

BESCHWERDEKAMMERN  
DES EUROPÄISCHEN  
PATENTAMTS

BOARDS OF APPEAL OF  
THE EUROPEAN PATENT  
OFFICE

CHAMBRES DE RECOURS  
DE L'OFFICE EUROPEEN  
DES BREVETS

**Internal distribution code:**

- (A) [ ] Publication in OJ  
(B) [ ] To Chairmen and Members  
(C) [X] To Chairmen

**D E C I S I O N**  
**of 1 December 1998**

**Case Number:** T 0059/95 - 3.3.3

**Application Number:** 82101447.9

**Publication Number:** 0059434

**IPC:** C08L 79/08

**Language of the proceedings:** EN

**Title of invention:**

Multi-layer printed circuit board and process for production thereof

**Patentee:**

Hitachi, Ltd.

**Opponent:**

Ciba Spezialitätenchemie Holding AG

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56, 84

**Keyword:**

"Claims-conciseness (yes)"

"Inventive step (yes) - unexpected effect provided in an unexpected way"

**Decisions cited:**

T 0219/83, T 0751/89, T 0246/91

**Catchword:**

-



Europäisches  
Patentamt

European  
Patent Office

Office européen  
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Case Number: T 0059/95 - 3.3.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.3.3**  
**of 1 December 1998**

**Appellant:** Ciba Spezialitätenchemie Holding AG  
(Opponent) Klybeckstrasse 141  
Postfach  
4002 Basel (CH)

**Representative:** -

**Respondent:** Hitachi, Ltd.  
(Proprietor of the patent) 5-1, Marunouchi 1-chome  
Chiyoda-ku  
Tokyo 100 (JP)

**Representative:** Ebbinghaus, Dieter, Dipl.-Ing.  
Patentanwälte v. Fünér, Ebbinghaus, Finck  
Postfach 95 01 60  
81517 München (DE)

**Decision under appeal:** Interlocutory decision of the Opposition Division  
of the European Patent Office dated 13 September  
1994, issued in writing on 22 November 1994  
concerning maintenance of the European patent  
No. 0 059 434 in amended form.

**Composition of the Board:**

**Chairman:** C. Gérardin  
**Members:** R. Young  
A. Lindvist

## Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 059 434, with three claims, in respect of European patent application No. 82 101 447.9, filed on 25 February 1982 and claiming a JP priority of 4 March 1981 (JP 29909/81) was announced on 12 August 1992 (Bulletin 92/33). Claim 1 read as follows:

"A multi-layer circuit board having a plurality of unit circuit layers connected by through-holes, which comprises

(I) a plurality of unit circuit sheets having circuit layers on at least one surface of said unit circuit sheets in which a resin composition has been

impregnated in a reinforcing material and cured, and

(II) a plurality of prepreg resin sheets in which a resin composition has been impregnated in a reinforcing substrate and cured, wherein the unit circuit sheets and prepreg resin sheets are laminated and bonded alternatively, with heating under pressure to form a multi-layer laminate,

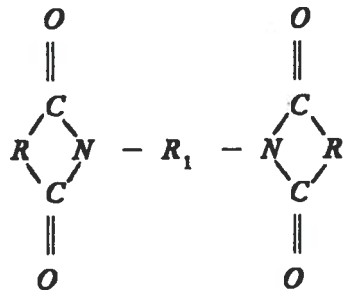
(III) outermost layer circuit patterns, which are formed on the outermost surfaces of said laminate by etching, and

(IV) through-holes on the multi-layer laminate, which connect the circuit layers and outermost layer circuit patterns with plating of the through-holes,

**characterized** in that the resin composition for at least the prepreg resin comprises

(III) a prepolymer obtained by preliminarily reacting with heating

(a) a bisimide of the formula



(1)

wherein R is a divalent organic group having at least one carbon-carbon double bond; and R<sub>1</sub> is a divalent organic group having at least two carbon atoms, and

(b) a diamine of the formula

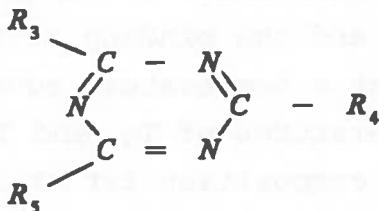


(2)

wherein R<sub>2</sub> is a divalent organic group having at least two carbon atoms,

