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Datasheet for the decision of 6 December 2010

Case Number: T 0630/10 - 3.3.03

Application Number: 06075440.5

Publication Number: 1700875

IPC: C08G 59/50

Language of the proceedings: EN

Title of invention:
Curable composition having low coefficient of thermal expansion, method of making an integrated circuit, and an integrated circuit made there from

Applicant:
Delphi Technologies, Inc.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 84, 123(2)

Relevant legal provisions (EPC 1973):
-

Keyword:
"Novelty - yes"
"Inventive step - yes"
"Clarity - yes"
"Amendments - added subject-matter - no"

Decisions cited:
-

Catchword:

-

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Case Number: T 0630/10 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 6 December 2010

Appellant: Delphi Technologies, Inc.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 24 November 2009 refusing European application No. 06075440.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: R. Young
Members: M. C. Gordon
C.-P. Brandt

Summary of Facts and Submissions

I. European Patent Application no. 06075440.5, filed on 28 February 2006 and claiming priority dates of: 7 March 2005 from US serial number 60/659 294 and 31 August 2005 from US serial number 11/216 942 and published on 13 September 2006 as EP-A-1 700 875 was refused by a decision of the examining division dated and posted on 24 November 2009.

The decision was based on a set of 12 claims filed with a letter dated 5 May 2009, annexed to the decision. Although the decision referred to a set of claims dated "6.8.09" there was in fact no such set and no submission of this date. There had however been a submission dated 6 August 200**8** and a further submission, containing revised claims, dated 5 May 2009. This latter set of claims was that annexed to the decision. Claims 1, 6, 8 and 10 read as follows:

1. A curable composition, comprising

(i) a binder comprising from 98 to 100% by weight, based on the total nonvolatile weight of the binder (i), of at least one epoxy compound of the structure:

$$X\text{-}((CH_2)_m\text{-}(N)\text{-}((CH_2)_n\text{-}(Z))_2)_p$$

wherein X is an aromatic ring or a six membered cycloaliphatic ring, m is from 0 to 2, n is from 1 to 3, Z is an epoxy group of empirical formula C_2H_3O, p is a number from 2 to 3, and

(ii) a cross-linking agent comprising from 98 to 100% by weight of a polyamine selected from the group consisting of 1,3-bis(3-aminophenoxy)benzene, 1,3-bis(4-aminophenoxy)benzene, or 1,4-bis(4-aminophenoxy)benzene, based on the total nonvolatile weight of the crosslinking agent (ii),

wherein the curable composition is substantially free of fillers and has a coefficient of thermal expansion (CTE) of no more than 60 ppm/°C when the curable composition is cured for a time of from 20 to 60 minutes at temperature of from 100 to 240°C.

6. A method of making an integrated circuit assembly, comprising

applying the curable composition of claim 1 to a substrate,

placing a die in communication with the applied composition, and

curing the applied composition to provide an integrated circuit assembly,

wherein at least one of the substrate or die comprises one or more bumps.

8. An integrated circuit assembly comprising

a substrate comprising one or more substrate bumps,

a die having an active side comprising one or more flip chip bumps, said die being in communication with the substrate such that the substrate bumps are joined to the flip chip bumps, and

a cured composition in communication with the substrate and the die, and surrounding the joined bumps, the cured composition being substantially free of fillers and having a CTE of no more than 60 ppm/°C and comprising the reaction product of

(i) a binder comprising from 98 to 100% by weight, based on the total nonvolatile weight of the binder (i), of at least one epoxy compound of the structure:

$$X\text{-}((CH_2)_m\text{-}(N)\text{-}((CH_2)_n\text{-}(Z))_2)_p$$

wherein X is an aromatic ring or a six membered cycloaliphatic ring, m is from 0 to 2, n is from 1 to 3, Z is an epoxy group of empirical formula: C_2H_3O, p is a number from 2 to 3, and

(ii) a cross-linking agent comprising from 98 to 100% by weight of a polyamine selected from the group consisting of 1,3-bis(3-aminophenoxy)benzene, 1,3-bis(4-aminophenoxy)benzene, or 1,4-bis(4-aminophenoxy)benzene, based on the total nonvolatile weight of the crosslinking agent (ii).

