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D E C I S I O N
of 3 November 1999

Case Number: T 0904/94 - 3.4.3

Application Number: 89120640.1

Publication Number: 0368262

IPC: H01L 23/498

Language of the proceedings: EN

Title of invention:
Wiring substrate, film carrier, semiconductor device made by using the film carrier, and mounting structure comprising the semiconductor device

Applicant:
Nitto Denko Corporation

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 82, 56, 123(2)

Keyword:
"Unity of invention (yes - after amendments)"
"Subject-matter extending beyond the content of the application as filed (no - after amendments)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:

-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0904/94 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 3 November 1999

Appellant: Nitto Denko Corporatoin
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Representative: Grünecker, Kinkeldey,
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 4 July 1994 refusing European patent application No. 89 120 640 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
A. C. G. Lindqvist

Summary of Facts and Submissions

I. European patent application No. 89 120 640.1 (Publication No. 0 368 262) was filed with 19 claims, whereby independent claims 1 and 3 concerned a wiring substrate and a method of manufacturing a wiring substrate, respectively, and independent claim 6 was for a film carrier. Claim 11 concerned a semiconductor device comprising a semiconductor element having an outer connecting element being connected to the bump-like metal protrusion of the film carrier as defined in claim 6, and claim 16 was for a mounting structure of a semiconductor device comprising an outer substrate and the semiconductor device as defined in claim 11.

II. The European patent application was refused in a decision of the examining division dated 4 July 1994 on the ground that the application containing an amended set of claims 1 to 25 submitted by the applicant lacked unity of invention in accordance with Article 82 EPC.

In the decision, the examining division took the view that there were two groups of claims, i.e. claims 3 to 5 and 20 to 25, the latter group having been added by the applicant after the European Search Report, and that the inventions defined by said two groups of claims were not so linked as to form a single general inventive concept.

Moreover, the examining division added that the objections of additional subject-matter under Article 123(2) EPC, lack of clarity and conciseness and lack of inventive step already raised *inter alia* in the official communication dated 17 August 1993 still

applied to the claims on file. The prior art documents which were cited in the above communication were

D1: US-A-3 868 724,

D2: Patent Abstracts of Japan, vol. 10, no. 209 (E-421) ©2265ª, 22 July 1986; & JP-A-61 48952, and

D3: IBM Technical Disclosure Bulletin, vol. 30, no. 9, February 1988, "Process for making a self-aligned removable VLSI connector", pages 353 to 354.

As further stated in the decision (cf. item 6 of the "Summary of facts and submissions"), the application with a main claim directed to a device and a further main claim directed to a method of producing it comprising a set of particular features as suggested in the above communication could meet the objections and be allowable.

III. The applicant lodged an appeal against this decision on 14 September 1994 paying the appeal fee on the same day and filed the statement of the grounds of appeal on 14 November 1994. It was stated in the statement of the grounds of appeal that claims 20 to 25 were cancelled.

IV. During the oral proceedings of 3 November 1999 which had been requested auxiliarily, the appellant (applicant) filed a new set of claims and new description pages, and requested that the decision under appeal be set aside and that a patent be granted on the basis of the following patent application documents:

Claims: 1 to 17 as filed during the oral proceedings;

Description: pages 2, 3, 9, 10, 12 to 33 as filed; pages 1, 4 to 6, 8 and 11 as filed during the oral proceedings; (there is no page 7);

Drawings: Sheets 1/8 to 8/8 as filed.

Independent claims 1 and 10 and dependent claim 13 read as follows:

"1. A semiconductor device comprising:

a conductor pattern with at least one bonding pad formed on one surface of an insulating support (2, 2');

a plurality of through-holes (4) running in the direction of the thickness of said insulating support, said holes being formed in the region of said bonding pad where said bonding pad is in contact with said insulating support and in the vicinity thereof, wherein the through-holes (4) have a distance smaller than the width of the bonding pad and only those through-holes in the region of the bonding pad are filled with metal forming a conductive passage in said through-holes, and

bump-like metal protrusions formed on said conductive passages protruding from the opposite side of the surface of said insulating support (2, 2'), and

a semiconductor element which is mounted thereon having at least one outer connecting electrode (7) being in

contact with and connected to said bump-like metal protrusions."

