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D E C I S I O N
of 12 December 1996

Case Number: T 0278/90 - 3.2.2

Application Number: 83112791.5

Publication Number: 0114338

IPC: C22C 9/00

Language of the proceedings: EN

Title of invention:
Lead frame and method for manufacturing the same

Patentee:
KABUSHIKI KAISHA TOSHIBA

Opponent:
KM Europa Metal Aktiengesellschaft

Headword:
Lead frame/TOSHIBA

Relevant legal provisions:
EPC Art. 54

Keyword:
"Prior public use - no"

Decisions cited:
-

Catchword:
-

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Case Number: T 0278/90 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 12 December 1996

Appellant: (Opponent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 20 February 1990 concerning maintenance of European patent No. 0 114 338 in amended form.**

Composition of the Board:

Chairman: J. Seidenschwarz
Members: R. Lunzer
M. Auz Castro

Summary of Facts and Submissions

I. European patent No. 114 338 was granted on 20 October 1986 on the basis of application No. 83 112 791.5, filed on 19 December 1983, claiming a priority date of 23 December 1982 based on Japanese Application No. 230402/82. Claim 1 of the patent as granted, and Claim 2 as amended during the opposition, took the following form:

"1. A lead frame comprising a copper alloy consisting of 0.1 to 1% by weight of chromium, 0.001 to 0.5% by weight of zirconium, optionally not more than 1% by weight of at least one member selected from the group consisting of magnesium, silicon, tin, nickel, iron, zinc, menganese, phosphorus, boron, silver, beryllium, cobalt, titanium and yttrium, and balance copper apart from unavoidable impurities and having a precipitate with a grain size from 0.5 to 50 μm distributed therein at a rate of 1,000 to 10,000 grains/mm^2.

2. A method for manufacturing a lead frame as defined in Claim 1, comprising the steps of: casting a copper alloy consisting of 0.1 to 1% by weight of chromium, 0.001 to 0,5% by weight of zirconim, optionally not more than 1% by weight of at least one member selected from the group consisting of magnesium, silicon, tin, nickel, iron, zinc, manganese, phosphorus, boron, silver, beryllium, cobalt, titanium and yttrium, and balance copper apart from unavoidable impurities by continuous casting, when casting is started from a melting temperature of 1100 to 1300°C and is solidified at a cooling rate of about 10°C/sec. or higher; performing rolling; performing a solution treatment; performing a cold working; and performing an age-hardening."

II. An opposition was filed by the Appellant on the ground of Article 100(a) EPC, alleging lack of novelty (Article 54 EPC), and lack of any inventive step (Article 56 EPC) having regard to the following documents:

(1) US-A-3 392 016
(2) GB-A-1 030 427
(3) DE-A-2 743 471
(4) Metals Engineering Quarterly, Nov. 1972, pages 41 to 45
(5) EP-A-0 023 362.

III. By its decision issued in writing on 20 February 1990, the Opposition Division identified document (4) as the closest prior art, but found that the alleged invention as defined in Claim 1, and Claim 2 as amended, satisfied the requirements of novelty and inventiveness. The processing steps of the invention, involving casting the alloy continuously, instead of semi-continuously, cooling at a rate of at least 10°C/s, and solution annealing- both steps which were not mentioned in document (4)-, was held not to be obvious. The other cited documents were regarded as being more remote. The patent was therefore maintained as amended.

IV. An appeal against that decision was filed on 5 April 1990, the appeal fee was paid on 10 April 1990, and the statement of grounds of appeal was filed on 21 June 1990. In that statement the Appellant introduced an allegation of prior public use of the invention by its own manufacture and sale since February 1973 of "Elbrodur RS" Cu, Cr, Zr alloys to Texas Instruments Deutschland GmbH. These alloys, when rolled into their final form as strip having a thickness in the range of 0.30 to 2.5mm, had precipitated particles whose size and distribution met

all the requirements specified in Claim 1. It alleged that its prior manufacture, together with the features known from document (4) left no room for the subject-matter of the patent in suit. In particular it attacked the novelty of Claim 1 on the ground that the "Elbrodur RS" products made before and after the priority date by a practically unchanged process had between 7,000 and 9,000 particles per square mm when examined in the **unetched** condition, albeit that the same samples, when examined in an **etched** condition, were seen to have 10,000 or more particles per square mm. To establish the relevant facts of its prior use the Appellant offered as a witness Dipl.-Ing. Horst Gravemann, who had been responsible for the development and production of the "Elbrodur RS" alloys, and an "Eidesstattliche Erklärung" signed by him was filed to establish the facts of the alleged manufacture.

