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DECISION
of 24 August 1995

Case Number: T 0760/92 - 3.4.1

Application Number: 88113946.3

Publication Number: 0304929

IPC: H01L 23/48

Language of the proceedings: EN

Title of invention:
Semiconductor device having an electrode covered with a protective film

Applicant:
KABUSHIKI KAISHA TOSHIBA

Opponent:
-

Headword:
Protective film/TOSHIBA

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (no)"

Decisions cited:
-

Catchword:
-

Case Number: T 0760/92 - 3.4.1

DECISION
of the Technical Board of Appeal 3.4.1
of 24 August 1995

Appellant:	KABUSHIKI KAISHA TOSHIBA 72, Horikawa-cho Saiwai-ku Kawasaki-shi Kanagawa-ken 210 Toyko (JP)
Representative:	Frank, Veit Peter Hoffmann, Eitle & Partner Patentanwälte Postfach 81 04 20 D-81904 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office dated 15 April 1992 refusing European patent application No. 88 113 946.3 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman:	G. D. Paterson
Members:	R. K. Shukla
	Y. J. F. van Henden

Summary of Facts and Submissions

I. European patent application No. 88 113 946.3 was refused by a decision of the Examining Division on the ground that the subject-matter of independent claim 1 did not fulfil the requirement of Articles 52 and 54 EPC regarding novelty in view of the prior art disclosed in document

D1: US-A-4 622 576.

II. In the above mentioned decision, the Examining Division held that even if claim 1 was amended to include a feature specifying that the protection layer completely covers the device, the claimed subject-matter would not fulfil the requirement of inventive step.

III. The Applicant lodged an appeal against the decision and requested that a patent be granted on the basis of an amended claim 1, filed with the Grounds of Appeal, dated 6 August 1992.

This claim has the following wording:

Claim 1

"A semiconductor device comprising:
an active semiconductor layer (2,3);
an electrode layer (7,8) comprising bonding portions (7A,8A); and
a protection layer (12) formed to cover said active semiconductor layer (2,3) and said electrode layer (7,8); characterized in that

said protection layer (12) is a semiconductor protection layer formed of a semiconductor material;
said semiconductor protection layer (12) covers said active semiconductor layer (2,3) and said electrode layer (7,8) entirely; and
a portion of said semiconductor protection layer (12) covering the electrode layer (7,8) is formed thin on said bonding portions (7A,8A) of said electrode layer, thereby permitting said bonding portions to be electrically connected to an external element (W) through said thin portion of said semiconductor protection layer."

IV. In a communication annexed to the summons to oral proceedings, the Board informed the Appellant of its preliminary opinion that the claimed subject-matter did not involve an inventive step in view of the disclosure in document D1.

V. With a letter dated 10 August 1995, the Appellant filed an amended claim 1 as an auxiliary request. This claim differs from claim 1 of the main request cited in section IV above in that the resistivity of the semiconductor material forming the protection layer is stated to be between 10^7 and 10^8 Ohm.cm.

VI. Oral proceedings took place on 24 August 1995.

VII. The Appellant's arguments in support of inventive step in the subject-matter of claim 1 can be summarized as follows:

Document D1 discloses a wire 25 attached to a protective layer 22 which covers a bonding portion 14.

The protective layer 22 is disclosed to be conductive and is composed of heavily doped polysilicon or metal silicide. The doping level for silicon is stated to be 10^{20} atoms/cm^3 which confirms that the protective layer is highly conductive. Also the document emphasises that the protective layer must be highly conductive such that the wire attached to it is in electrical contact with the underlying bonding portion. As a result, in the device of document D1 a moat 24 is provided in the protective layer so that the bonding area is electrically isolated from the surrounding areas.

The inventors of the present invention realised that a protection film having a relatively high resistance and sufficiently small thickness over a bonding portion would have sufficiently high resistance along its length such that adjacent bonding portions would not be short-circuited, and would have sufficiently low resistance in its thickness direction such that a wire attached to the protection film would be electrically connected to the underlying bonding portion. Such a device would not, therefore, require a moat to isolate adjacent bonding portions. The present invention based on these considerations thus goes against the teaching of document D1 which emphasises the need for a highly conductive protection layer for an electrical connection between an external wire and the bonding portion, and provides a protection film requiring a simplified process of its manufacture and having improved moisture resistance.

In claim 1 of the auxiliary request a particular range of resistivity values of the protection layer is claimed. There is no hint in the cited prior art to select this range of resistivity values.

VIII. At the end of the oral proceedings the decision was announced that the appeal is dismissed.

Reasons for the Decision

1. *Main request*

1.1 In claim 1 it is stated, "a portion of said... protection layer is formed thin on the bonding portions of said electrode layer, thereby permitting said bonding portions to be electrically connected to an external element".

Having regard to the description of the invention in the application as filed, in the Board's view, it follows that the above statement is not to be interpreted to mean that the protection layer over the bonding portion is thin in relation to its thickness elsewhere, but rather to mean that the protection layer is sufficiently thin so as to permit an electrical contact between an element such as a wire and the bonding portion.