(II) an epoxy resin, and

(III) at least one amine selected from the group consisting of a s-triazine type amine compound of the formula:



(3)

wherein  $R_3$ ,  $R_4$ , and  $R_5$  are independently hydrogen, halogen, a hydrocarbon group, an amino group, a hydroxyl group, an amino-substituted hydrocarbon group, a hydroxyl-substituted hydrocarbon group, or a hydrocarbon-substituted amino group, and at least one of  $R_3$ ,  $R_4$ , and  $R_5$  being an amino group or an amino-substituted hydrocarbon group, and dicyandiamide."

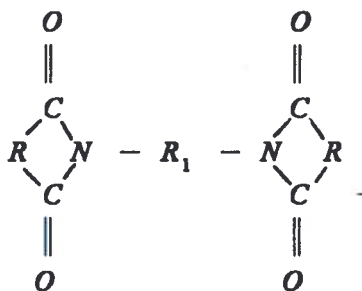
Claim 2, an independent claim, was worded, after correction of a printing error, as follows:

"A process for producing a multi-layer circuit board according to claim 1 which comprises laminating a plurality of unit circuit sheets having circuit layers on at least one surface of said unit circuit sheets in which a resin composition has been impregnated and cured, via prepreg resin sheets, said prepreg resin sheets having been prepared by impregnating a reinforcing substrate with a resin composition, binding the laminated sheets with heating under pressure to form a multi-layer laminate, drilling through-holes on the multi-layer laminate, followed by plating of the through-holes, and forming outermost layer circuit patterns by etching, **characterized** in that the resin composition for the

prepreg resin is cured by heating it at a temperature equal to or lower than both the glass transition temperature ( $Tg_1$ ) of the cured resin in the unit circuit sheets and the glass transition temperature ( $Tg_2$ ) of the cured resin in the prepreg resin sheets after curing, and the binding of the laminated sheets is performed at a temperature equal to or lower than both the temperatures of  $Tg_1$  and  $Tg_2$  and the resin composition for at least the prepreg resin comprises

(I) a prepolymer obtained by preliminarily reacting with heating

(a) a bisimide of the formula



(1)

wherein R is a divalent organic group having at least one carbon-carbon double bond; and  $R_1$  is a divalent organic group having at least two carbon atoms, and

(b) a diamine of the formula

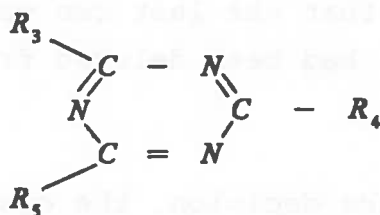


(2)

wherein R<sub>2</sub> is a divalent organic group having at least two carbon atoms,

(II) an epoxy resin, and

(III) at least one amine selected from the group consisting of a s-triazine type amine compound of the formula:



(3)

wherein R<sub>3</sub>, R<sub>4</sub>, and R<sub>5</sub> are independently hydrogen, halogen, a hydrocarbon group, an amino group, a hydroxyl group, an amino-substituted hydrocarbon group, a hydroxyl-substituted hydrocarbon group, or a hydrocarbon-substituted amino group, and at least one of R<sub>3</sub>, R<sub>4</sub>, and R<sub>5</sub> being an amino group or an amino-substituted hydrocarbon group, and dicyandiamide."

Claim 3, a dependent claim, was directed to an elaboration of the process according to Claim 2.

II. Notice of Opposition was filed on 5 May 1993 on the ground of lack of inventive step. The opposition was supported *inter alia* by the documents:

D1: DE-A-2 559 417; and

D3: Chemical Abstracts, 130471c, 89, 1976, corresponding to JP-A-1978-55 399, considered in the form of an English sworn translation (D3b).

