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**D E C I S I O N**  
of 7 April 2003

**Case Number:** T 0841/99 - 3.4.3

**Application Number:** 91910167.5

**Publication Number:** 0485627

**IPC:** H01L 23/50

**Language of the proceedings:** EN

**Title of invention:**

Lead frame and semiconductor package using it

**Applicant:**

KABUSHIKI KAISHA TOSHIBA

**Opponent:**

-

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 123(2), 84, 56

**Keyword:**

"Admissibility of the amendments (yes)"

"Clarity (yes)"

"Inventive step (yes - after amendments)"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 0841/99 - 3.4.3

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.3  
of 7 April 2003

**Appellant:** KABUSHIKI KAISHA TOSHIBA  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 3 March 1999  
refusing European patent application  
No. 91 910 167.5 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** R. K. Shukla  
**Members:** M. Chomentowski  
M. B. Günzel

## Summary of Facts and Submissions

I. The European patent application No. 91 910 167.5 (Publication No. 0 485 627) was refused by a decision of the examining division dated 3 March 1999 on the grounds that the claims of the three requests submitted by the applicant did not involve an inventive step.

II. Claim 1 of the **main request** forming the basis of the decision under appeal read as follows:

"1. A lead frame having an improved adhesive property to a sealing plastic, comprising:

a matrix for said lead frame consisting essentially of a copper based alloy containing dispersed particles of an element other than copper contained in said copper based alloy, a portion of said dispersed particles being distributed on the surface of said matrix, said copper based alloy containing P, the P content being 30 ppm or less and an oxide layer formed on said matrix, said oxide layer having a thickness in the range of 3 nm to 50 nm and containing an oxide of said dispersed particles distributed on the surface of said matrix."

Claim 1 of the **first auxiliary request** differs from claim 1 of the main request as discussed below:

(a) The wording "dispersed particles of an element other than copper contained in said copper based alloy", in lines 4 and 5 of claim 1 of the main request, is replaced by the expression "dispersed particles of an element capable of forming a surface oxide layer with a good adhesive property to a sealing plastic" in claim 1 of the auxiliary request.

- (b) The following subject-matter is added at the end of claim 1 of the main request:

"the copper based alloy containing additives comprising at least one element selected from a group comprising Cr, Zr, and Ti at a content of 0.005% to 2% by weight and the balance substantially Cu, and/or 0.005% by weight to 1% by weight of at least one selected from the group consisting of Ni, Sn, Fe, Co, Zn, Be, B, Mg, Ag, Si, Mn, Cd, Al, rare earth elements, Ca and Ge, and/or 0.005% by weight to 1% by weight of at least one selected from the group consisting of Nb, V, Hf, Mo, W, Y, Ta, La and Ga for 100% by weight of said copper based alloy, said dispersed particles being derived from one or more of the additives in said copper based alloy".

Claim 1 of the **second auxiliary request** differs from claim 1 of the first auxiliary request in that the wording "the balance substantially Cu, **and/or** 0.005% by weight to 1% by weight of at least one selected from the group consisting of Ni, Sn, ..." is replaced by "the balance substantially Cu, **and** 0.005% by weight ...".

- III. The reasoning in the decision under appeal can be summarized as follows:

*Main request*

The subject-matter of claim 1 differs from the lead frame made of the material of Sample 8 of Table 1 known from document

D8: US-A-4 872 048,

by the provision of an oxide layer with a thickness of

3 to 50 nm formed on the copper alloy and surface particles of the lead frame.

The problem addressed by this feature is that of the adhesion between a copper based alloy lead frame and a sealing plastic or resin. This problem, which is mentioned in the application, is already recognized in documents

D4: US-A-4 612 167 or

D5: US-A-4 888 449.

In document D4, the mechanism by which an improved adhesion between lead frame and resin arises is alluded to; moreover, in Example 2, the copper alloy is heated at 350°C for two minutes to simulate a wire-bonding operation of a lead frame. This teaching is in broad agreement with the content of document

D2: JP-A-52 095 176 and its abstract,

which describes the formation of an oxide layer on a copper lead frame during wire bonding.