Also, since the protection layer according to the application as filed has a thickness in the range of 0.2 to 3.0 micron and a resistivity in the range of 10^7 to 10^8 Ohm.cm (see claims 6 and 7), it follows that the protection layer has a relatively high resistance (between 200 and 30000 Ohm for a contact area of 1 cm^2) in its thickness direction. In other words, the protection layer of the invention as claimed does not provide a low resistance electrical contact between an external element and the bonding portion.

1.2 Document D1, which constitutes the closest prior art, is concerned with the same general technical problem as the present application, i.e. to provide an improved protection layer (or "passivation layer") over bonding portions of a semiconductor device, which dispenses with openings which are normally required in the protection layer over the bonding portions for electrical contact thereto (see document D1, column 1, lines 30 to 45). According to the document, the protection layer 22 may be of heavily doped polysilicon doped to a level of 10^{20} atoms per cm^3 (column 3, lines 6 to 10), and is sufficiently thin such that a wire 25 is electrically connected through the protection layer to the underlying bonding portion 14 (see column 3, lines 15 to 16 and column 4, lines 10 to 13).

In the wording of claim 1 of the main request, document D1 thus discloses (see in particular Figure 2 and the corresponding part of the description) a semiconductor device comprising:
an active semiconductor layer (19);
an electrode layer (14) comprising bonding portions (see Figures 1 and 2);
a protection layer (22) formed to cover said active semiconductor layer (19) and said electrode layer (14);
wherein said protection layer (22) is a semiconductor protection layer formed of a semiconductor material;
said semiconductor protection layer (22) covers said active semiconductor layer (19) and said electrode layer (14); and

a portion of said semiconductor protection layer (22) covering the electrode layer (14) is formed thin on said bonding portions of said electrode layer, thereby permitting said bonding portions to be electrically connected to an external element (25) through said thin portion of said semiconductor protection layer.

Since the protection layer according to document D1 is a good conductor, a moat 24 needs to be provided in the protection layer so as to isolate the protection layer over the bonding portion from the rest of the protection layer.

The claimed subject-matter is thus distinguished over the prior art disclosed in document D1 in that the protection layer covers the active semiconductor layer and the electrode layer entirely. In other words, there is no moat in the protection layer. As the formation of a moat entails an extra process step, it is evident that the manufacture of a semiconductor device having a protection layer entirely covering the electrode layer as in claim 1 of the application in suit is considerably simplified in relation to that disclosed in document D1. Also, it follows that a continuous protection layer of the claimed semiconductor device is likely to provide better protection against moisture and other contaminants.

In the semiconductor device technology, as in any other technology, it is generally the aim to simplify device fabrication and construction, and to improve device properties. In the Board's view, contrary to the submissions by the Appellant, to a skilled person confronted with the above tasks, it would be evident that the fabrication and construction of the semiconductor device as disclosed in document D1 would be considerably simplified and its moisture resistance would be improved if the moat was not required in the protection layer. Also, since formation of a protection layer of a semiconductor material as in the device of document D1 necessarily entails considerations of basic parameters such as the resistivity and dimensions of the protection layer (e.g. cross sectional area and length), and of one of the most basic laws of electricity, i.e. Ohm's law, the Board is of the view that it was well within the competence of the skilled person to realise that by appropriately choosing a resistivity value (it being generally known in the art that the resistivity of silicon can be adjusted by controlling the impurity concentration) and thickness of the protection film, the resistance of the protection film along its length can be made sufficiently high so that the provision of a moat around the bonding pad portion would not be necessary. Also, as the semiconductor devices, such as memory devices, operating at low currents are generally known, it would have been evident to the skilled person that in case of low-current devices, a relatively high resistance electrical contact (in relation to the resistance of the electrical contact in document D1) would not be detrimental to the performance of the device since the voltage drop across the electrical contact would be sufficiently small.

In the Board's view, therefore, the person skilled in the art would be led to modify the device known from document D1 such that the resistivity of the protection layer is increased and its thickness sufficiently reduced, so that the provision of a moat is not required. The skilled person would thus arrive at the subject-matter of claim 1 without the exercise of any inventive skill.

2. *Auxiliary Request*

The resistance of the protection layer required to prevent short-circuit between adjacent bonding portions is known to depend on the resistivity and thickness of the layer, and on the distance between the bonding portions. Depending on the circumstances, the skilled person would, therefore, arrive at a suitable resistivity value by routine calculations and trials. Therefore, in the Board's opinion, the selection of a resistivity between 10^7 and 10^8 Ohm.cm as in claim 1 would be regarded as obvious by the skilled person.

3. In the Board's judgment, therefore, the subject-matter of claim 1 of both the main and the auxiliary requests do not involve an inventive step as required by Articles 52(1) and 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Beer G. D. Patersonq