10. A method of making an integrated circuit comprising

providing a substrate comprising one or more substrate bumps thereon,

applying a curable composition to the substrate, said curable composition being substantially free of fillers and comprising

(i) a binder comprising from 98 to 100% by weight, based on the total nonvolatile weight of the binder (i), of at least one epoxy compound of the structure:

$$X\text{-}((CH_2)_m\text{-}(N)\text{-}((CH_2)_n\text{-}(Z))_2)_p$$

wherein X is an aromatic ring or a six membered cycloaliphatic ring, m is from 0 to 2, n is from 1 to 3, Z is an epoxy group of empirical formula: C_2H_3O, p is a number from 2 to 3, and

(ii) a cross-linking agent comprising from 98 to 100% by weight of a polyamine selected from the group consisting of 1,3-bis(3-aminophenoxy)benzene, 1,3-bis(4-aminophenoxy)benzene, or 1,4-bis(4-aminophenoxy)benzene, based on the total nonvolatile weight of the crosslinking agent (ii),

placing a die on the applied curable composition , said die comprising one or more flip chip bumps,

subjecting the assembly to a temperature sufficient to cause flow and joining of the bumps, and

subjecting the assembly to a temperature sufficient to cause curing of the applied curable composition.

Claims 2-5 were dependent claims, directed to preferred embodiments of the curable composition of claim 1.

Claim 7 was directed to the integrated circuit made by the method of claim 6 comprising a cured composition having a CTE ("coefficient of thermal expansion") of from 35 to 50 ppm/°C.

Claim 9 was directed to a preferred embodiment of the integrated circuit assembly of claim 8.

Claims 11 and 12 were directed to preferred embodiments of the method of claim 10.

(a) According to the decision the claims did not meet the requirements of Art. 123(2) EPC since:
   - The feature that the curable composition was "substantially free of fillers which adjust the coefficient of thermal expansion thereof" had no sound basis in the originally filed documents;
   - The description as originally filed provided a basis for a composition being "substantially free of 'traditional' CTE adjusting fillers";
   - The omission of the term "traditional" meant that also non-traditional nanofillers were excluded, which added subject matter.

(b) The requirements of Art. 84 EPC were not met since:
   - The definition of CTE in claim 1 was not sufficiently clear;
   - The curing - and hence the thermal expansion - of a composition depended on the exact time and temperature of curing;

– Hence a composition would exhibit different CTE under different conditions and hence one and the same composition might or might not fulfil the requirement of claim 1 depending on the exact time/temperature used for curing.

(c) Novelty was acknowledged since none of the cited documents disclosed the combination of epoxy binder and crosslinker specified in operative claim 1.

(d) With regard to inventive step, although a full discussion was not possible, it was noted that the examples on file appeared to show no technical effects linked with the selection of polyamines and/or the absence of traditional fillers.

II. A notice of appeal against the decision was filed on 30 December 2009, the prescribed fee being paid on the same day.

III. The statement of grounds of appeal was filed on 18 March 2010.

A new set of 12 claims was submitted, which differed from the set of claims on which the decision was based by:

– Deletion of the curing time and temperature from claim 1;

– Insertion of the curing time and temperature formerly specified in claim 1 into claims 6 and 10

– Insertion of the term "traditional" into claims 1, 8 and 10 so that the relevant parts read "…substantially free of traditional fillers…".

(a) With regard to the objection pursuant to Art. 84 EPC, which the appellant indicated it did not fully understand, the following was submitted:

- The composition as claimed had to have a specific CTE following curing at defined ranges of temperature and time;
- It was irrelevant that different conditions would produce different CTE values as long as the resultant CTE had a value as claimed;
- There would be no difficulty for the skilled person to understand this requirement.