V. The Respondent argued in its counterstatement that the alleged prior use was irrelevant because, on the Appellant's own admission, significantly more particles than the upper maximum limit were shown in 8 out of 9 samples relied on when examined in the **etched** condition, the 9th sample showing 10,000 exactly. The smaller number of particles to be seen in the unetched condition was irrelevant.

VI. A communication from the Board sent with the summons dated 8 December 1995 to attend oral proceedings drew attention to the issue of whether the number of particles observed under the microscope ought to be based on the examination of etched or unetched specimens, and invited both parties to demonstrate by reference to standard works which of the two states of sample preparation was relevant to the present case.

VII. At the oral proceedings held on 13 March 1996 the Appellant introduced the published literature listed in paragraph IX below, which, it contended, supported its contention that the determination of the number of precipitated particles, whether in the patent in suit or in the samples it had produced in the past, would normally be carried out on **unetched** samples. It justified the late production of these documents on the ground that the Board had asked in its communication for a "demonstration" of the relevant facts, which it had interpreted as meaning that this was to be demonstrated at, but not ahead of, the oral proceedings. The Respondent contended that it was taken by surprise by the late filed documents, which went to the central issue of the Appellant's present attack, and that information would be needed from experts on whether the documents introduced by the Appellant supported the arguments based on them or not.

VIII. In the light of these conflicting positions, the Board adjourned the oral proceedings, and ordered that the procedure in the appeal be continued in writing. The Appellant should file within a period of one month a written statement setting out the contentions made at the oral proceedings, and the Respondent was invited to deal with the issue of whether the patent in suit measured particles in an etched or unetched condition within a period of five months.

IX. In a letter dated 2 April 1996 the Appellant argued that the correct interpretation of the patent in suit, when it referred to an observed number of particles per square mm, could only be that this observation had been made on specimens in the **unetched** condition. It observed that the structure shown in the photomicrograph which was Figure 1 of the patent in suit showed grain boundaries in the form of isolated

points, rather than points joined by lines which, as shown by the lately introduced literature, would be seen on a specimen in an etched condition. The text-book "Metallographisches Ätzen" by Günter Petzow, Max-Plank-Institut für Metallforschung, Institut für Werstoffswissenschaften, Stuttgart (Gebr. Borntraeger, Berlin-Stuttgart 1976) showed in its first paragraph on page 29 that what was needed for microscopic examination of a structure was a difference of light reflectivity of at least 10%, which condition was satisfied when the constituents had sufficient difference of colour, or if through differential hardness they were differentially eroded during polishing. Here the deposited particles of the intermetallic compounds of Cr-Zr satisfied both conditions, being much harder than the copper matrix in which they were embedded, and of strongly contrasting colour.

Reference was also made to:

(6) "Osservazioni su un difetto in leghe Cu-Cr dovuto a cattiva condotta nella fusione", by Azzolini and Cogito, published in La Fonderia Italiana, No. 3 1966, pages 85 to 98;

(7) "Über die Eigenschaften einer technisch verwendbaren Kupfer-Chrom-Legierung" by Bunge et al, Metallkunde 44 (1953), pages 71 to 76;

(8) "Aus der Praxis der Herstellung von Kupfer-Chrom-Formguß" by Schlatter, Giesserei, February 1962; and

(9) "Herstellung, Eigenschaften und Verwendung von Kupfer-Chromlegierungen" by Nielsch, Metall, No. 11, November 1959.

With respect to these documents, the Appellant contended that document (6) showed side by side in Figures 18 and 19 the same structure, with the sole distinction that an unetched sample was used for Figure 18, and an etched sample for Figure 19. The unetched sample of Figure 18 showed exactly the same as did Figure 1 of the patent in suit, with the crystal boundaries appearing as a row of precipitated particles. In the area of oxidation, where the Cr had been oxidised to an oxide which was more easily detached from the surface during polishing, no grain structure could be seen. In contrast, the etched structure of Figure 19 revealed the grain boundaries, even in the oxidised area. Figures 18 and 19 confirmed what is stated in document (5), that an unetched structure is observed under the microscope when there is sufficient difference in colour between the phases.

Document (7) showed in Figures 1, 3 and 4, photomicrographs of Cu:Cr alloys in the unetched condition, as is usual for these alloys. Similarly document (8) showed in Figure 15 oxidation at the surface of a test piece of such an alloy, making specific reference to the fact that the examination was made in the unetched condition. In document (9), the captions to Figures 2a, 2b, and 2c referred to the fact that the photomicrographs were made using specimens in the unetched condition.

These documents showed convincingly that the skilled worker, when told to determine the number of particles, would do so as a matter of course through the examination of specimens in the unetched condition.

