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D E C I S I O N
of 30 September 2003

Case Number: T 1049/01 - 3.4.3

Application Number: 96105280.0

Publication Number: 0723289

IPC: H01L 21/56

Language of the proceedings: EN

Title of invention:
Method of curing a mold compound used to encapsulate a semiconductor device

Applicant:
TEXAS INSTRUMENTS INCORPORATED

Opponent:
-

Headword:
Infrared lamp/Texas Instruments

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive Step (no)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1049/01 - 3.4.3

DECISION
of the Technical Board of Appeal 3.4.3
of 30 September 2003

Appellant: TEXAS INSTRUMENTS INCORPORATED
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Dallas
Texas 75265 (USA)

Representative: Degwert, Hartmut, Dipl.-Phys.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 4 May 2001 refusing European application No. 96105280.0 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: G. L. Eliasson
J. H. van Moer

Summary of Facts and Submissions

I. European patent application No. 96 105 280.0 was refused in a decision of the examining division dated 4 May 2001 on the ground that the application did not meet the requirement of inventive step having regard to the prior art documents

D1: EP 0 114 258 A; and

D7: EP 0 468 874 A.

The prior art document

D4: Karl Mütze, "ABC der Optik" (Verlag Werner Dausien, Hanau, 1972), pages 210 to 211; and

was also cited in the decision under appeal.

II. The appellant (applicant) lodged an appeal on 20 June 2001 paying the appeal fee the same day. A statement of the grounds of appeal was filed on 7 September 2001.

III. In response to a communication of the Board accompanying summons to oral proceedings, the appellant filed new claims 1 to 5 with a letter dated 15 September 2003.

IV. At the oral proceedings held on 30 September 2003, the appellant requested that the decision under appeal be set aside and a patent be granted on the basis of claims 1 to 5 filed with the letter of 15 September 2003.

V. Independent claims 1 and 2 according to the appellant's request read as follows:

"1. A method of curing a mold compound used to encapsulate a semiconductor die, comprising the steps of:

attaching the semiconductor die (20) to a metallic lead frame (24);

encapsulating the semiconductor die (20) with a mold compound (80) by transfer molding; and

curing the mold compound (80) by exposing the encapsulated semiconductor die to a lamp (28) emitting near infrared light having a wavelength between 0.8 µm and 2.8 µm and being not focused on the semiconductor die (20),

wherein the current through the lamp (28) is varied during curing."

"2. A method of attaching a semiconductor die (2) to a support pad of a metallic lead frame (24) with a die attach material (22), including the step of exposing the die (20) to a lamp (28) emitting near infrared light having a wavelength between 0.8 µm and 2.8 µm and being not focused on the semiconductor die (20), wherein the current through the lamp (28) is varied during curing, heat being transferred from the die (20) to the attach material (22) and to the support pad of the lead frame (24), and the portion of the lead frame

(24) not covered by the attach material (22) and die (20) substantially reflecting light radiation from the lamp (28)."

VI. The appellant presented essentially the following arguments in support of his request:

(a) With respect to the method according to claim 1, the closest prior art is represented by the prior art method described in the application in suit (cf. application as published, column 3, lines 28 to 45). The problem addressed by the application in suit relates to speeding up the post-mold cure of the mold compound (cf. application, column 3, lines 45 to 46).

(b) The method according to claim 1 solves the above problem by using a combination of the claimed process steps which *in combination* contribute to reduce the time required for the post-mold cure (cf. application, column 8, line 54 to column 9, line 10). In particular, for curing the mold compound, the wavelength of the infrared light is selected so that it is selectively absorbed by the mold compound and is reflected by the exposed metallic lead frame. The lead frame as a result is not heated up. Moreover, the current through the lamp is controlled so as to optimise the heating process.

(c) Document D7 is concerned with annealing of semiconductor wafers, a process which takes place at 850 °C or higher, whereas a post-mold cure takes place at about 175 °C. Therefore, the

skilled person seeking to improve the prior art method described in the application in suit would not consider the teaching of document D7 to be relevant.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

2. *Inventive step - Claim 1*

The only issue in the present appeal is that of inventive step.

2.1 It is common ground that the prior art method of curing a mold compound encapsulating a semiconductor die as described in the application in suit represents the closest prior art (cf. application, column 3, lines 28 to 45). In the prior art method, which according to the application in suit is disclosed in "Microelectronics Packaging Handbook" by R. Tummala and E. J. Rymaszewski, a semiconductor die attached to a metallic lead frame is encapsulated with a mold compound by a conventional transfer molding process. A step of curing the mold compound follows where the encapsulated chip and lead frame assembly are placed for several hours in an oven at a temperature of about 175 °C.

A similar method is disclosed in document D1 as well (cf. D1, page 1, line 19 to page 2, line 14).