Alternatively, from document D5, it is known to oxidize a copper alloy in order to provide improved bonding to resin or plastic.

Therefore, the skilled person wishing to form a lead frame from the alloy sample number 8 of Table 1 of document D8 which is indicated as having suitable properties and desiring to improve adhesion to a resin package would provide a lead frame comprising all the features of claim 1, which are either known from the prior art documents or directly and unambiguously derivable therefrom.

Consequently, the subject-matter of claim 1 lacks an inventive step.

*First auxiliary request*

The subject-matter of claim 1 does not involve an inventive step since the additional features are disclosed with respect to embodiments of document D8 and the skilled reader would understand from this document that the mentioned precipitates must be formed from one or more of the additives in the copper alloy.

*Second auxiliary request*

The argumentation used for the main and first auxiliary request also applies to claim 1 of this request since in both the first and second embodiment of document D8 it is clearly stated that the elements Cr, Zr and Ti are provided in addition to the other listed elements.

The set of claims according to each of the above requests included additionally an independent claim concerning a semiconductor package comprising a semiconductor chip, a lead frame having said semiconductor chip mounted thereon, said lead frame being electrically connected to said semiconductor chip, and a sealing plastic for gas-tight sealing said semiconductor chip and a part of said lead frame, the lead frame having the features in accordance with claim 1 of the respective request. These claims were also found to lack an inventive step in the decision under appeal.

Moreover, in the decision under appeal, doubts were expressed about the admissibility of features pursuant to Article 123(2) EPC in all the requests and also

about clarity arising because of the use of expressions such as "an element capable of forming a surface oxide layer".

IV. The applicant lodged an appeal on 30 April 1999 paying the appeal fee on the same day. A statement setting out the grounds of the appeal was filed on 13 July 1999.

V. With letters dated 6 November 2002 and 3 February 2003 the appellant (applicant) filed inter alia a new main request. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of inter alia his main request consisting of the following patent application documents:

**Description:** pages 1, 2, 5, 9, 14, 16 and 19 to 21 filed on 23 December 1991;  
pages 7, 10 to 12, 15, 17 and 18 filed with applicant's letter dated 18 May 1995;  
pages 3, 4, 6, 8 and 13 (Main request) filed with appellant's letter dated 6 November 2002;

**Claims:** 1 to 5 (first part) (Main request) filed with appellant's letter dated 6 November 2002;  
claim 5 (second and last part) (Main request) filed with appellant's letter dated 3 February 2003;

**Drawings:** Sheets 1/3 to 3/3 filed on 23 December 1991;

Claims 1 and 5 are the only independent claims of the set of 5 claims of the appellant's main request and they read as follows:

"1. A lead frame having adhesive property to a sealing plastic, comprising:

a matrix for said lead frame consisting essentially of a copper based alloy containing dispersed particles of at least one element selected from Cr, Zr, and Ti **and their intermetallic compounds with copper** at a content of 0.005% to 2% by weight, a portion of said dispersed particles being distributed on the surface of said matrix, said copper based alloy containing P, the P content being **between 2 and 30 ppm** and **a uniform** oxide layer formed on said matrix, said oxide layer having a thickness in the range of 3 nm to 50 nm and containing an oxide of said dispersed particles distributed on the surface of said matrix."

"5. A semiconductor package comprising a semiconductor chip, a lead frame having said semiconductor chip mounted thereon, said lead frame being electrically connected to said semiconductor chip, and a sealing plastic for gas-tight sealing said semiconductor chip and a part of said lead frame,

said lead frame comprising:

a matrix for said lead frame consisting essentially of a copper based alloy containing dispersed particles of at least one element selected from Cr, Zr, and Ti **and their intermetallic compounds with copper** at a content of 0.005% to 2% **by weight**, a portion of said dispersed particles being distributed on the surface of said matrix, said copper based alloy containing P, the P content being **between 2 and 30 ppm**; and **a uniform** oxide layer formed on said matrix, said oxide layer having a



thickness in the range of 3 nm to 50 nm and containing an oxide of said dispersed particles distributed on the surface of said matrix."

