtering is occurring. However, since Yamaha is concerned with obtaining an enhanced step coverage, Hoffman et al, on page 108, states a heated substrate is required, and this temperature appears to be greater than 220°C. Also, it is noted that Wolf et al, on page 269, states that for improved coverage with aluminum films, the substrate must be heated to greater than 250°C before significant coverage improvement is observed during sputtering. Thus, it is believed that while Wolf et al talks about heated and unheated substrates during sputtering, these references illustrate that for desired coverage, heating above 200°C is required for good coverage and, thus, a person of ordinary skill in the art having the teachings of Wolf et al and Hoffman et al, as well as Yamaha, would not find it obvious to sputter at temperatures equal to or less than 150°C. It is also submitted that nothing has been shown in the references relied on by the Examiner to suggest that silicon nodules would be deposited at the boundaries between the conductive layers while sputtering at or below 150°C.

(Id. at 2-3.) None of the other applied references cure the deficiencies noted above.

For the foregoing reasons, supplemented by the other reasons expressed by the appellants, we are not persuaded that teachings from the prior art would have suggested the invention. Therefore, we reverse the rejection of claims 22

and 33 as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman; the rejection of claims 25 and 34 under as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Howard; the rejection of claims 27 and 35 as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Chen or Ho; and the rejection of claim 32 as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Inoue or Mori.

CONCLUSION

In summary, the rejection of claims 22 and 33 under 35 U.S.C. § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, is reversed. The rejection of claims 25 and 34 under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Howard, is also reversed. In addition, the rejection of claims 27 and 35 under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in

view of Chen or Ho, is reversed. Furthermore, the rejection of claim 32 under § 103(a) as obvious over Yamaha in view of Thomas and Gardner, further in view of Wolf and Hoffman, and further in view of Inoue or Mori, is reversed.

REVERSED

JAMES D. THOMAS)	
Administrative Patent Judge)	
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)	BOARD OF PATENT
ANITA PELLMAN GROSS)	APPEALS
Administrative Patent Judge)	AND
)	INTERFERENCES
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)	
LANCE LEONARD BARRY)	
Administrative Patent Judge)	

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