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D E C I S I O N
of 25 May 2005

Case Number: T 1134/04 - 3.4.3

Application Number: 98107810.8

Publication Number: 0865083

IPC: H01L 23/485

Language of the proceedings: EN

Title of invention:
Electrode for semiconductor device and method of manufacturing it

Applicant:
Kabushiki Kaisha Toshiba

Opponent:
-

Headword:
Polycrystalline layer/TOSHIBA

Relevant legal provisions:
EPC Art. 76(1), 123(2), 56

Keyword:
"Inventive step (yes); claim of divisional application a restricted version of claim granted in parent application pursuant to a previous decision of the board in a different composition"

Decisions cited:
-

Catchword:
-

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Case Number: T 1134/04 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 25 May 2005

Appellant: Kabushiki Kaisha Toshiba
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 19 April 2004 refusing European application No. 98107810.8 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. G. O'Connell
Members: G. L. Eliasson
P. Mühlens

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division to refuse European patent application No. 98 107 810.8 which was filed as a divisional application to application No. 90 307 234.6 on which European patent No. 0 407 133 has since been granted as ordered in decision T 517/02.

II. The ground for refusing the present divisional application was that the claims according to a main request and a first auxiliary request did not meet the requirements of Article 76(1) EPC for essentially the following reasons:

> The feature "wherein the full width at half maximum of a closed-packed plane θ-scan diffraction profile, used as a measure of the orientation distribution, of said close-packed plane oriented layer is less than 6°" in claim 1 is not derivable from the parent application. Although embodiment 15 shows results for θ-scans for particular multilayer structures comprising a hexagonal crystal layer and an oriented Al-Si-Cu layer (fcc-crystal) for the (111)-plane with six discrete values including 6°, it does not refer to films having a full width at half maximum of less than 6° nor is there an implicit teaching relating to films having a crystal orientation distribution in this range. Thus, the range "less than 6°" has its upper limit arbitrarily selected from the examples and has no basis in the parent application as filed.

III. The following prior art document was cited in the examination procedure:

D1: WO 81 01 629 A.

IV. In the appeal procedure, the appellant filed with a letter dated 25 April 2005 new claims forming a main request and seven auxiliary requests.

V. At oral proceedings held before the board, the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the third auxiliary request filed with letter dated 25 April 2005.

VI. Claim 1 of this request reads as follows:

"1. A semiconductor device comprising a semiconductor substrate having active regions electrically isolated from each other on a predetermined surface thereof, and an electrode line arranged on said semiconductor device through an insulating layer,
wherein said electrode line comprises a lamination of electrode line layers comprising a metal polycrystal layer consisting of crystal grains and a second polycrystal layer which is provided below the metal polycrystal layer, said second polycrystal layer having a hexagonal crysta1 structure,
the metal polycrystal layer being a close-packed plane oriented layer and having a predetermined full width at half maximum of close-packed plane θ—scan diffraction profile measured by using X-ray

diffraction as a measure of an orientation distribution of crystal grains of the metal polycrystal layer, the predetermined full width at half maximum being less than 6°."

VII. Claim 1 of the parent application as granted reads as follows (board's emphasis):

"1. A semiconductor device comprising:

a semiconductor substrate having active regions electrically isolated from each other on a predetermined surface thereof, and

an electrode line arranged on said semiconductor substrate through an insulating layer,

wherein said electrode line comprises a lamination of electrode line layers comprising a metal polycrystal layer consisting of crystal grains **and at least 95% of the crystal grains are arranged so that the normal direction of the close-packed planes of said crystal grains forms 80° or less with the normal line direction of the bottom surface of said electrode line**, and a second polycrystal layer which is provided below said metal polycrystal layer, said second polycrystal layer having a hexagonal crystal structure."

VIII. The appellant's arguments relevant to the present decision can be summarized as follows:

(a) It follows from Figures 16 and 17 of the parent application as filed that a film having a Full Width at Half Maximum (FWHM) of 6° (curve "i" in

Figure 17) has greatly improved electromigration resistance over a conventional Al film (curve "h" in Figure 16). The curve "I" in Figure 17 for a film having FWHM of 1.2° shows that the electro migration improves further when the FWHM is reduced below 6°. Thus, the skilled person would understand that a polycrystalline film having a value of 6° for the FWHM represents an improved device over prior art materials and that devices having an FWHM less than 6° would have even higher resistance against electro-migration. Therefore, the range "FWHM less than 6°" is disclosed in the parent application as filed as well as in the present application as filed.