The most important amendments with respect to the corresponding claims of the main request forming the basis of the decision under appeal have been highlighted by the Board.

VI. The appellant's arguments in support of his main request can be summarized as follows:

*Clarity (Article 84 EPC)*

Whilst the surface oxidation treatment mentioned in the description provides a convenient means for forming the oxide layer, this is not necessarily the only way in which an oxide layer providing the advantage of the present invention might be formed, and this is not derivable as being an essential feature of the present invention. Thus, the claims are clear.

*Inventive step*

The present invention intends to provide improved adhesion of a semiconductor lead frame to a sealing resin without detrimentally affecting the other properties of the semiconductor package or the cost. An oxide layer is provided on the lead frame including oxidised particles of specific elements (Cr, Zr and Ti), the layer having a specific thickness range, and the lead frame alloy containing moreover phosphorus in a specific composition range where it acts as a deoxidizer without detrimental effect on the adhesive property of the oxide layer.

None of the cited prior art documents disclose or render obvious the synergistic combination of constructional and compositional features of the present invention.

Document D8 does not concern a lead frame with an oxide layer, so that controlling the P content of the lead frame, which in the present invention is important for adhesion, is not obvious.

Although it is indicated in document D4 (see column 4, lines 40 to 55) that Al, Si, Mn and Mg form fine oxide particles on the lead frame which contribute to the improvement in the adhesion of lead frames to packaging resins, there is however no suggestion to provide an oxide layer having the specific thickness range of claim 1. Forming an oxide layer with such a thickness range is also not disclosed in document D2 since the oxide layer formed during wire bonding have a different thickness range. Therefore, in document D4, forming an oxide layer of the required thickness range and uniformity would not automatically result from wire bonding.

In document D5, there is no disclosure of the surface of the lead frame having distributed particles for improving the adhesion to the sealing resin.

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

## **Reasons for the Decision**

1. The appeal is admissible.

2. *Main request*

2.1 Admissibility of the amendments and clarity

In the matrix of the lead frame consisting essentially of a copper based alloy containing dispersed particles, the dispersed particles are restricted to at least one element selected from Cr, Zr, and Ti **and their intermetallic compounds with copper** at a content of 0.005% to 2% by weight. The lower limit of the range of the P content is indicated as being **2 ppm**, as e.g. in Example 2 of Table 1, and the oxide layer is mentioned as being **uniform**. These features are disclosed in the application as filed (see claims 1, 3 and 5, Example 2 of Table 1 and page 10, first complete paragraph, respectively).

The amendments to the other claims are similar and the amendments in the description are for adaptation to the new claims. These amendments are considered as meeting the further objections in the decision under appeal.

Therefore, the amendments satisfy the requirement of Article 123(2) EPC that a European patent application may not be amended in such a way that it contains subject matter which extends beyond the content of the application as filed.

Moreover, the description has been amended in order to disclaim Examples which no more fall within the scope of the new claims. Whilst surface oxidation treatment mentioned in the description provides a convenient means for forming the oxide layer, it is credible that, as convincingly argued by the appellant, this is not necessarily the only way in which an oxide layer providing the advantage of the present invention might

be formed. Moreover, it is not derivable from the present application that this means is an essential feature of the present invention.

Therefore, the Board is satisfied that the claims are clear in the sense of Article 84 EPC.

3. *Novelty and inventive step*

None of the prior art documents discloses a lead frame having all the features of claim 1, so that the subject-matter of the claim is new in the sense of Article 54 EPC.