III. By an interlocutory decision which was given at the end of oral proceedings held on 13 September 1994 and issued in writing on 22 November 1994, the Opposition Division found that the patent in suit could be maintained in amended form, on the basis of an auxiliary request, filed as "Auxiliary Petition II", on 22 August 1994 and including a set of Claims 1 to 3. The claims differed from the corresponding claims as granted in that the last two words "and dicyandiamide" had been deleted from Claims 1, 2 and 3 respectively.

According to the decision, the claimed subject-matter differed from the closest state of the art, D1, which disclosed a multi-layer circuit board having a plurality of through-holes connecting the unit circuit layers, and alternating prepreg resin sheets prepared from a resin composition comprising

- a) a diamino bismaleinimide prepolymer,
- b) an epoxy resin, and
- c) a maleic anhydride copolymer,

only in that component c) had been replaced by an s-triazine.

The problem to be solved was that of providing further (or "better") multi-layer printed circuit boards with high through-hole reliability. Although the use of s-triazines was disclosed in D3b, there was no explicit link to the technical problems associated with copper-clad laminates. In any case, component c) belonged to the core of the subject-matter of D1 and was therefore not exchangeable. Consequently, there was an inventive step.



IV. On 20 January 1995, a Notice of Appeal against the above decision was filed, together with payment of the prescribed fee.

In the Statement of Grounds of Appeal, filed on 24 March 1995, the Appellant (Opponent) argued in substance as follows:

(a) Whereas the broadest definition of the multi-layer printed circuit board in the application in suit as originally filed had been limited to matrix resins for the unit circuit sheets based on a relationship between the glass transition temperature  $Tg_1$  of the cured such resin and the curing temperature of the prepreg resin, these temperature requirements had been deleted, so that the definition now covered all resins. Consequently, the subject-matter of Claim 1 extended beyond the content of the application as filed (Article 123(2) EPC).

(b) The finding in the decision under appeal that it would not have been obvious to exchange component c) of D1 for an s-triazine was wrong, since, in the search for the solution to the technical problem which, as here, called for an alternative, the skilled person could not forgo the option of replacing one or more components of the prepreg resin composition. In this connection, it was clear that, of the three components of the composition used according to D1, component c) was the one which, having a merely supporting function, was replaceable. Furthermore, the technical field of D3 was the same as that of that of D1. Finally, the curing

properties associated with the triazine in D3 were precisely what was required in D1. Consequently, there was no inventive step in the exchange.

- (c) Analogous arguments applied to the subject-matter of Claim 2, since the relationships to Tg<sub>1</sub> and Tg<sub>2</sub> were automatically fulfilled and thus inherent.

V. The Respondent (Patentee) argued, in a submission filed on 22 September 1995, substantially as follows:

- (a) The only reason for leaving out the references to Tg<sub>1</sub> and Tg<sub>2</sub> was because they had been regarded as unnecessary by the Examining Division. The Respondent would be prepared to re-insert them in Claim 1.
- (b) The arguments submitted by the Appellant with regard to inventive step were no different from those brought in the opposition proceedings, which had been unsuccessful. Reference was made to the written counterarguments in the opposition proceedings (submission filed on 22 August 1994).
- (c) With regard to D3, this used a bismaleimide instead of a prepolymer of a bismaleimide and a diamine. Furthermore, the very fast curing time at around 140°C in D3 was an undesirable characteristic compared with the compositions according to the patent in suit, which had a slow curing speed at below 150°C, but cured rapidly at above 160°C. Finally, the teaching of the relevant Example 4 of D3 was not applicable

to the patent in suit, since it gave inferior values of flexural strength, both in resin plate and in prepreg form, of thermal expansion coefficient and of glass transition temperature.

The submission was accompanied by an "Additional Test Report" to demonstrate the superiority of the claimed compositions over those according to D3.

- VI. Following the issue, on 30 September 1998, of a communication by the Board, accompanying a summons to oral proceedings, which questioned, *inter alia*, the admissibility of the issue, raised by the Appellant for the first time in appeal, under Article 123(2) EPC, and raised certain issues of clarity in relation to the claims, the Respondent filed, on 29 October 1998, two further sets of Claims 1 to 3 and corresponding adapted pages of description, designated "Enclosure A" and "Enclosure B", forming a new main and auxiliary request, respectively.