2.2 The method according to claim 1 differs from the known method in that the step of placing the encapsulated chip and lead frame assembly into an oven is replaced by the steps of:

(i) curing the mold compound (80) by exposing the encapsulated semiconductor die to a lamp (28),

(ii) where the lamp is emitting near infrared light having a wavelength between 0.8 µm and 2.8 µm,

(iii) the light being not focused on the semiconductor die (20),

(iv) wherein the current through the lamp (28) is varied during curing."

2.3 The problem addressed by the application in suit relates to finding a method which speeds up the post-mold cure of the mold compound in comparison with the known method which requires several hours of heating in an oven (cf. item VI(a) above).

2.4 Document D7 discloses a method of annealing a semiconductor wafer using infrared lamps as heat source (cf. column 2, lines 42 to 57; Figures 2A, 2B, 3A, and 3B with the accompanying text). Each infrared lamp is connected to an independent power control system in order to ensure homogenous temperature of the wafer. Each power control system 5 is fed with a signal from a corresponding temperature sensor 6 via a feedback control system. The lamps are arranged in such a manner

that they emit light spread over and around the semiconductor wafer, i.e. the light is not focused. According to document D7, the use of infrared lamps as a heating source has the advantage over a conventional process using an electrical furnace in that the annealing time can be shortened and a more precise control of the temperature is possible (cf. D7, column 1, lines 33 to 53).

2.5 The appellant argued that a skilled person seeking to improve the conventional method of post-mold curing would not consider document D7, since it is concerned with annealing of semiconductor wafers which takes place at much higher temperatures (typically about 850 °C) than the post-mold curing, which takes place at about 175 °C (cf. item VI(c) above).

2.5.1 The Board is however not convinced by the above argument, since document D7 shows that lamps emitting infrared light can be employed successfully in the field of semiconductor device manufacturing even for very demanding applications such as high temperature annealing of semiconductor wafers. Since the temperatures required for post-mold curing are considerably lower than that of the applications envisaged in document D7, the skilled person would deduce from the teaching of document D7 that an arrangement of infrared lamps of the kind disclosed in document D7 could readily be modified for rapidly heating an encapsulated semiconductor die to temperatures of about 170 °C by appropriate adjustments of the temperature-fed feedback control system which controls the current to each infrared lamp (cf. Figure 2A with accompanying text).

2.5.2 Thus, the Board finds that the skilled person faced with the task of shortening the post-mold curing time of the known process of curing a mold would consider the teaching of document D7 using infrared lamps as heating source.

2.6 As to the spectral range of emitted infrared light (0.8 µm and 2.8 µm) (feature (ii) referred to in item 2.2 above), document D7 does not specify the type of infrared lamp, and therefore, the skilled person seeking to modify the conventional process of curing a mold by employing the teaching of document D7 would have to select a suitable type of lamp.

It is commonly known in the art to use tungsten halogen lamps or xenon high-pressure lamps as a source for high-intensity infrared light, both of which emit light in the claimed range (cf. application in suit, column 5, lines 8 to 13; document D4, Figure on page 211). Therefore, the skilled person making the routine choice from one of two of the most common types of lamps emitting infrared light would arrive at a method having all the features of claim 1.

2.7 Notwithstanding the above, the Board also notes that the application in suit fails to disclose that the claimed wavelength range contributes either independently or in conjunction with one of the other features to the reduction of the time required for post-mold curing. The only passage in the description concerning the wavelength of the emitted infrared light relates to a method of attaching a silicon die to a metallic lead frame and not to a method of curing a

mold (cf. application, column 5, column 14 to 22). This disclosure, therefore, cannot be of any relevance for the claimed method of curing a mold, since the semiconductor die is encapsulated by the mold compound and the die is therefore not directly exposed to the emitted infrared light.

Therefore, the choice of spectral range as specified in claim 1 is no more than a routine choice from the available infrared lamps as discussed above.

At the oral proceedings before the Board, the appellant was also not able to show convincingly that the claimed wavelength range had some special relevance in reducing the post-mold curing time (cf. item VI(b) above).

2.8 The appellant alleged furthermore that all the features of the method of claim 1 act in combination to reduce the post-mold time (cf. item VI(b) above).

The Board is not convinced by this argument as the alleged synergistic effect of the combination of the claimed features was not shown to exist.

Moreover, there is not hint in the application as filed that the process step of claim 1 of attaching the semiconductor die to a metallic lead, which is a standard practice in microelectronic packaging, had any influence on the curing of the mold compound.

2.9 For the above reasons, in the Board's judgement, the subject matter of claim 1 does not involve an inventive step within the meaning of Article 56 EPC. The application in suit therefore does not meet the requirements of Article 52(1) EPC for patentability.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

P. Martorana R. K. Shukla