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D E C I S I O N
of 25 June 1996

Case Number: T 0722/93 - 3.4.1

Application Number: 87201454.3

Publication Number: 0257681

IPC: H01L 21/56

Language of the proceedings: EN

Title of invention:
Method for manufacturing plastic encapsulated semiconductor devices and devices obtained thereby

Applicant:
SGS-THOMSON MICROELECTRONICS S.r.l

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
T 0176/84

Catchword:
-

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Case Number: T 0722/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 25 June 1996

Appellant: SGS-THOMSON MICROELECTRONICS S.r.l.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 25 March 1993 refusing European patent application No. 87 201 454.3 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: Y. J. F. Van Henden
H. J. Reich

Summary of Facts and Submissions

I. European patent application No. 87 201 454.3 (publication No. 0 257 681) was refused by a decision of the Examining Division. The reason given for the refusal was that, having regard to the state of the art which can be derived from the documents

D1: EP-A-0 066 188 and

D2: FR-A-2 556 645,

the single claim filed on 22 September 1992 did not involve an inventive step.

II. The Applicant lodged an appeal against the decision of the Examining Division, requesting that said decision be set aside and that a European patent be granted on the basis of the single claim filed on 22 September 1992. Oral proceedings were subsidiarily requested.

III. In a communication annexed to a summons to attend oral proceedings, the Board took the preliminary view that the allowability of claim 1 as filed on 22 September 1992 could be prejudiced by documents (D1) and (D2).

IV. In response to the Board's communication, the Appellant filed on 23 May 1996 three amended versions of its single claim forming the respective bases of a main request and two auxiliary requests.

In the accompanying letter, the Appellant referred to the further documents

D3: S. M. Sze "VLSI Teschnology", McGraw-Hill, New York (USA), 1988, pages 566, 567 and 595 to 607;

D4: P. Antognetti "Power Integrated Circuits", McGraw-Hill, New York (USA), 1986, pages 7.1 to 7.17, 8.1 to 8.3 and 8.12 to 8.27, and

D5: A. I. Isaiev "Injection and Compression Molding Fundamentals", Marcel Dekker Inc., New York (USA), 1987, pages III to XIV, 329 to 333, 340, 341, 344 to 359 and 377 to 381.

V. The claim forming the basis of the Appellant's main request reads

"Method for manufacturing a plastic encapsulated semiconductor device, comprising

- a semiconductor chip,

- a metallic plate (31) serving both as an electrode and as a heat sink, having a first one of its two surfaces soldered to said semiconductor chip,

- a plastic housing, encapsulating said metallic plate so as to cover its second surface with a thin and uniform plastic layer,

- a lead (38) connected to one end portion of said plate, and where, during encapsulation, the correct position of said end portion of the plate in an encapsulating mold is performed by locators of said lead (38), present in the mold,

characterised by the following steps:

- placing the metallic plate within the mold cavity, and performing the correct positioning of the other end portion of the plate by at least a pair of retractable locating pins (43, 44) protruding

from opposite sides of the mold cavity and with their ends into contact with the opposite sides of said other end portion of the plate,

- introducing a polymerisable thermosetting plastic material into the mold cavity,

- withdrawing the locating pins when the plastic material begins to polymerise,

- further introducing the plastic material into the mold cavity through an input opening (47) located close to said locating pins, in order to fill the space vacated by the locating pins, and

- removing the encapsulated semiconductor device from the mold cavity after the polymerisation of the plastic material."

According to each of the Appellant's auxiliary requests, the last but one clause of the single claim states that the input opening (47) is "located substantially equally close to both said locating pins" instead of stating that it is "located close to said locating pins". In the claim of the second auxiliary request, the additional feature "and in such a way that the flow of the plastic material through the input opening is directed substantially towards both said locating pins" was furthermore inserted in the same clause after "close to both said locating pins".

VI. Oral proceedings were held on 25 June 1996.

VII. The Appellant requested that the decision under appeal be set aside and that a European patent be granted on the basis of the main request, or the first or second auxiliary request, as filed on 23 May 1996.

In support of these requests, the Appellant argued in substance as follows:

As evidenced by documents (D3) and (D4), IC packaging is associated with so many difficulties that a skilled person working in that field would never expect solutions to his specific problems to be already available in other technical fields. The problem solved by the present invention was to provide a thin and uniform layer of plastic material under plate (31), and the difficulty to be overcome was to prevent the leads (36 to 38) from being bent during the final phase of the injection, i.e. after the pins (43, 44) have been retracted. It is indeed clear that, because of the difference in thickness of the resin layers, the pressure exerted during injection of plastic material is lower on the other side of said plate. To achieve the desired result, the invention proposes the use of a thermosetting resin and a location of the injection point close to said pins (43, 44). After retraction of the latter, the plastic material is thus not disturbed.