Document D8 concerns semiconductor devices having copper alloy leads, whereby one of the compositions to be used for such lead frame, i.e. Sample No. 8 of Table 1, has a composition comprising Cr, Zr and P. However, the appellant has convincingly argued as follows:

The composition of Sample 8 of Table 1 is an isolated composition among a plurality of compositions outside of the scope of the claim. The document is not concerned with the problem of adhesion of the lead frame to plastic, and the disclosed lead frame has not the means for this purpose. It is thus not the relevant starting point for the invention.

Since document D4 is concerned with the problem of adhesion of a lead frame to packaging resins, the Board considers it to be a relevant starting point. For the stated purpose, Al, Si, Mn and Mg, which form fine oxide particles, are included in the composition of the lead frame. However, it has no specifically disclosed oxide layer for improving adhesion, and no indication that oxide particles with Ti (or Cr or Zr) are good for adhesion.

Indeed, the lead frame of document D4 may be submitted to further operations such as wire bonding.

The English abstract of Document D2 concerns semiconductor device production by forming a silicon pellet on a lead frame of Cu or an alloy thereof, attaching gold wire leads and covering with resin; during the bonding steps, which are done in an atmosphere of inert gas, the lead frame is oxidized to form a copper oxide film thereon. However, the abstract does not contain any information as to the thickness or uniformity of the formed oxide film. Moreover, the appellant has provided in the statement setting out the grounds of the appeal a translation of the relevant passages of the Japanese document (see the third page, lines 4 to 7 and 8 to 18, respectively) which clearly shows that the thickness of a copper oxide film resulting from the operations of attaching the semiconductor pellet on the lead frame and of wire bonding lies between 50 and 60 nm and is about 100 nm, respectively. Thus, even by taking into account the teaching of document D2, it is not derivable from document D4 that an oxide film formed during specific operations such as wire bonding will have the thickness mentioned in claim 1 of 3 to 50 nm.

Indeed, in document D5 (see column 5, lines 16 to 43; see also column 2, lines 46 to 57) it is disclosed that a film containing oxide on a Cu-alloy lead frame results in better adhesion to the sealing resin. However, as convincingly argued by the appellant, this document discloses oxidizing a metal or metal alloy to form a conversion type coating on the surface using a hot, alkaline, chlorite solution, and there is no disclosure of the surface having distributed particles for improving the adhesion to the sealing resin.

The further prior art documents are less relevant.

Starting from any of these prior art documents, it is thus not obvious to arrive at the lead frame of claim 1.

Therefore, in the judgment of the Board, the subject-matter of claim 1 involves an inventive step in the sense of Article 56 EPC.

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

Claim 5 concerns a semiconductor package comprising a semiconductor chip, a lead frame having said semiconductor chip mounted thereon, said lead frame being electrically connected to said semiconductor chip, and a sealing plastic for gas-tight sealing said semiconductor chip and a part of said lead frame, the lead frame being in accordance with that defined in claim 1. Thus, claim 5 is also patentable for the same reasons. The same applies to the dependent claims 2 to 4 which concern particular lead frames according to claim 1.

Since the main request is allowable in the sense of Article 97(2) EPC, it is not necessary to take into consideration the auxiliary request or to schedule oral proceedings as requested auxiliarily by the appellant.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent of the appellant's main request consisting of:

**Description:** pages 1, 2, 5, 9, 14, 16 and 19 to 21  
filed on 23 December 1991;  
pages 7, 10 to 12, 15, 17 and 18 filed  
with applicant's letter dated 18 May  
1995;  
pages 3, 4, 6, 8 and 13 (main request)  
filed with appellant's letter dated  
6 November 2002;

**Claims:** 1 to 5 (first part) (main request) filed  
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claim 5 (second and last part) (main  
request) filed with appellant's letter  
dated 3 February 2003;

**Drawings:** Sheets 1/3 to 3/3 filed on 23 December  
1991.

The Registrar:

The Chairman:

M. Zawadzka

R. K. Shukla