The submission was accompanied by a technical report, entitled "Measurement of Tg in D1", to show that the glass transition temperature, Tg, of the prepreg resin according to Example 1 of D1 was considerably lower than that according to Example 1 of the patent in suit, and by a "Comparative Experiment", to show that the s-triazine component according to the patent in suit indeed contributed to improved properties.

- VII. Oral proceedings were held on 1 December 1998. During the oral proceedings, the Respondent withdrew his main request, and elected to prosecute the appeal on the basis of the auxiliary request (Enclosure B), subject to certain amendments to Claim 1 and the corresponding passage on page 3 of the patent in suit. The Appellant withdrew his objection under Article 123(2) EPC.

Claim 1 of the sole request differs from that of the auxiliary request underlying the decision under appeal (Section III, above) in that there has been added, at the end of the claim, i.e. after "amino-substituted hydrocarbon group", the phrase "said resin composition for at least the prepreg resin having been cured and the laminated sheets bound by heating at a temperature equal to or lower than both the glass transition temperature ( $Tg_1$ ) of the cured resin in unit circuit sheets and the glass transition temperature ( $Tg_2$ ) of the cured resin in the prepreg resin sheets after curing."

Page 3 of the description differs from that underlying the decision under appeal in that the same phrase has been inserted, at line 41, in the statement of invention corresponding to Claim 1.

Claims 2 and 3 are unchanged compared with the version of "Auxiliary Petition II", underlying the decision under appeal (Section III, above).

VIII. The Appellant requested that the decision under appeal be set aside, and the patent in suit revoked in its entirety.

The Respondent requested, as sole request, that the decision under appeal be set aside, and the patent maintained on the basis of the sole request filed during oral proceedings, i.e. the following text:

Claims:

Amended Claim 1 as filed on 1 December 1998, and Claims 2 and 3 filed on 29 October 1998 (Enclosure B);

Description:

pages 2 and 4 to 12 filed on 29 October 1998 (Enclosure B); and page 3 filed on 1 December 1998.

## Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

There is no objection to the insertion of the curing temperature limitation in Claim 1 (Section VII, above), since this was supported by the relevant corresponding limitation in independent process Claim 2 of the patent in suit as granted.

The amended passage of description corresponds to amended Claim 1.

No objection to the amended text was raised under Article 123(2) or 123(3) EPC, the previous objection of the Appellant under Article 123(2) EPC to the absence of all reference to the curing temperature (Section IV(a), above) having been withdrawn. Nor does the Board see any reason to raise such an objection of its own. Hence, the text on which the decision is based is held to meet the requirements of Article 123 EPC.

3. *Article 84 EPC; conciseness*

The Appellant objected, at the oral proceedings, that the amended claims as a whole did not meet the requirements of conciseness of Article 84 EPC, in that the subject-matter of Claim 1, which was a product-by-process claim, was already protected, by virtue of Article 64(2) EPC, by process Claim 2. There was thus no suggestion of a lack of conciseness in the wording

of any individual claim. On the contrary, the only objection was essentially that there were two claims where one would have done. This argument is not, however, convincing to the Board, for the following reasons:

- 3.1 Firstly, such an objection falls, in the Board's view, rather in the domain of Rule 29(5) EPC relating to what is a reasonable number of claims, than of Article 84 EPC. Only in an extreme case could such an objection be validly maintained under Article 84 EPC.
- 3.1.1 In this connection, another Board has held, in the case of an application having 157 claims, that whilst no hard and fast definition could be accorded the term "reasonable", nevertheless, to form a valid and commercially useful opinion on whether or not any one of these claims could prevent or hinder the commercial activities had, in the nature of things, to impose a severe and totally undue burden on the public, so that the application fell foul not only of Rule 29(5) EPC but also of Article 84 EPC (T 0246/91 of 14 September 1993, not published in OJ EPO; Reasons for the decision, points 7.1 and 7.2).
- 3.1.2 In the present case, however, the issue hangs on the burden imposed by only two claims. Such a burden cannot, in the Board's view, be severe or undue.
- 3.1.3 On the contrary, if such a burden were held to be severe or undue, this would practically exclude the drafting of any dependent claim, since such a claim could always be objected to on the basis that it re-claimed subject-matter already protected by a broader, antecedent main claim, and was therefore redundant.