Nevertheless claim 1 had been amended to delete the references to time and temperature whilst references to time and temperature were introduced into claims 6 and 10, which thus now read: "…[curing] for a time of from 20 to 60 minutes at a temperature of from 100 to 240°C…".

(b) The appellant/applicant further indicated that it interpreted the decision as indicating that the invention was held to be novel and non-obvious with respect to the prior art.

IV. In a communication issued on 16 August 2010 the Board:

- Raised an objection pursuant to Art. 123(2) in respect of claim 6 since the time and temperature ranges specified for the method had been disclosed in respect of two different and distinct "curing profiles" in the application as filed;
- Raised an objection pursuant to Art. 84 EPC in respect of claim 9;
- The Board further provisionally considered that the documents cited in the search report did not

give rise to objections pursuant to Art. 54 or 56 EPC.

V. In a response dated 24 August 2010 the appellant/applicant filed an amended set of 11 claims. Former claim 9 had been deleted and the subsequent claims renumbered.
With respect to the objection pursuant to Art. 123(2) EPC in respect of claim 6 it was submitted that:

- The claimed ranges were identical to those in claim 1 as originally filed;
- The time range claimed lay within the broadest range disclosed in the application as originally filed and was a further restriction of the described process;
- Hence this was not added subject matter;
- Nevertheless the appellant/applicant indicated it was prepared to amend the temperature range in claim 6 to 160 to 220°C although no such amendments were offered at this time.

VI. In a further communication, dated 23 September 2010 the Board maintained its objection in respect of claim 6 and confirmed that the same objection arose in respect of claim 9.
Original claim 1 could not be relied upon as a basis for this subject matter since this had been directed to a "curable composition". Operative claim 6 was however directed to a method, i.e. was of a different category and relied on a different part of the original disclosure.
The Board indicated that the amendment outlined in the letter of the appellant of 24 August 2010 (see section V, above) would meet the objection.

The Board also recalled that in view of the amendments adaptation of the description would be required.

VII. With a letter dated 21 October 2010 the appellant/applicant filed two sets of 11 claims, identified as "Appendix 1" and "Appendix 2" respectively whereby Appendix 1 was to take priority.
The claims of Appendix 1 were identical to those submitted with the letter of 24 August 2010 (see section V, above).
The claims of Appendix 2 differed therefrom in that claims 6 and 9 had been amended regarding the temperature ranges.

Thus claims 6 and 9 of Appendix 2 specified curing the composition for a time for 20 to 60 minutes at a temperature of from 160 to 220°C.

With respect to the objection pursuant to Art. 123(2) EPC in respect of claims 6 and 9 of claim set Appendix 1 the appellant submitted:

- Operative claim 1 was directed to a curable composition having the same specified CTE as specified in originally filed claim 1;
- Claim 6 of Appendix 1 referred back to claim 1.
- Thus there was a direct link between claim 6 of Appendix 1 and originally filed claim 1;
- Consequently claim 6 of Appendix 1 was not objectionable pursuant to Art. 123(2) EPC;
- The same conclusion applied to claim 9 of Appendix 1;
- The corresponding claims of Appendix 2 had nevertheless been amended in line with the indications of the Board.

Amended pages 22, 23 and 24 of the description were also submitted.

VIII. The appellant/applicant requested that the decision under appeal be set aside and that a patent be granted on the basis of the set of claims according to Appendix 1, or alternatively that a patent be granted on the basis of the set of claims according to Appendix 2, each filed with the letter dated 21 October 2010.

Reasons for the Decision

1. The appeal is admissible.

2. *The claims under consideration*

The appellant/applicant has provided - with the letter of 21 October 2010 - two sets of claims (see section VII, above). The Board interprets the submissions of the appellant as indicating that the claim set of "Appendix 1" is to be treated as the main request and that of "Appendix 2" as the auxiliary request.