(b) Claim 1 contains the features that the metal polycrystalline layer is close-packed and has a FWHM less than 6°, and that a second polycrystal layer having a hexagonal crystal structure is provided below the metal polycrystal layer. Therefore, the scope of claim 1 is narrower than that of claim 1 of the parent application as granted, since the feature "at least 95% of the crystal grains are arranged so that the normal direction of the close-packed planes of said crystal grains forms 80° or less with the normal line direction of the bottom surface of said electrode line" in the latter claim translates into an upper limit for FWHM of 11.7°.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments and Clarity (Articles 76(1), 84 and 123(2) EPC)*

2.1 Claim 1 is based on embodiment 15 of the application as filed, which reproduces embodiment 15 of the parent application as filed. This embodiment discloses an electrode line which is composed of a multilayer structure having a metal polycrystalline layer on a second polycrystalline layer having a hexagonal crystal structure formed on a silicon oxide layer (cf. application as published, page 12, line 10 to page 13, line 11). In Table 3, the Full Width at Half Maximum ("FWHM"), which indicates the orientation distribution of the metal polycrystalline layer, varies between 1.5 and 8° depending on the material of the hexagonal polycrystalline layer.

2.2 In the decision under appeal, the examining division found that the feature of "FWHM less than 6°" in claim 1 was not derivable from the parent application as filed.

2.2.1 As convincingly demonstrated by the appellant, however, it follows from Figures 16 and 17 of both the parent application as filed and the present divisional application as filed, that a film having a metal polycrystalline layer with FWHM equal to 6° on a polycrystalline layer having a hexagonal crystal structure (curve "i" in Figure 17) has considerably greater resistance against electromigration than a

conventional aluminium film (curve "h" in Figure 16), and that for films having even smaller value of the FWHM, such as 1.2°, a further improvement of electromigration resistance is observed (curve "I" in Figure 17) (cf. item VIII(a) above). Thus, the board finds that the parent application as filed, as well as the present divisional application as filed, discloses that an improved resistance against electromigration over a conventional film is obtained across the whole claimed range for the FWHM.

2.3 According to the description, the ratio of the c-axis to the a-axis of the second polycrystal layer having a hexagonal crystal structure "is set to" 1.60 or more, whereas claim 1 does not specify the c/a ratio at all (cf. divisional application as published, page 12, lines 12 to 14). As convincingly argued by the appellant referring to table 3, however, c/a ratio of 1.60 or more is not a prerequisite for obtaining a semiconductor device which falls within the scope of claim 1, i.e. having an FWHM less than 6°.

2.4 The dependent claims 2 to 6 contain features which are disclosed in embodiment 15 as well.

2.5 For the above reasons, the board judges that the requirements of Article 76(1) and 123(2) EPC are met. In the judgement of the board, the requirements of Article 84 EPC are met as well.

3. *Novelty and Inventive Step*

In decision T 517/02 made by the present board in a different composition, it was held that the parent

application met the requirements of novelty and involved an inventive step having regard to document D1 (cf. reasons, 4.2), and consequently, grant of a patent was ordered.

Claim 1 under consideration differs from claim 1 of the parent patent as granted in that the feature "at least 95% of the crystal grains [of the metal polycrystal layer] are arranged so that the normal direction of the close-packed planes of said crystal grains forms 80° or less with the normal line direction of the bottom surface of said electrode line" in claim 1 of the parent patent is replaced by the formulation that "the metal polycrystal layer being a close-packed plane oriented layer and having a predetermined full width at half maximum of close-packed plane θ—scan diffraction profile measured by using X-ray diffraction as a measure of an orientation distribution of crystal grains of the metal polycrystal layer, the predetermined full width at half maximum being less than 6°". As shown by the appellant, the formulation used in claim 1 of the parent patent as granted corresponds to a range for the full width at half maximum being less than 11.7° (cf. item VIII(b) above). Thus, claim 1 of the divisional application is in effect a restricted version of claim 1 of the parent patent as granted, so that the reasoning given in T 517/02 regarding novelty and inventive step applies *a fortiori* to present claim 1.

Having reconsidered the reasoning given T 517/02, the board in its new composition finds no reason to depart from its earlier reasoning regarding novelty and inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent in the following version:

   - claims: 1 to 7 filed as third auxiliary request with letter dated 25 April 2005

   - description: pages 1 to 78 filed in the oral proceedings

   - drawings: figures 1 to 36 as originally filed.

Registrar: Chair:

C. Eickhoff R. G. O'Connell