Document (D2), however, relates to the production of molded objects in which inserts are completely incorporated in a thermoplastic resin and copes with the problem of accurately positioning the inserts with respect to the outer surface of the completed articles. With such resin, the viscosity can be held constant during its entry into the mould and the beginning of hardening is easy to start by lowering the temperature. Therefore, choosing the right moment for retracting support pins in the case of a thermosetting material cannot be derived from document (D2), and actually the less so as using the latter material is associated with processing difficulties, as can be seen from document (D5).

According to document (D2), the insert (5) is supported by a pin (7) and the molten plastic material is introduced into the mould through an upper opening. This gives rise to a downward movement of the insert after removal of pin (7), which movement has a magnitude higher than the tolerance admissible for the semiconductor device. Furthermore, asserting that document (D2) would make it obvious to provide opposite locating pins to assure said tolerance is gratuitous. It was also not noticed that placing the injection gate near the supporting pin (7) would result in the piece (5) being moved upwards. In fact, positioning the injection gate was, in the present case, matter of choosing the point which gives rise to the least movement of the metallic plate (31) rather than that of least injection resistance.

It is only by chance that document (D2) discloses a solution similar to the present invention. Contrary to document (D2), the invention also teaches to retract the locating pins at a time when the plastic is as fluid as when the injection started. This is actually necessary for, otherwise, the small wire bonds (34, 35) would be damaged by the movement of the rapidly solidifying thermosettable material which surrounds them. This choice is not suggested by document (D2), for the insert is dragged by the almost solidified material.

For these reasons, document (D2) does not belong to a technical field neighbouring the specific field of the invention. Therefore, the considerations set out in decision T 176/84, namely that the skilled person attempting to solve the problem underlying the invention would have expected a solution to be found there, is not met. Finally, inventiveness does not require the presence of a surprising effect.

VIII. After deliberation by the Board, the decision was announced that the appeal is dismissed.

Reasons for the Decision

1. Document (D1) relates to semiconductor devices encapsulated in plastic material and to a method for manufacturing such devices - see page 1, lines 6 to 8. Figure 11 of that document shows a third embodiment of the invention disclosed there, and Figures 12 to 14 are views for explaining the steps of the method for manufacturing said third embodiment - see page 5, lines 7 to 13.

An encapsulated semiconductor device according to Figure 11 of document (D1) comprises a transistor (1), a plate (2) serving as a heat sink and a first face to which the transistor is "adhered", and a plastic housing (3') encapsulating said plate (2) and covering its second face with a thin plastic layer - see: Figure 12; from the line 22 of page 12 to the third line of page 13; page 14, lines 24 to 27. In order to make said device, a lead frame of the kind represented in Figure 5 is used, which lead frame comprises a lead (6) extending from an "end portion" of the plate (2) - see page 12, lines 22 to 26. In the Board's view, a skilled person derives from the overall disclosure of document (D1) that the plate (2) is metallic and also serves as an "electrode", i.e. that its surface which is not covered by the thin plastic layer is soldered to the transistor (1). This view is further supported by the fact that transistors have to be connected in three points and only two further leads (10, 11) are provided - see also page 6, lines 23 to 27, as well as page 1, lines 21 to 24.

Bearing in mind that the present patent application also concerns the encapsulation of a transistor - see the lines 25 and 26 of page 4 - it follows that document (D1) relates to the encapsulation of a semiconductor device such as defined in the pre-characterising part of the claims filed on 23 May 1996.

2. The process for encapsulating a semiconductor device disclosed in document (D1) comprises the steps of: placing the metallic plate (2) in a cavity delimited by a lower mold (14) and an upper mold (13), the side on which the external leads (6, 10, 11) are formed being clamped between said lower and upper molds; introducing plastic material into the mold cavity and, finally, removing the encapsulated semiconductor device from the mold cavity - see: page 13, lines 3 to 7; page 4, lines 22 to 25; page 7, lines 10 to 24.

The subject-matter of the single claim forming the basis of the Appellant's main request is consequently distinguished over the method known from document (D1) in that:

- before the plastic material is introduced into the cavity of the mold, the end portion of the metallic plate (31) remote from the lead (38) is correctly positioned by means of at least a pair of retractable locating pins protruding from opposite sides of said cavity and having their ends in contact with the opposite sides of said end portion;

- a polymerizable thermosetting plastic material is used;

- the locating pins are withdrawn when the plastic material begins to polymerize;

- in order to fill the space left empty upon retraction of the locating pins, further plastic material is introduced into the mold cavity through an opening located close to said pins, and in that

- the removal of the encapsulated device takes place after polymerization of the plastic material. --

The Appellant did not contest these findings - see letter of 23 May 1996, second paragraph of page 3/8.

3. *Inventive step*

3.1 In the field of encapsulated semiconductor devices, attempting to achieve a uniform thickness of the thin layer of plastic material covering the rear surface of the metallic support is a known problem - see the paragraph bridging pages 2 and 3 of document (D1). The authors of the latter document admittedly express the opinion that the solution to this problem disclosed there would be satisfying. Nevertheless, there is no indication of the tolerances to be met for said solution to be such. Furthermore, it is obvious that said thickness will be more or less uniform according as the material to be introduced into the cavity of the mold has a lower or a higher viscosity, and according as the time allowed for filling said cavity is longer or shorter. Now, increasing production rates is of acknowledged economical interest in all fields of the technique. Therefore, deciding to investigate whether the reliability of the method disclosed in document (D1) can still be improved does not require from the skilled person any initiative going beyond his normal task.

