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D E C I S I O N
of 29 January 2003

Case Number: T 0728/01 - 3.4.2

Application Number: 93117992.3

Publication Number: 0616489

IPC: H05K 3/38, H05K 3/02

Language of the proceedings: EN

Title of invention:
Copper-clad laminate and printed wiring board

Patentee:
POLYCLAD LAMINATES, INC.

Opponent:
Isola AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no"

Decisions cited:
-

Catchword:
-



Case Number: T 0728/01 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 29 January 2003

Appellant: POLYCLAD LAMINATES, INC.
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 18 January 2001
revoking European patent No. 0 616 489 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: A. G. M. Maaswinkel
G. E. Weiss

Summary of Facts and Submissions

I. The appellant (proprietor of the patent) lodged an appeal, received on 9 February 2001, against the decision of the opposition division, dispatched on 18 January 2001, revoking the European patent No. 0 616 489 (application No. 93 117 992.3). The fee for the appeal was paid on 13 February 2001. The statement setting out the grounds of appeal was received on 24 May 2001.

Opposition had been filed against the patent as a whole on the basis of Article 100(a) EPC in combination with Articles 52(1) and 56 EPC. To support its objections the opponent referred to documents D1 to D6. After expiration of the nine month period according to Article 99(1) EPC the opponent filed further documents D7 and D8 with respective translations D7a and D8a. The opposition division did not admit these documents in the proceedings under Article 114(2) EPC.

With a letter dated 6 March 2002 the respondent (opponent) requested to admit these documents and newly cited documents D9 and D10 to the appeal proceedings.

In a letter dated 23 December 2002 the appellant made reference to a declaration D11 and to exhibits A, B and C in support of its case.

II. On 29 January 2003 oral proceedings were conducted according to an auxiliary request of the respondent.

At the oral proceedings the appellant requested that the decision under appeal be set aside and that the patent be maintained unamended (main request) or, in the alternative, on the basis of the first or second auxiliary requests submitted with the statement of grounds of appeal.

The respondent requested that the appeal be dismissed.

III. The numbering of the documents referred to in this decision reads:

(D1) US-A-4 997 516

(D7) JP-A-5 29740

(D7a) English translation of D7

(D8) JP-A-64 64392

(D8a) English translation of D8

(D9) Proceedings of the Printed Circuit World Convention 5, Glasgow (1990) Technical Paper B8/1, Fujio Kuwako et al., "A New Very Low Profile Electrodeposited Copper Foil";

(D10) Proceedings of the Printed Circuit World Convention 5, Glasgow (1990) Technical Paper A7/1, P.L. Britton et al., "Conductor Line Imaging - Dry Film or Liquid Photoimaging Technology?";

(D11) Expert Report of Steven A. Ostrow;

Exhibit A IPC-TM-650 Test Methods Manual;

Exhibit B Report of T.J. Williams "Effect of Etching Factor and Dielectric Constant on Impedance";

Exhibit C Printed Circuit Design Magazine, March 1998, D. Brooks "PCB Impedance Control: Formulas and Resources".

IV. The wording of claim 1 according to the main request reads as follows:

" A copper clad laminate which consists essentially of an electrolytic copper foil (1) and a substrate (3), said substrate (3) having two sides, said electrolytic copper foil (1) having a glossy surface side (1a) and a matte surface side (1b), said glossy surface side (1a) is bonded through a granular copper layer (2) to at least one side of said substrate (3), characterized in that said granular copper layer (2) is electrodeposited to a height of 0.2 - 2.0 μ m on said glossy surface side (1a)".

The wording of claim 1 according to the first auxiliary request reads as follows:

" A printed wiring board prepared by etching a copper clad laminate which consists essentially of an electrolytic copper foil (1) and a substrate (3), said substrate (3) having two sides, said electrolytic copper foil (1) having a glossy surface side (1a) and a matte surface side (1b), said glossy surface side (1a) is bonded through a granular copper layer (2) to at

least one side of said substrate (3), in the direction from said matte surface towards said glossy surface, characterized in that said granular copper layer (2) is electrodeposited to a height of 0.2 - 2.0µm on said glossy surface side (1a)".

The wording of claim 1 according to the second auxiliary request is identical to that of claim 1 of the first auxiliary request with the addition of the feature "...and the printed wiring board has a fine pitch wiring pattern of up to 150µm" at the end of the claim.