3.1.4 Quite apart from this, the Board is not satisfied that the product protection accorded, pursuant to Article 64(2) EPC, by Claim 2 is necessarily identical with that conferred by Claim 1 in the present case, because the former provision extends only to the products **directly** obtained, whereas the latter is not subject to any corresponding restriction as to its interpretation under the EPC (cf. Article 69(1) EPC).

3.1.5 In summary, the Board is unable to discern any lack of conciseness in the claims of the sole request.

Consequently, this requirement of Article 84 EPC is held to be met.

4. *The patent in suit; the technical problem*

The patent in suit relates to a heat resistant, dimensionally stable, multi-layer printed circuit board having a plurality of through-holes connecting the unit circuit layers, alternating with prepreg resin sheets prepared from a resin composition comprising

- a) a diamino bismaleinimide prepolymer;
- b) an epoxy resin, and
- c) a further non-neutral component capable of affecting the cross-linking density of the resin components (cf. Claim 1).

Such a printed circuit board is, however, known from D1, which by common consent represents the closest state of the art.

4.1 According to D1, the resin composition used in the prepreg layers of the printed circuit board comprises, as component c), a thermally stable high molecular weight copolymer of one or more aromatic vinyl compounds, preferably styrene, with maleic anhydride or a partial alkyl ester thereof, having a number average molecular weight of 1 000 to 60 000. Owing to the high carboxylic anhydride or carboxyl group content, the copolymer can react not only with the polyepoxy compound but also with the residual amino groups in the polyaminobismaleimide to increase the density of cross-linking between the resin components (Claim 1; page 14, lines 10 to 18).

The addition of component c) counteracts the decrease in heat resistance caused by the presence of the epoxy resin, and furthermore brings about an improvement in the adhesive properties to metal foil, especially copper foil, sufficient for the drastic conditions to which a multi-layer printed circuit board is in practice exposed, as well as a level of reactivity so that the resin composition can be cured adequately at 150 to 170°C (page 14, line 19 to page 15, line 13).

A moulded laminate produced in this manner has satisfactory properties without being after-baked. However, in order to relieve the strain developed during the moulding cycle and to develop effectively the excellent dimensional stability of the resin composition, it is preferable to subject the moulded laminate to heat treatment to a certain extent, and, if necessary, the moulded laminate may be after-baked at 180 to 250°C for up to 20 hours (page 17, lines 10 to 19).

According to Example 1, a 0.1 mm thick  $\gamma$ -glycidoxypropyltriethoxysilane-treated glass cloth is impregnated with a varnish containing 45 wt% of a



resin composition comprising a) a polyaminobismaleimide formed by the reaction of N,N'-4,4'-diphenylmethanebismaleimide with 4,4'-diaminophenylethane (molar ratio 1:1) in the molten state (100 pbw); b) a bisphenol-A type diglycidyl ether having an epoxy equivalent of 450 to 500 (100 pbw); and c) a styrene-maleic anhydride copolymer containing 50 mole% of maleic anhydride (10 pbw), and dried to form a B-stage resin (pages 20 to 23). Such prepregs are furthermore used, according to Example 10, to assemble an eight-layer board, 2.0 mm in thickness, by lamination, under heat and pressure (170°C at 50 kg/cm<sup>2</sup> for 2 h), of three sheets of an inner circuit board formed from a two-side copper-clad laminate bearing a high density pattern, two outermost sheets of copper-clad laminate with copper foil on one side, and intermediate sheets of a 0.1 mm thickness glass fibre prepreg. The board, having been provided with surface circuits and through holes, is tested *inter alia* for dimensional stability and inner layer peel strength (pages 29, 30). The board shows a negative dimensional change, after formation of the circuit, of 0.01%, compared with 0.03% for an epoxy type printed circuit board, and an inner layer peel strength of 1.3 kg/cm, compared with 0.7 kg/cm for an epoxy-type board (Table 4, page 37).