The photomicrograph produced by the Respondent at the oral proceedings identified as "Hv171" did not lead to the conclusion that it had been made by the examination of an etched specimen. On the contrary. The absence of

any lines joining the grain boundaries, which are visible in etched specimens, cf. Figure 19 of document (6), suggested that this photomicrograph had been made using an unetched specimen.

In its aforesaid letter, the Appellant offered again the evidence of its witness in relation to the facts of prior manufacture of the "Elbrodur RS" alloys, and requested that the opinion of an expert should be obtained to establish that the relevant count of visible particles had to be made on samples in the unetched condition.

X. In answer thereto, the Respondent argued in its letter of 28 October 1996 that documents (6) to (9) inclusive were concerned with the examination of microstructures for purposes wholly other than for the estimation of the number of precipitated particles. In the present case, the count had to be made of particles having a size as small as 0.5 µm. To observe such small particles it was indispensable to etch before attempting to count their number.

XI. The Appellant requested that the decision under appeal be set aside, and the patent revoked in its entirety. The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of amended Claim 2*

The amendment to Claim 2, which involves the addition of the words, "when casting is started from a melting temperature of 1100 to 1300°C and is solidified at a

cooling rate of about 10°C/sec or higher;" is supported by the disclosure at page 3, lines 28 to 35 of the application as filed, corresponding to column 3, lines 20 to 23 of the patent specification. The introduction of this further limitation to the Claim restricts its scope. Although the Appellant objected that the introduction into Claim 2 of the words "about 10°C/sec" made the Claim unduly vague, the Board considers that in these particular circumstances, where a high rate of cooling is specified irrespective of some uncertainty created by the word "about", the requirements of Article 84 EPC are satisfied. Accordingly, the requirements of Articles 123(2) and 123(3) EPC are satisfied, and the amendment is therefore allowable.

3. *The alleged invention*

Copper is the most widely used electrical conductor. In some circumstances superior mechanical properties are required. In the present case, the aim is to secure improved bonding performance, hardness, and in particular bending strength. The desired effects are achieved through the use of the known class of copper alloys containing Cr and Zr, the novelty of the alleged invention residing in the proposed combination of rapid cooling during casting, and subsequent mechanical and thermal treatment, so as to attain an end structure which has the specified deposited particle size and distribution after conventional heat treatment involving solution treatment, and precipitation hardening. In the patent in suit five Examples are given, of which four are in accordance with the alleged invention, and the fifth is a comparative Example. That Example is distinguished by the fact that the rate of cooling in the mould was 5°C/sec or less, with the result that its properties; i.e. bending strength, hardness, and bonding performance, were all inferior.

The Board finds it credible that superior properties may be obtained by securing the desired rate of cooling during casting, and thereafter ensuring that the desired structure with respect to particle size and distribution is produced.

4. *Novelty and Inventiveness in the light of the cited prior art*

Having reviewed the cited documents, the Board is satisfied that none of them discloses a lead frame having all the features defined in Claim 1. Therefore the subject-matter of Claim 1 is considered to be novel within the meaning of Article 54 EPC. Novelty being uncontested at the appeal stage, other than on the basis of prior use, more detailed reasons are unnecessary. The Board is also satisfied that the Opposition Division reached the correct conclusion in holding that none of the cited documents made the alleged invention obvious.

Although the Appellant contended in relation to document (4) that it would be self-understood by the skilled worker in this art that the semi-continuous casting there disclosed could be replaced by continuous casting, as this citation fails to disclose the rapid cooling which is an essential feature of Claim 1, the particle size and distribution of Claim 1 in suit, and actually teaches that the properties sought can be achieved without any annealing treatment, it is not regarded as a pointer in the direction of the present invention.

5. *Alleged prior use by the appellant*

5.1 Although at the start of the present appeal the alleged prior use was inadequately particularised, in response to a request by the Board much greater detail was

provided. In addition the Respondent brought to the oral proceedings, Dipl.-Ing. Horst Gravemann, and offered him for examination by the Board. In his "Eidesstattliche Erklärung" dated 18 June 1990, he had set out his experience, showing that he was a person well qualified to give evidence as to the alleged prior use by the Appellant on the basis of his personal knowledge.

5.2 At the oral proceedings, the Board decided that even if it were to be convinced of the facts surrounding the alleged prior use, to the extent that the Appellant had, before the priority date of the patent in suit, produced and sold without any obligation of confidence the alloys which it alleged had been made and sold, no purpose would be served by calling Mr Gravemann as a witness so long as there was a fundamental dispute on whether the relevant numbers of particles defined by Claim 1 of the patent in suit related to the higher number to be observed in a specimen under the microscope in the etched condition, or the smaller number to be seen in the unetched condition.