V. The appellant's arguments may be summarised as follows.

The closest prior art for the subject-matter of independent claim 1 of all requests is disclosed in document D1 which relates to a method for improving the adherence of copper foils to resinous substrates. The method involves treating an oxidised copper surface by reducing it and then further treating in a specified manner. In column 7, lines 26 to 39 the document discloses a special treatment for producing a multilayer laminate, in which case the shiny side of the copper foil is subjected to electrolytic deposition of copper microdendrites, which layer increases the peeling strength of the foil when laminated to the substrate. There is no disclosure in document D1 of the thickness of this layer nor is there any discussion of the improved etching factor resulting from the selection of the height of this layer as recognised in the present invention. The objective problem solved by the invention is the provision of a high etch factor. The solution of this problem, the selection of the narrow range of a height between 0.2µm and 2.0µm, is

not obvious, because document D1 merely teaches to roughen the shiny copper surface in order to increase the peeling strength if this surface is laminated. The man skilled in the art would therefore expect that in order to increase the peeling strength it would be more advantageous to select a thicker layer, rather than the very thin layer of the claimed range. The reference in the patent specification in column 1, lines 44 to 46 to a prior art process in which copper particles of size 0.2 to 3.5 μ m are applied to improve the strength of peeling from the substrate is not relevant for the range defined in claim 1. Firstly, the *size* of the copper particles is not indicative for the *height* of the deposited layer because the granular layer may comprise plural layers of stacked particles in which case the height would be larger than the particle size. Furthermore the cited passage refers to roughening of the *matte* surface of a copper foil by depositing granular particles, and in fact, apart from the citation in document D1, none of the prior art documents discloses or suggests to deposit copper granular particles on the shiny side of a copper foil.

The range for the height of the granular layer in claim 1 is selected by the consideration that it should provide an acceptable adherence, which determines the lower value of 0.2 μ m, and, on the other hand, provide a high etch factor, which determines the upper value. This is shown in the examples of the patent specification. The height of the granular layer is calculated by subtracting the value of the base roughness of the foil prior to treatment from the total roughness after the electrodeposition treatment. In Example 1 the height of the layer is calculated as 1.5 μ m and the etch factor amounts to 9.0. Furthermore

in Example 2 the layer height is $1.6\mu\text{m}$ and the etch factor is 8.4. These examples show that for the height values smaller than $2.0\mu\text{m}$ the etch factor is high. To further corroborate the effect of the height of the granular layer on the resulting etch factor Mr Ostrow has carried out additional measurements of the etch factor for a layer of approximately $2\mu\text{m}$ height which results are summarised in the report D11. It is submitted that the procedure for measuring the height of the granular layer in these measurements is the same as in the examples in the patent and is carried out according to the method in the Exhibit A. As discussed in the report D11, for layers of $1.97\mu\text{m}$ to $2.04\mu\text{m}$ height an etch factor value of approximately 3 is found. The further calculations carried out by Mr Williams and reported in Exhibit B based on the formulas in Exhibit C demonstrate that if the etch factor drops below a value of 3 the impedance of a microstrip trace will deviate from a designed value of e.g. 50 ohms by more than 5 ohms which would not be acceptable. Therefore the upper value of the height of the granular layer should not exceed the value of $2.0\mu\text{m}$ to ensure that the etch factor is at least 3. The prior art has not recognised the relevance of the height of the granular layer for the etching factor; furthermore, D1 is the only document disclosing to laminate a copper foil with its shiny side to a resinous substrate and teaches to improve the peeling strength by depositing a layer of copper dendrites, therefore the skilled person would expect that selecting a thicker layer would be more advantageous, which teaches away from the invention. Also the other cited documents do not lead to a different view. In particular, none of the documents D7 to D10 offers any teaching relating to electrodeposition of a granular layer onto the glossy

surface of an electrolytic copper foil, nor do they relate to practices wherein etching is initiated from the matte side of such a foil.

As to the auxiliary requests, claim 1 of the first auxiliary request is directed to a printed wiring board, for which boards the property of having a high etching factor is highly important. The second auxiliary request includes the additional feature that the wiring board has a fine pitch wiring pattern of up to 150µm. By the graphs of Exhibit B it can be appreciated that the finer the line width of the wiring board gets the more important is a high etching factor.