"10. A method for manufacturing a semiconductor device according to claim 1, comprising the steps of:

(a) forming a conductor pattern having a bonding pad (3, 3') on at least one surface of an insulating support (2, 2');

(b) forming a plurality of through-holes (4) in the region of a bonding pad (3, 3') where said bonding pad is in contact with said insulating support and in the vicinity thereof, said through-holes being apart from each other with a distance smaller than the width of said bonding pad (3, 3') and running in the direction of the thickness of said insulating support (2, 2'), and

(c) conducting electroplating using said conductor pattern as an electrode after masking the surface of said insulating support (2, 2') on which said conductor pattern is formed, thereby depositing and growing a metal material only in said through-holes (4) that are formed in the region of the bonding pad (3, 3'), so that a conductive passage is formed in each of these through-holes (4) and subsequently forming a bump-like metal protrusion (6) on said conductive passage."

"13. A mounting structure for mounting a semiconductor element (1) on a substrate (9) using a semiconductor device with said insulating film according to one of the previous claims 2 to 9, wherein a plurality of

further through-holes (4) are provided in a bonding region of said insulating film (2') in which region said insulating film (2') is in contact with a land portion (10) of said substrate (9);

a metal material (5) is charged into said further through-holes (4) that are provided in said bonding region, and

bump-like metal protrusions (6) are formed on said metal material (5), a further lead (3') of the insulating film (2') being connected to said land portion (10) through said bump-like protrusions (6)."

Claims 2 to 9 are dependent claims and are appended to claim 1. Claims 11 and 12 are dependent on claim 10 and claims 13 to 17 are dependent on claim 1.

V. The appellant (applicant) submitted the following arguments in support of his request:

Claims 20 to 25 of the set of claims forming the basis for the decision under appeal have been cancelled. Therefore, the objection of lack of unity of invention contained in the decision under appeal is no more relevant.

The present main claims correspond in substance to the text of the claims suggested by the Examining Division, except for the specific feature concerning the use of thermal adhesive resin for connecting the semiconductor element to the support or carrier. However, this feature was presented originally as advantageous, but not as essential to the performance of the invention.

Besides, the claims are based on different aspects of the technique derivable from the application as filed and are clear in that they define correctly and unambiguously the matter to be protected.

The closest prior art is represented by document **D1** which describes a connecting structure for integrated circuits. In this known connecting structure, each outer connecting electrode of the semiconductor element which is mounted thereon corresponds and is connected to one metal-filled through-hole of the insulating support. This device is costly in that it is used with expensive metals, e.g. copper or gold, which are to be filled in through-holes having about the same width as the bonding pad they will be connected to. The present invention solves this problem by replacing, for the same bonding pad, the metal-filled through-holes of about the same width as the bonding pad by a plurality of filled through-holes, thus of smaller width, i.e. with metallic elements of smaller thickness. In the present invention, there are also through-holes in the vicinity of the bonding pad, but these through-holes are not filled with metal. Therefore, the cost of such devices is smaller.

Both documents **D2** and **D3** belong to a different technical field, using insulating substrates or foils with substantially uniform distribution of conductive paths generally perpendicular to the main surfaces of said substrates or foils. There is no indication in these documents for providing through-holes which are not filled with a conductive material so that the replacement of the metal-filled through-hole having about the same width as the bonding pad of document **D1**

by a plurality of metal-filled through-holes with empty through-holes in the vicinity of the bonding pad, was not obvious for the skilled person.

Therefore, the subject-matter of the claims involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Unity of invention*

Since claims 20 to 25 of the set of claims forming the basis for the decision under appeal have been cancelled, the objection of lack of unity of invention between the two groups of invention as defined by claims 3 to 5 and 20 to 25, respectively, in the decision under appeal, has been overcome.