6. *Metallography*

6.1 The examination of carefully prepared metal samples under the microscope is a routine familiar to every physical metallurgist. Although biologists and botanists use transmission microscopes, in which light is transmitted through the sample, as metals are opaque, use has to be made of a reflecting microscope, which has its light source located to the side of the microscope tube, the rays being reflected down and through the objective lens by a fine plate of glass set at 45° to the axis of the microscope tube, illuminating

the specimen and enabling it to be observed. The sample for preparation is filed flat, and then polished on a rotating wheel, using a cloth impregnated usually with water and a very fine abrasive.

6.2 After polishing, it is rare that a surface is produced which is capable of being directly examined under the microscope. In most samples, there is insufficient colour contrast for observations to be made, and also there is a minute flow at the surface of the metal sample which obscures the underlying structure. Those obstacles to observation under the microscope are normally easily removed by etching. Examination of the surface prior to etching is a known and recommended technique. However, in the Board's view, when making a count of the fine particles which are to be expected to result from a step of precipitation hardening, absent any contradictory instruction, the skilled metallurgist would normally count the particles **after etching**.

7. *The appellant's data*

7.1 The data attached to the "Erklärung" of Mr Gravemann relate to ingots of identified compositions, falling within the claims of the patent in suit. These alloys were continuously cast as billets having a cross section of 1030 x 205 mm, hot rolled to a thickness of 70 to 90 mm, and then finished as strip of 0.3 to 2.5 mm thickness. As these alloys were cast with a thickness of 205 mm, any possibility of achieving the cooling rate specified in Claim 2 of the patent in suit is precluded. However Claim 1 specifies a structure, and the question to be considered is whether the particle size and distribution of Claim 1 could have been met.

7.2 The first page of attached data gives the particle sizes and distributions observed on 13 samples taken from the as cast billets, and a further 11 samples taken from slabs in the hot rolled condition. Although in some cases the particle distribution is below the 10,000 maximum limit specified in Claim 1, as these are intermediate products, and not lead frames, it would not matter whether they otherwise satisfy the requirements of Claim 1. It is regarded as significant that the data given on the first page is accompanied by no suggestion that the samples examined were in an unetched condition. As indicated in paragraph 6.2 above, in the absence of an indication that a photomicrograph was taken from an unetched specimen, the skilled reader, when told nothing as to etching, will assume that the sample had been etched. This leads the Board to the inference that all of the samples the subject of the first page of data attached to the report must have been etched.

7.3 The data given on the second page relate to the finished products. The figures are set out below:

Thickness in mm	**Composition**			**Particles per mm^2 (observed under microscope)**
	Cr	**Zr**	**P**	
0.30	0.73	0.13	0.020	18,000
0.30	0.71	0.13	0.022	40,000
				40,000
0.35	0.77	0.14	0.019	17,000 (ca. 9,000 unetched)
				17,000
				25,000
2.5	0.81	0.13	0.021	15,000 (ca. 9,000 unetched)
				17,000 (ca. 7,000 unetched)
				10,000

7.4 With regard to particle size, there was no dispute that the particles in the samples made in accordance with the alleged prior use satisfied the broad range of 0.5 to 50µm specified in Claim 1. Furthermore, it is clear that if it is legitimate to take into account the figures for the unetched samples, three are reported as being inside the range of 1,000 to 10,000. It is shown here, as is to be expected, that an etched specimen reveals roughly twice the number of visible particles. This suggests that all of the last 6 samples listed above may have revealed less than 10,000 particles per mm^2 if viewed under the microscope in the unetched condition. Hence, as indicated above, the dispute centred on whether the proper figure for particle distribution to be taken into account was that given for the samples in the etched or the unetched condition.

8. *Conclusion on the issue of whether to look at the figures for etched or unetched samples*

8.1 In reaching its conclusion, that the relevant tests were those carried out on the etched samples, and not those in the unetched condition, the Board has taken into account the following facts:

a. It is the common knowledge of those skilled in the art that, although it is sometimes useful to examine a specimen in the unetched condition, it is the norm in metallography to work with etched samples.

b. Although the Appellant seeks to rely on the first paragraph of page 29 of the book by Petzow mentioned in paragraph IX above, to the effect that all the conditions were satisfied in the present case for the polished section to be

suitable for examination of the speciment without etching, because of differences of both hardness and colour, nonetheless the Board concludes that those considerations are overridden by what is stated in the next paragraph of that text which expresses the general rule in these words (translated from the original):

"Generally, a polished sample does not show any structure, because the incident light is almost uniformly reflected; the small differences of reflectivity between different elements of the structure are below the level of perception of the human eye. Hence in general contrasts have to be brought out to make the structure visible. This production of contrasts for the purposes of metallographic examination has become known as "etching" although it does not invariably involve etching in the strict sense of the word."