VI. The respondent's arguments may be summarised as follows:

Document D1, which relates to printed circuit fabrication during which onto the glossy layer of a copper foil layer a granular structure is deposited for improving its adherence strength, forms the closest prior art for all requests. The subject-matter of claim 1 of the main and the first auxiliary requests differs from the disclosure in D1 merely by the numerical definition of the height of this granular layer. However, the patent in suit does not give any information how this height is defined or how it could be measured. Furthermore, in none of the examples of the patent specification there is any indication of the height of the electrodeposited granular copper layer. According to the patent, the objective technical problem solved by the selection of the height of the granular layer is the provision of a high etching factor. But the examples in the patent do not show that the height of the granular layer would have an effect

on the value of the etching factor. Rather they show that the etching factor depends on the surface roughness, wherein a higher roughness is caused by larger granular particles which, of course, penetrate more deeply into the substrate and take longer time to be etched away. This relationship between surface roughness, particle size and etching is known in the art. For instance, in Figure 3 of document D7 and in the corresponding passages [0005] and [0006] of the translation D7a it is discussed that in a coarsening treatment of an electrolytic copper foil surface irregularities are formed which bite into the insulating substrate. According to claim 3 of D7a this coarsening treatment can result in a surface roughness ranging from 0.2µm to 5µm. Therefore the skilled person knowing this range and opting for a high etching factor would envisage a surface roughness in the lower part of the range known from D7a, thereby automatically arriving at the subject-matter of claim 1. Furthermore reference is made to D8a, page 10, first paragraph, where it is explained that protrusions on the electrolytic copper foil embedded into the substrate resin are difficult to remove, which removal may require over-etching and thereby lower the etching factor. Document D9 discloses in Chapter 5 on page B8/1-7 that the electrolytically deposited VLP-foil disclosed in this document has a very low surface roughness and therefore a better etchability than conventional foils. From the photographs on page B8/1-4 it is estimated that the surface roughness of the VLP foil is below 2µm. Finally the choice of an upper boundary of 2µm height in claim 1 does not involve any surprising effect and this upper value is therefore completely arbitrary. The arguments of the appellant that the etching factor should at least have the

value 3 for guaranteeing that the impedance of a microstrip does not deviate more than 5 ohm from the design value and the reference to Exhibit B in this respect are not convincing. Firstly, the impedance of a microstrip line is determined by a plurality of factors which a circuit designer can select in order to obtain the correct impedance, including selecting an etching factor smaller than 3. Secondly the graphs in Exhibit B even show that a copper foil of 18µm thickness and a linewidth of 125µm, which is below the linewidth defined in claim 1 of the 2nd auxiliary request, still has an impedance within the tolerance value, even if the etching factor is as small as one. Therefore the subject-matter of claim 1 according to the main and the first auxiliary request is obvious. Finally document D10 discusses in Section VII.1 that etching distances below 150µm in 1990 were feasible and that the trend is towards linewidth below 100µm, whence the additional feature of claim 1 of the second auxiliary request is equally obvious.

VII. The board gave its decision at the end of the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the late filed documents*

Documents D7, D7a, D8 and D8a had been filed by the opponent in the opposition procedure in support of its arguments concerning the relation between peeling strength, surface roughness and etching factor for a

copper surface layer. Documents D9 and D10 had been submitted by the respondent in reaction of the first and second auxiliary requests filed with the grounds of appeal of 24 May 2002. Since these documents are related to properties of copper foils in the context of copper laminates and printed wiring circuits and the contents of these documents are readily understandable to the skilled reader the board has admitted them in the present proceedings. Similarly the board has admitted the late filed expert declaration D11 and the Exhibits A, B and C submitted by the appellant with its letter of 23 December 2002.

3. *Main Request*

Inventive step

3.1 There is agreement amongst the parties that document D1 discloses the closest prior art. Furthermore the parties agree that the subject-matter of claim 1 of the main request differs from the laminate disclosed in document D1, Section 6, in that the height of the granular copper layer is in the range of 0.2 to 2.0 μ m.

3.2 According to the appellant, the technical problem addressed by the selection of this range may be seen in the provision of a high etching ratio. In the opinion of the respondent, from the examples in the patent in suit it may not be concluded that a high etching factor is obtained by the selection of the height of the granular layer. In its written submissions the respondent had argued that the objective problem may only be seen in optimising the copper clad laminate, respectively the printed wiring boards according to the teaching of document D1 so as to obtain simultaneously

sufficient adherence properties of the copper foil to the substrate and a high etching factor.