Furthermore, according to Example 12, read in conjunction with Example 3, a 0.3 mm thick sheet of mixed glass-asbestos paper is impregnated with a varnish containing a (i) polyaminobismaleimide formed by the reaction of N,N'-4,4'-diphenylmethanebismaleimide with 4,4'-diaminophenylmethane (molar ratio 2:1) in the molten state (100 pbw); (ii) a brominated bisphenol-A type diglycidyl ether having an epoxy equivalent of 450 to 500 (30 pbw), and (iii) a maleic anhydride- $\alpha$ -methyl-p-isopropylstyrene copolymer containing 30 mole-% of

maleic anhydride (30 pbw). A stack of six such sheets is laminated under heat and pressure (180°C at 100 kg/cm<sup>2</sup> for 2.5 h) with a 0.1 mm thick nichrome foil to obtain a one-side nichrome-clad laminate, 1.6 mm in thickness. This laminate has a heat distortion temperature of 182°C and could be used, for instance in a heat resistant resistor circuit board (pages 39, 40).

4.2 With the trend to greater compactness and densification of the multi-layer circuit boards, however, a disadvantage limiting the number of layers has been the need for greater dimensional stability between layers and higher through-hole reliability (patent in suit, page 2, lines 5 to 9). Compared with the state of the art represented by D1, therefore, the technical problem may be seen as the provision of an improved multi-layer printed circuit board characterised by a further degree of heat resistance and dimensional stability, in particular with respect to through-hole reliability.

4.3 The solution proposed according to Claim 1 of the patent in suit is to replace component c) by certain amino s-triazines as defined under (III) of Claim 1, so that the resin composition for at least the prepreg can be cured and the laminated sheets bound by heating at a temperature equal to or lower than both the glass transition temperature ( $T_{g1}$ ) of the cured resin in the circuit sheets and the glass transition temperature ( $T_{g2}$ ) of the cured resin in the prepreg sheets after curing, and curing at such a temperature.

4.3.1 The effect that curing may be carried out at a temperature below the glass transition temperature of the prepreg itself after curing is confirmed by Example 1 of the patent in suit, in which the prepreg, after curing at 170°C, was found to have a glass

transition temperature of 210°C (Table 1). This removes the necessity of after-baking and thus eliminates a source of lateral positional shift of a pad relative to a through hole, resulting in higher "through-hole reliability" (submission filed on 22 August 1994, pages 4 and 5). The "maximum positional shift" recorded in Example 1 is about one third that found in a commercial epoxy type multi-layer board. Such a low positional shift in turn enables a larger number of circuit layers to be stacked without unacceptable loss of register (Respondent's submission filed on 22 September 1995, pages 5 and 6 in conjunction with the drawing "High Density Multilayer PWB Bonding").

4.3.2 Whilst D1 is concerned, in general terms, with dimensional stability of printed circuit boards, there is no mention of lateral positional shift between layers. On the contrary, the only measure of dimensional stability given in D1 is in terms of the coefficient of thermal expansion, perpendicular to, and in the plane of, the printed circuit board (Example 10, Table 4). This is, however, a characteristic of the board as a whole, whereas the through-hole reliability is dependent on lack of movement between layers of the board, and is thus an "intra-board" phenomenon.

4.3.3 The argument of the Appellant, that the process according to D1 also does not require after-baking of the printed circuit board, is not itself evidence that D1 provides the same result as the patent in suit. In any case, the disclosure of D1 is equivocal on this point, stating that post-curing is "preferable", *inter alia* to develop effectively the dimensional stability of the resin (page 17, lines 10 to 19).

4.3.3.1 In the latter connection, whilst it is stated in Example 1 of D1 that the copper-clad laminate shows only small differences (improvements) in thermal characteristics, such as thermal expansion coefficient perpendicular to the laminate, when it has been subjected to after-baking (page 22, last paragraph before "Vergleichsbeispiel 1"; and Table 1, columns "Example 1" and "Example 1(after-cured)"), this applies to only one laminate without through-holes and hence has no relevance to the provision of "through-hole reliability".

4.3.3.2 Consequently, the reference to the optional nature of an after-baking step in D1 is not evidence of any capability of providing through-hole reliability in the sense of the patent in suit.