3. *Art. 123(2) EPC - main request/Appendix 1 (page and line references are to the originally submitted typescript).*

3.1 Claim 1 is based on:

- the disclosure of claim 1 as originally filed;
- page 7 lines 1-3 (amount of epoxy in the binder);
- Page 10 lines 8,9 (amount of cross-linking agent);

- Page 9, last complete paragraph (specified polyamides);
- Page 12, lines 24-26 (feature that the curable composition is "substantially free of traditional fillers which adjust the coefficient of thermal expansion thereof").

The final feature of claim 1, i.e. "coefficient of thermal expansion of no more than 60 ppm/°C" is disclosed at page 14, last two lines going on to page 15, first two lines in the context of the same curable composition as specified in original claim 1. Accordingly this feature is disclosed - independently of any curing conditions - in the application as filed. From this it follows that the deletion of the curing conditions (compared to original claim 1) does not result in an extension of the subject matter beyond the disclosure of the application as filed.

3.2 Claims 2-5 correspond to originally filed claims 10-13.

3.3 The method specified in operative claim 6 is, with the exception of the specified time and temperature ranges, that of originally filed claim 14.
This method is discussed in the description at page 14 starting at line 21.
According to page 14 one "reasonable" curing profile is to cure for a time of 5 minutes to several hours at temperatures of from about 100 to 240°C. This is the temperature range specified in claim 6 of the main request.
Continuing further on page 14 of the application as filed it is disclosed that "more preferred reasonable curing profiles" include times of from 20 minutes to 60 minutes at temperatures of from 160-220°C. The time

given for this profile is that specified in claim 6 of the main request.
Thus the description discloses two distinct and separate curing profiles, each with defined ranges of time and temperature. There is no statement or indication that the ranges for time and temperature disclosed for these two profiles are interchangeable. Nor are the ranges of temperature and time disclosed in the form of two separate, independent lists. On the contrary the curing conditions are disclosed only in the form of defined, linked parameter value pairs.
The appellant/applicant in its letter of 24 August 2010 has argued that the range of time given in claim 6 (20-60 minutes) is within the broader range disclosed. This statement is correct but overlooks the fact, explained above, that this time range is disclosed only and exclusively in combination with a specific temperature range, which is not that specified in claim 6 of the main request. Also since, as noted above, the time and temperatures are disclosed only as fixed combinations but not in the form of independent lists for each parameter, the application as filed does not provide any means by which a disclosure of the combination present in operative claim 6 could admissibly be constructed from the original disclosure.

The consequence is that claim 6 contains subject matter extending beyond the content of the application as filed, which is contrary to the requirements of Art. 123(2) EPC.

3.4 Claim 7 corresponds to originally filed claim 15.

3.5 Claim 8 is based on the subject matter of originally filed claim 16 (the integrated circuit assembly). The features relating to starting materials of the cured composition correspond to the subject-matter of operative claim 1 (see 3.1, above).

3.6 Claim 9 is based on a combination of original claim 18 (a method of making an integrated circuit) and operative claim 1 (the constitution of the curable composition).
However the specified curing conditions - a time of from 20 to 60 minutes at a temperature of 100 to 240°C are, as explained for claim 6, not disclosed in the application as filed (see section 3.3, above).
Consequently claim 9 does not meet the requirements of Art. 123(2) EPC.

3.7 Claims 10 and 11 correspond to claims 19 and 20 as originally filed.

3.8 Since the subject matter of claims 6 and 9 extends beyond the content of the application as filed, the main request does not meet the requirements of Art. 123(2) EPC.

3.9 The main request (Appendix 1) is therefore refused.

4. *Auxiliary request/Appendix 2 - Art. 123(2) EPC.*
This differs from the main request in that in claims 6 and 9 the temperature range is specified as "from 160 to 220°C".
This range is disclosed at page 14 line 27 in combination with a time of from 20 minutes to 60 minutes as being "more preferred reasonable curing

profiles".
Thus the combination of time and temperature specified in claims 6 and 9 of the auxiliary request is disclosed in the application as filed.

Accordingly the auxiliary request meets the requirements of Art. 123(2) EPC.