Present claim 1 relates to a semiconductor device and the independent claim 10 relates to a method comprising method steps which are specifically adapted to produce the device according to claim 1. As discussed below, the subject-matter of claim 1 involves an inventive step, so that independent claims 1 and 10 are so linked as to form a single general inventive concept, as required by Article 82 EPC.

3. *Amendments*

Claims 20 to 25 of the set of claims forming the basis

for the decision under appeal have been cancelled, so that the objection of additional subject-matter under Article 123(2) EPC mentioned in the decision under appeal against these claims is no more relevant.

Present claim 1 corresponds to the text of the main device claim considered to be allowable by the Examining Division in the above-mentioned official communication except that the feature concerning the use of a thermal adhesive resin for connecting the semiconductor element to the support or carrier is not mentioned in the claim. However, the use of thermal adhesive resin, in the application as filed (see in particular claim 1), is not mentioned for all embodiments and is thus not derivable as being an essential feature. In this respect, it is to be noted that present claim 1 is restricted to a semiconductor device comprising a wiring substrate corresponding in substance to that defined in claim 1 as filed. Moreover, in present claim 1, the expression "minute through-holes" of claim 1 as filed has been replaced for clarity, and in agreement with the whole content of the application as filed, by the expression "wherein the through-holes have a distance smaller than the width of the bonding pad".

The remaining claims are either device claims or method claims, and they are all drafted with a direct or indirect dependency on present claim 1 or claim 10, and there is no additional subject-matter extending beyond the content of the application as filed. The amendments in the description mainly concern its adaptation to the new claims, the embodiments illustrated by the drawings remaining unamended.

Therefore, the Board is satisfied that the present patent application has not been amended in such a way that it contains subject-matter which extends beyond the content of the application as filed and thus meets the requirement of Article 123(2) EPC.

4. The subject-matter of claim 1 does not contain all the features which were considered to be necessary by the examining division for the claim to comply with the requirement of inventive step. In the following, therefore, the issue of inventive step is discussed.

5. *Inventive step*

5.1 The semiconductor device known from document **D1** (see the whole document, more in particular Figures 1, 2d and 4) comprises:

a conductor pattern (20) with at least one bonding pad, i.e. the extremity of the respective conductor (20), formed on one surface (10a) of an insulating support (10);

a plurality of through-holes (16) running in the direction of the thickness of said insulating support (10), said holes being formed in the region of said bonding pad where said bonding pad is in contact with said insulating support, and

bump-like metal protrusions (24b, 24c, 24e, 24k, 24j, 24m, 24n, 24p) formed on said conductive passages protruding from the opposite side of the surface of said insulating support (10), and

a semiconductor element, i.e. the integrated circuit chip (17) which is mounted thereon having at least one outer connecting electrode (17b, 17c) being in contact with and connected to said bump-like metal protrusions (24b, 24c).

5.1.1 Document **D1** can be considered as representing the closest prior art in that, contrary to the devices disclosed in documents **D2** and **D3**, it shows a through-hole (16) formed in the region of the bonding pad where said bonding pad is in contact with the insulating support and further through-holes (12, 18) outside of this area, some of which comprising no conductive passage. In particular, the equally spaced apertures (12) formed along the edges of the insulating support are for indexing the support during various stages of fabrication and bonding the integrated circuit chip (17) thereto, and holes (18) are used for registration of the assembled package to a connecting substrate; these apertures and holes are mentioned as not being for allowing penetration of metallic conductors therein.

5.1.2 However, contrary to the semiconductor device of present claim 1, in the semiconductor device known from document **D1**, there is only one through-hole for each bonding pad and thus there are no through-holes (12, 14, 16, 18) having a distance between the holes smaller than the width of the bonding pads (20).

Moreover, as set forth here above in relation to clarity, the terms "in the vicinity of" of present claim 1 are to be understood in the context of the width of the bonding pad and of the distance between through-holes; the device of document **D1**, however, does not show any through-holes being formed in the vicinity of the region of said bonding pad where said bonding pad is in contact with said insulating support, whereby only those through-holes in the region of the bonding pad are filled with metal forming a conductive passage in said through-holes.