3.3 For the determination of the technical problem the board follows the approach explained in Chapter I.D.4.3 of the case Law of the boards of Appeal (Fourth edition, page 107) according to which an objective definition of the problem to be solved by an invention should normally start from the problem described in the contested patent. In this respect, the patent specification discloses in column 2, lines 47 to 54 "it is an object of the present invention to provide a printed wiring board which exhibits a high etching factor without suffering from a lowering in peeling strength, and which is free from the adhesion and remaining of copper particles at the root of the wiring pattern and has a wiring pattern of desirable fine pitch, and to provide a copper-clad laminate for use in the printed wiring board". Furthermore according to the subsequent passage (column 2, line 55 to column 3, line 1) this object can be attained "by forming a copper electrodeposit on a glossy surface side of an electrolytic copper foil and then bonding the copper foil on the glossy surface to a substrate". In these passages there is no disclosure concerning the influence of the *height* of the copper electrodeposit on the solution of the technical problem.

3.4 In the preferred embodiments in the patent (Examples 1 and 2) it is disclosed that copper foils with roughened *glossy* surfaces after bonding onto a resinous substrate and etching show higher etching factors (9.0 and 8.4) than the same foils with treated and bonded *rough* surfaces (etching factors of 4.0 and 2.4 in Comparative Examples 1 and 2). It is observed that in all examples

the foil surfaces have been treated by electrodeposition by plating, which, according to these examples, is carried out "under the same conditions as in Example 1". Therefore, these electrodeposition conditions being the same, it is expected that the *height* of the electrodeposition layer should also be similar for all examples. Rather the only data concerning the foil surfaces before and after this electrodeposition treatment are the different values for the respective *surface roughnesses*. Since the only further condition differing between Examples 1 and 2 and the comparative Examples 1 and 2 resides in the *orientation* of the foil surface with respect to the substrate (*glossy* surface versus *rough* surface) it appears that the solution of the problem of attaining a high etching factor is indeed obtained by selecting the glossy surface of a copper foil for the electrodeposition and bonding, as set out in the cited passage in column 2, line 55 of the patent specification, and that possibly a further factor affecting this etching factor could be the *surface roughness* of the (glossy) foil surface.

- 3.5 With respect to the feature of the *height* of the copper electrodeposit the only information provided in the patent specification is in the passage in column 3, lines 15 to 16 "The height of the copper electrodeposit is desirably in the range of 0.2 to 2.0 μm ". The further occurrences of "height" in the patent specification (column 4, line 39; Example 1, column 6, line 15; Example 2, column 6, line 52; Comparative Example 1, column 7, line 23; and Comparative Example 2, column 7, line 49) are in the context of the height of the lines of the wiring pattern which is unrelated to the question of the height or thickness of

the electrodeposition layer.

3.6 During the oral proceedings the appellant had argued that the height of the granular layer could be calculated by subtracting the value of the base roughness of the foil prior to treatment from the total roughness after the electrodeposition treatment and that therefore the examples would show the effect of the height electrodeposition layer on the etching factor. In this respect the appellant made reference to the measuring procedure in Exhibit A and to the results of further measurements summarised in report D11.

3.7 The scope of the IPC-TM-650 Test method in Exhibit A is to define the procedure for determining the roughness or profile of metallic foils (Exhibit A, Section 1). According to paragraph 1.1 of this Section, the surface roughness or finish shall be evaluated using a parameter R_a , which is defined as the arithmetic average value of all absolute distances of the roughness profile from the center line within the measuring length. Furthermore paragraph 1.2 discloses that the foil profile shall be evaluated using the parameter R_z or R_{TM} , which is defined as the average maximum peak to valley height of five consecutive sampling lengths within the measurement length.

3.8 From these passages the board is unable to find a convincing support for the determination of the height of the granular copper layer as proposed by the appellant by subtracting the values of the foil's surface roughness before and after treatment. Also the remainder of this document does not provide any teaching in this direction. Rather, it must be concluded that according to D11 "surface roughness" and

"foil profile" are different concepts. Since in the examples of the patent the expression "surface roughness (RZ)" is used, no unambiguous conclusions relating to the height of the granular layer can be drawn from the disclosed values of the surface roughness. In particular, since the patent is silent about the method according to which the surface roughnesses in the examples are determined, a conversion of these roughnesses to a height is not possible. In consequence, there is no convincing argument that the additional data summarised in D11, which are based on this conversion (paragraph 7 of D11), are comparable to those in the examples of the patent.