5. *Auxiliary request/Appendix 2 - Art. 84 EPC*
The decision under appeal held that the then operative claim 1 did not meet the requirements of Art. 84 EPC due to the specification of the curing conditions.
The offending wording has now been deleted.
The feature retained in the claim that the CTE is no more than 60 ppm/°C can only be interpreted, in accordance with the wording of the passage bridging pages 14 and 15 as being the properties resulting after curing the curable composition i.e. "providing a cured composition" with the specified CTE.
Consequently the Board is satisfied that the subject matter of claim 1 of the auxiliary request is clear and thus meets the requirements of Art. 84 EPC.

6. *Auxiliary request/Appendix 2 - Art. 54 EPC*
D1 (EP-A-1 657 742), a document comprised in the state of the art pursuant to Art. 54(3) EPC, relates according to claim 1 and the summary of the invention to an underfill composition for flip chip systems. This underfill system is based mandatorily on TGMX epoxy resin (tetraglycidyl meta-xylenediamine) and aminophenyl silsesquioxane as a curing agent.
TGMX epoxy resin falls within the scope of the epoxy resin specified in operative claim 1.
The amine specified in D1 is however not one of those

specified in the independent claims of the auxiliary request.

Nor do any of the other documents cited disclose the combination of epoxy and amine as required by the independent claims.
Accordingly the Board can concur with the findings of the decision under appeal that the subject matter of the claims is novel (Art. 54 EPC).

7. *Auxiliary request/Appendix 2 - inventive step*

7.1 The application in suit is directed to the provision of a curable composition having a low coefficient of thermal expansion, a method of making an integrated circuit and the resulting integrated circuit, in particular so-called "flip chip" circuits.

The description of the application in suit emphasises the need to obtain compositions with a low coefficient of thermal expansion (CTE), in particular less than 60 ppm/°C and that the provision of epoxy compositions meeting this requirement represents a challenge.

7.2 The examples of the application demonstrate that the claimed compositions achieve this aim.
Accordingly the problem set out in the application has, at least as far as this aspect is concerned, been solved.

7.3 Of the documents cited in the search report the only one to address the provision of compositions for the manufacture of flip chips is D1, which as noted above, is comprised in the state of the art pursuant to

Art. 54(3) EPC and therefore cannot be cited pursuant to Art. 56 EPC.
The other documents cited - comprised in the state of the art pursuant to Art. 54(2) EPC and hence citable under Art. 56 EPC - are however directed to different technical fields:

- D2: EP-A-0 588 120: casting resin containing iron powder, e.g. for use in the repair of metallic equipment or as a moulding material for resin moulds for metal parts;
- D3: EP-A-0 411 834 and D4: EP-A-1 454 936: Epoxy resins for fibre reinforced materials (prepregs).

7.4 Thus there is no cited document comprised in the state of the art pursuant to Art. 54(2) EPC that concerns the problem, or even the technical field which the application in suit addresses.
Under these circumstances the Board can come to no other conclusion that the subject matter claimed is not rendered obvious by the cited prior art.

7.5 Accordingly the subject matter of the claims of the auxiliary request meet the requirements of Art. 56 EPC.

8. *Adaptation of the description*

The independent claims of the auxiliary request have been restricted compared to the claims of the application as filed in respect of the permissible amine compound.
Although the appellant/applicant has furnished amended pages 22-24 of the description the general exposé has not been amended. Thus, for example at page 2 of the description there is still a reference to the amines as

specified - more broadly - in originally filed claim 1, which is thus inconsistent with operative claim (Art. 84 EPC).

Accordingly the Board considers it appropriate to remit the case to the first instance for adaptation of the description.

Order

For these reasons it is decided that:

The decision under appeal is set aside.

The case is remitted to the first instance with the order to grant a patent on the basis of the auxiliary request (claims 1-11) filed with the letter dated 21 October 2010 as "Appendix 2", and after any necessary consequential amendments to the description.

The Registrar: The Chairman:

E. Görgmaier R. Young