In this respect, it is to be noted that, in document **D1** (see column 6, lines 7 to 24; Figure 4), the through-holes (14) are for connection with an external circuitry, and not for mounting a semiconductor element with at least one outer connecting electrode (7) being in contact with and connected to said bump-like metal protrusions on said through-holes, as required by present claim 1.

It is further to be noted that, except for the equally spaced apertures (12) formed along the edges of the insulating support for indexing and except for the holes (18) used for registration, there is no indication in document **D1** that there are through-holes which are not filled with metal; on the contrary, it is indicated (see column 2, lines 36 to 39) that the contacts on the support are substantially the same size as the contacts on the integrated circuit chip, and the respective contacts correspond on a one-to-one ratio.

5.2 As mentioned in the present application (see page 6, third paragraph) and as argued by the appellant, the semiconductor device known from document **D1** has *inter alia* a drawback in that the cost of the device is high since expensive metals such as copper and/or gold are used for filling the through-holes (16) having the same size as the electrical contacts (17b, 17c) of the integrated circuit chip (17).

It is credible that, as argued by the appellant, by replacing each through-hole (16) in the region of the bonding pad of the known device by a plurality of through-holes of smaller width, less metal is needed without increasing too much the electrical resistance of said conductive fillings, thereby arriving at a less expensive device with comparatively similar properties.

5.3 The semiconductor device known from document **D2** (see the abstract) comprises an insulating substrate (3) wherein a plurality of fine conductive wires (7) are embedded perpendicularly to the main surfaces of the substrate (3); the integrated element (1) is located on a bed (2) on one main surface of the substrate (3) in contact with embedded fine conductive wires (7), and inner leads (4), which are connected to electrodes of the integrated circuit (1), are also located elsewhere on said main surface of the substrate (3) in contact with other embedded fine conductive wires (7).

However, contrary to the device of present claim 1, in the device of document **D2**, through-holes are shown as being substantially uniformly distributed on the whole surface of the support (3) and all the through-holes are filled with fine conductive wires. Empty holes in

the vicinity of a bonding pad are not derivable from this document.

In document **D3** (see the whole document), a very large scale integrated (VLSI) connector is disclosed comprising metal-filled capillaries substantially perpendicular to the main surfaces of the foil-shaped connector; the connector is used as an adhesive or soldering contact between a packaging substrate and chip pads. However, also in this document there is a substantially uniform distribution of the capillaries and, moreover, capillaries in the vicinity of the bonding pads without conductive material therein are not derivable.

In the Board's view, therefore, by combining any of the documents **D2** and **D3** with document **D1**, the skilled person would not arrive at a structure of the support as in claim 1, wherein filled through-holes are located only at the location of the bonding pads, and the through-holes in the vicinity of said bonding pad are not filled with metal. Moreover, as convincingly argued by the appellant, although the use of insulating supports or supporting parts with a plurality of through-holes filled with metal and contacting an outer connecting electrode of a semiconductor element was known from the documents **D2** and **D3**, it is only with hindsight that the person skilled in the technical field of document **D1** would have taken into account the substantially uniformly embedded wires or filled through-holes of document **D2** or **D3** and would have replaced each of the relatively wide through-holes corresponding to one bonding pad of the support of document **D1** with a plurality of filled through-holes.

For the foregoing reasons, in the Board's judgement, the subject-matter of present claim 1 involves an inventive step in the sense of Article 56 EPC.

Consequently, present claim 1 is patentable in the sense of Article 52(1) EPC.

5.4 Since the method according to claim 10 is specifically adapted to produce the semiconductor device of claim 1, claim 10 is also patentable for the same reasons as those for claim 1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division with the order to grant a European patent on the basis of the following application documents:

Claims: 1 to 17 as filed during the oral proceedings;

Description: pages 2, 3, 9, 10, 12 to 33 as filed;
pages 1, 4 to 6, 8 and 11 as filed during the oral proceedings;
(there is no page 7);

Drawings: Sheets 1/8 to 8/8 as filed.

The Registrar: The Chairman:

D. Spigarelli R. Shukla