3.2 Document (D2) relates to a method for making pieces consisting of an insert encapsulated in moulded plastic material and completely surrounded by the latter. The Appellant submitted that the problems arising in that technical field would be too remote from those specific to IC packaging that both fields might be considered as neighbouring ones. Nevertheless, it is clear that, if an insert has to be completely embedded within a piece of moulded plastic material, accurately positioning said insert in the solidifying plastic material is a more acute problem than positioning an insert provided with protruding portions liable to be firmly held between parts of the mould. Therefore, the Board is satisfied that a skilled person concerned with IC packaging and faced with the problem underlying the present patent application would seek a solution to that problem in the field of moulded objects containing embedded inserts.

In other words, the Board is satisfied that IC packaging and the production of moulded objects containing embedded inserts are neighbouring technical fields within the meaning of decision T 176/84, and that a skilled person having document (D2) at his disposal would have taken the relevant teachings thereof into consideration while attempting to solve the problem set to the invention.

3.3 The teachings of document (D2) are admittedly exemplified by the production of a plastic valve incorporating a core (5) made of magnetic material. Nevertheless, this does not restrict their general validity, for the claims of that patent application do not refer to any particular object obtained by carrying out the method disclosed there. According to the latter, the insert (5) of the piece to be manufactured is placed in the cavity of a mould (1, 2) where it is

positioned by retractable pins (6, 7) protruding from the walls of said cavity, the ends of said pins being in contact with the surface of the insert - see Figure 2 and description, from the line 33 of page 3 to the second line of page 4 (i.e. the line actually numbered 3). Subsequently, the cavity of the mould is injected with molten plastic material, the insert being immobilized by the retractable pins during that time - see Figure 3 and page 4, lines 4 to 7. Before solidification of the plastic material, the pins (6, 7) are withdrawn and plastic material is injected into the cavity of the mould in order to fill up the space previously occupied by said pins - see Figures 4 to 7 and page 4, lines 8 to 16. Finally, after complete solidification of the plastic material, the mould (1, 2) is opened and the piece is removed from its cavity - see page 4, lines 17 to 19. Since no part of the insert (5) remains uncovered, finishing touches for covering areas of the insert previously in contact with the support pins are no longer needed - see page 4, lines 25 to 27; note furthermore that the patent application in suit also aims at achieving this result, as can be seen from page 2, lines 8 to 12.

3.4 Document (D2) teaches to introduce the additional quantity of molten plastic material through an opening located at the top of the mould, whereby a downward movement of the insert (5) may be expected after retraction of the lower support pin (7) - see the figures. However, if the diameter of the pin is small, the displacement of the insert will also be small. It is obvious that, because of the viscosity plastic materials anyway exhibit before solidifying, this displacement is essentially determined by the ratio (v/V), where (v) denotes the volume to be filled after removal of the support pins and (V), the total volume of plastic material. Furthermore, to understand that a

body lying within a mass of viscous material will follow any movement of said material, it is not necessary to be a specialist of rheology. Therefore, a skilled person concerned with the problem of encapsulating semiconductor devices and attempting to alleviate the drawbacks of the method disclosed in document (D1) readily perceives that, under the proviso of injecting the additional quantities of plastic material at places such that no excessive deformation of the filling already present in the mould takes place, the use of retractable support pins known from document (D2) represents the sought solution. Furthermore, a skilled person understands that, in order not to affect the neighbouring plastic material when filling the space previously occupied by the locating pins, it is advisable to introduce the additional quantity of such material through input openings provided in the immediate vicinity of said pins. Thereby, no risk of bending the leads (36 to 38) has to be feared. Likewise, it is of obvious relevance to maintain a plate by means of pins contacting its opposite faces rather than edges thereof, as well as to remove the encapsulated device after complete polymerization if a polymerizable thermosetting plastic material is used in place of molten plastic material. Such use of a polymerizable material is a known alternative to that of molten plastic material and, in the field of IC packaging, appears to be the more advisable as the Appellant itself pointed out that the small wire bonds (34, 35) could deteriorate if the latter material were used.

3.5 For the above reasons, the single claim forming the basis of the Appellant's main request does not involve an inventive step.

3.6 Locating the input opening (47) at substantially equal distance from the pins (43, 44) and in such a way that the flow of plastic material be directed substantially towards said pins is an obvious measure for achieving, while the space previously occupied by the pins is being filled, a balance between the variations in pressure occurring on both sides of the plate (31) as a consequence of said flow. --

Therefore, the single claim according to each of the Appellant's first and second auxiliary requests does not involve an inventive step either.

4. The single claims forming the respective bases of the Appellant's main request and first and second auxiliary requests are consequently not allowable - Article 52(1) EPC in conjunction with Article 56 EPC. Therefore, the appeal has to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Beer G. D. Paterson