- 3.9 Therefore in the board's view, there is no clear evidence neither in the definition of the technical problem or of its generic solution in the patent specification, nor in the examples, that the definition of a selected range of heights in claim 1 attributes in solving the problem of obtaining a high etching factor.
- 3.10 Since the primary aim of the deposited granular layer is to improve the adhesion of the copper foil bonded with its glossy surface onto the substrate, the technical problem to be solved by the particular selection of the height of this layer should rather be defined as in the Decision under appeal, point 5.3 of the Reasons, "selecting an adequate height range for the electrodeposited copper layer in order to provide the glossy surface side copper with a rough surface layer whereby proper adherence, between the glossy surface side of the electrolytic copper foil and the substrate, is obtained".

3.11 Document D1 discloses in column 7, lines 26 to 39 a procedure of obtaining a laminate in which a copper foil is laminated with its glossy or shiny side onto a resinous substrate. In order to improve its adhesion, onto the glossy side of the copper foil a layer of copper microdendrites is electrodeposited according to a so-called "Treatment A" which is summarised in column 1, line 59 to column 2, line 16. D1 does not give any numerical values of the thickness or height of this electrodeposited layer. In column 2, lines 7 to 12 this document discloses that after treatment of the shiny surface the copper foil provides a peeling strength when bonded to an epoxy substrate of 7 to 9 lb/in, which corresponds to a peeling strength of 1.25 to 1.6 kg/cm. According to the examples in the patent specification the peeling strength after treatment of the glossy surface is 1.49 respectively 1.55 kg/cm.

3.12 Since in both D1 and in the patent in suit the aim of depositing the granular layer onto the glossy surface of the copper foil is to improve its adherence strength upon bonding, and since the adherence strength of the treated foil in D1 is very similar to that disclosed in the examples of the patent, it is concluded that the heights of the granular layers must also be similar, and that the selection of the range of heights as defined in claim 1 of the main request merely involves a routine measure of the skilled person in carrying out the process of treating the glossy surface of a copper foil according to the treatment A as set out in D1. In particular, it is obvious that this granular layer should have at least a minimum thickness in order to improve the peeling strength. Furthermore the skilled person is aware that a too thick granular layer may

cause too large protrusions as shown in Figure 3 of D7, which may give rise to overetching as disclosed in the passage in document D8a referred to by the respondent. Finally, since it could not be proven that the particular range of values for the height of this layer defined in claim 1 results in a surprising effect it must be concluded that the subject-matter of claim 1 of the main request does not involve an inventive step.

4. *First auxiliary request*

4.1 Admissibility

Claim 1 of this request defines the combined subject-matter of claims 1 and 2 of the patent as granted. Therefore the claim is admissible under Article 123(2) and (3) EPC.

4.2 Inventive step

The subject-matter of this claim is directed to a printed wiring board prepared by etching a copper laminate as defined in claim 1 of the main request.

According to document D1, column 7, lines 31 to 35, after treating the shiny (glossy) side of the copper foil and lamination onto the substrate the foil is subjected to photo etching forming circuit lines. In this embodiment this etching proceeds from the matte surface towards the glossy (bonded) surface.

Furthermore the Abstract of D1 discloses that the process in this document is especially useful in multilayer printed circuit fabrication. Therefore the subject-matter of claim 1 of the first auxiliary request is obvious for the similar reasons as given in

point 3.1 to 3.12 *supra*.

5. *Second auxiliary request*

5.1 Admissibility

The additional features of claim 1 of this request had been defined in claim 5, appended to claim 2, of the patent as granted. Therefore there are no objections as to the admissibility of this claim under Article 123(2) and (3) EPC.

5.2 Inventive step.

According to claim 1 of this request, the wiring board has a fine pitch wiring pattern of up to 150µm. In the board's assessment this further feature does not contribute to an inventive step, because, according to the patent, a printed wiring board formed by UV exposure through a pattern film with a resist width of 50µm and a circuit interval of 70µm is also obtained in the comparative examples, whence the attainment of the claimed upper value therefore does not appear to involve special measures. This is also confirmed in document D10, page A7/1-5, right column, penultimate paragraph, which discloses that "today" (in 1990) higher density patterns in the 100/125 micron line & space range were produced.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

P. Martorana

E. Turrini