4.3.4 The further argument of the same party, that because the "in-plane" coefficient of thermal expansion of a printed circuit board according to Example 10 in D1, and the "maximum positional shift" according to the patent in suit were in each case about one third that of a commercial epoxy-type printed circuit board (Sections 4.1, 4.4, above), the measure of dimensional stability must be the same, is also not convincing, because of the fundamentally different nature of the phenomena lying behind the two parameters (Section 4.3.2, above).

4.3.5 Quite apart from this, there is no mention in D1, of the Tg of the resins being above their temperature of curing.

4.3.5.1 On the contrary, according to evidence filed by the Respondent, of an attempt at measuring the value of Tg in D1, this lay **below** the curing temperature ("Additional Experimental Report", filed on 29 October 1998). Whilst this was criticised by the Appellant at

the oral proceedings, both on the basis that the alleged difficulties in drying the sample prior to curing indicated a deficient experimental technique, and that the existence of two Tg peaks meant that the finding was ambiguous, no counterevidence was filed by the Appellant to show that Tg lay higher than the curing temperature in D1. Yet at this stage of the proceedings, the onus was on the Appellant to do this. Consequently, even if the evidence of the Respondent is ignored, it cannot be concluded that Tg in Example 1 is higher than the curing temperature.

4.3.5.2 The argument of the Appellant, put forward for the first time at the oral proceedings before the Board, that there was an implicit disclosure, in Example 12 of D1, of curing at a temperature below the glass transition temperature of the relevant resin, in particular on the basis of the heat deflection temperature (HDT) quoted in the latter, relied on an assertion that it belonged to the general knowledge of the skilled person that the glass transition temperature was always higher than the corresponding HDT. This argument is not convincing, however, for the following reasons. Firstly, it implies that Tg, which corresponds to the first detectable change of polymer structure, as measured either by change of enthalpy or change of coefficient of expansion, is only detected once the entire sample has been heat-softened to the extent of deflecting under its own weight. That such a reversal of cause and effect is possible and indeed the rule, rather than an exception is, in the Board's view, contrary to the normal understanding of this phenomenon. Consequently, it is *a fortiori* unlikely that such a reversal could belong to the general knowledge of the skilled person. Secondly, the assertion was contradicted by the Respondent, who maintained that Tg was generally known to lie below the HDT.

Whilst the Appellant alleged that his assertion could be documentarily substantiated, no particular document was mentioned. Even if it had been, however, this would have involved the admission of new evidence during the oral proceedings, to which the Respondent would have had no adequate opportunity to reply. This, taken together with the low level of inherent credibility of the assertion, would not, in the Board's view have justified such an extension of the proceedings.

In any case, the two parties in the case must each be regarded experts in the relevant field and the Board would, therefore, following the relevant case law, have been obliged to resolve the issue in favour of the Patent Proprietor, in this case the Respondent (cf. T 0219/83, OJ EPO 1986, 211).

Finally, there is no mention of Tg in Example 12.

4.3.5.3 In summary, the Board has reached the conclusion that the Appellant has failed to show that D1 discloses, even implicitly, the curing of a resin impregnated laminate at a temperature below the glass transition temperature of the resin. The argument of inherency (Section IV(c), above) must therefore also fail.

4.3.6 In other words, the solution of the stated problem is distinguished from the disclosure of D1 not only by the through-hole reliability achieved (Section 4.3.1, above), but also the relationship of the curing temperature to the glass transition temperature of the resin, brought about by the choice of component (c) of the prepreg resin. This corresponds to a further degree of dimensional stability compared with D1. Consequently, it is credible to the Board that the claimed measures provide an effective solution of the stated problem.

5. *Novelty*

The novelty of the claimed subject-matter was not disputed. Nor does the Board see any reason of its own to take a different view. Consequently, the subject-matter of Claims 1 to 3 is held to be novel.

6. *Inventive step*

In the assessment of the issue of inventive step, it is necessary to ask whether the skilled person would have realised, starting from the disclosure of D1, that improved accuracy of register between the layers of a printed circuit board and thus improved through-hole reliability could be achieved, by replacing component (c) of D1 by an amino-s-triazine curing agent, thus enabling curing to take place at a temperature below  $T_g$ .

6.1 There is no suggestion to do this in D1, because the latter document does not disclose the concept of through-hole reliability, or of any particular relationship of curing temperature to  $T_g$ , let alone of replacing component (c) with an amino-s-triazine. On the contrary, component (c) is presented in D1 as an essential feature, i.e. not replaceable at all.

6.1.1 The argument of the Appellant, that the skilled person would have no choice but to consider such an exchange, was made on the basis of the decision T 0751/89 of 4 September 1989. Closer consideration of this decision, however, shows that it relates to a non-chemical field, in which the contemplated exchange would have "foreseeable consequences" (Reasons for the Decision, point 4.5). In the present case, however, the mere fact that component (c) is an essential feature means that some major change of effect would be expected if it were omitted. Such major changes are not, in

general, predictable in the polymer field with any degree of qualitative, let alone quantitative accuracy. Nor, in the particular case of D1, is there any reason to predict the relevant effect, since D1 does not even hint at such a possibility. Consequently, there is no basis for regarding an exchange of component (c) in D1 as a technical option for the skilled person, let alone a mandatory choice.

- 6.1.2 Even if, in spite of the above, the skilled person were nevertheless for some reason to consider such a replacement, there is nothing in D1 to suggest the use of an amino-s-triazine instead. On the contrary, the search in such a case would logically be for substances as similar as possible to component (c) of D1. An amino-s-triazine, being a low molecular weight amine base, however, is diametrically opposed in properties to component (c) in D1, which is a high molecular weight acidic compound containing carboxylic anhydride or carboxylic ester groups. Consequently, there is no hint to the solution of the stated problem in D1.
- 6.2 The argument that component (c) in D1 acts as a curing agent, and that the relevant amino-s-triazines were known from D3b as curing agents for systems of the type disclosed in D1 is supported neither by the disclosure of D1 nor by that of D3b.
- 6.2.1 In particular, as regards D1, whilst component (c) is stated to react with both the bismaleimide-diamine prepolymer and the epoxy resin and to result in a higher concentration of cross-linking (Claim 1; page 14, second paragraph), it is not stated to be a curing agent. On the contrary, according to



Comparative Example 3 (Vergleichsbeispiel 3) of D1, in which component (c) is omitted, a cured product is nevertheless obtained. Consequently, there is no basis for concluding that the skilled reader of D1 would regard component (c) as a curing agent.

6.2.2 Furthermore, as regards D3b, according to which an epoxy resin is melt kneaded with the triazine compound and a N,N-bismaleimide (Claim 1), the system differs from that of D1 additionally in that it does not comprise a bismaleimide-diamine prepolymer. Indeed, the formation of a prepolymer is referred to in D3b as being unsatisfactory, not only from the point of view of expense, but also as risking low storage stability (page 3, penultimate sentence). The argument of the Appellant, that the skilled person would realise that this was only a case of accepting a disadvantage to save cost, and therefore would modify the bismaleimide accordingly, is therefore not supported by the disclosure of D3b. On the contrary, to arrive at such a modification would involve ignoring an essential feature of the teaching of D3b as well as changing an essential feature of D1. Such a systematic contradiction of the central teachings of the state of the art cannot be regarded as an obvious step for the skilled person to take.

6.2.3 Consequently, there is no hint to a solution of the stated problem arising from the disclosure of D3b.

6.3 In summary, the solution does not arise in an obvious way from the state of the art. Rather, it provides an unexpected result in an unexpected way. Consequently, the subject-matter of independent Claims 1 and 2, which are both limited to the relevant features of the solution of the stated problem, and also that of Claim 3, which is directly dependent on Claim 2, involves an inventive step.

**Order**


**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the Opposition Division with the order to maintain the patent on the basis of Claim 1 (part) filed on 1 December 1998, Claims 1 (part), 2 and 3 filed on 29 October 1998 (as "Enclosure B") and the following description:
  - pages 2 and 4 to 12 as filed on 29 October 1998 (as "Enclosure B");
  - page 3 as filed on 1 December 1998.

The Registrar:

  
E. Gorgmaier

The Chairman:

  
C. Gérardin