The above statement is fully in line with the Board's understanding of the common practice in the art. A photomicrograph should normally be accompanied by an indication of the degree of magnification, and the etchant used. However, where, as in the patent in suit, there is an indication of degree of magnification, and no indication of whether the sample was etched or unetched, the skilled reader will normally assume that an etched sample has been examined. This is all the more so where a high degree of magnification is specified, in this case of 500x, and where the observer is attempting to count minute particles deposited during precipitation hardening down to a size of 0.5 µm. In this connection a clear contrast

is to be seen between the high level of magnification used for counting the particles in accordance with the patent in suit, and the low levels of magnification (50 - 100x) disclosed in connection with other prior art cited by the Appellant and discussed in greater detail in sub-paragraph f below.

c. That common practice is nowhere better reflected than in the Appellant's own experimental data. Out of a total of 33 samples (11 as cast, 13 as rolled, and 9 in the finished condition) figures are given for the number of particles observed in all 33 cases in an unspecified condition, whereas only in 3 cases is there an indication that the figures are given for a sample in the unetched condition; i.e. where nothing is said, the reader is expected to draw the inference that the sample is in the etched condition. Those working in the metallographic laboratory of the Appellant can be presumed to be well experienced in the microscopic examination of samples of these alloys. Had it been their normal practice to rely principally on examination in the unetched condition, that would have been stated.

d. Examination in the etched condition rather than unetched being the norm, the Board would have expected the specification of the patent in suit to have stated explicitly that the evaluation of the number of particles was made on samples in an unetched condition, if that had been intended. As no such mention is made, the etched condition is assumed to be used in making any estimation of particle distribution.

e. Although the Appellant has contended that it is able to observe from the photomicrograph which is Figure 1 of the patent in suit, and in particular from the absence of any grain boundaries other than as defined by precipitated particles, that the sample must have been unetched, the Board is unconvinced. That photomicrograph shows scattered points of light over most of the field, and an obscure mixture of light and dark in the lower left side of the field. From the structure itself the Board is unable to draw any conclusion. However, the fact that it is indicated at column 2, line 64 that the magnification is 500 x, and also that particles have to be observed down to 0.5 µm, leads the Board to expect that the sample was etched, a conclusion supported by the absence of any indication of whether the count was made in the etched or unetched condition.

f. The Appellant sought to support its arguments by reference to documents (6) to (9), all of which relate to Cu:Cr alloys. Document (6) Figure 18, document (8) Figure 15, and document (9) Figures 2a, b, and c, each contains specific reference to the fact that the photomicrographs shown in those Figures were produced by using samples in an unetched condition. However, the Board observes that where nothing is said as to whether the samples were etched or not, the skilled reader is left to draw the inference that the samples were in the usual, i.e. the etched condition. The purpose of the examinations made in Figures 18 and 15 of documents (6) and (8) respectively was to look at the surface oxide layers under low magnifications (100x and 50x). In Figure 15 of document (8), the metal in the left hand side of

the field looks undetailed. If asked to measure the particle distribution down to particles as small as 0.5 µm, the Board considers that the skilled worker would first etch the specimen, and then use a much higher magnification.

8.2 In the light of the above findings of fact, the Board declines the Appellant's requests respectively for further oral proceedings, and for hearing the oral evidence of the witness offered for examination. Furthermore the Board sees no need for the appointment of an expert to assist it in reaching a conclusion. The refusal of further oral proceedings is based on Article 116(1) second sentence, the parties and the subject of the proceedings being the same. The Board is in possession of no new facts going beyond what was available to it at the previous oral proceedings, the adjournment having been granted solely to allow the Respondent the opportunity to meet the impact of the newly introduced material. The Board having now found that the tests conducted in the etched condition are the material ones, it follows that the oral examination of Dipl.-Ing Gravemann could do no more than verify the facts in relation to the Appellant's past production of alloys. The present decision is based on the premise that what has been stated in his "Eidesstattliche Erklärung" is true.

8.3 Finally, as to the appointment of an expert, the Board would not have hesitated to do so, had it been in serious doubt on the point at issue. However, in the light of the considerations set out above, no sufficient doubt exists to justify such appointment.

9. *Conclusions*

9.1 From the foregoing it follows that the Board treats the figures for particle distribution in the etched condition as being relevant for deciding the issue of whether there was any prior public use as alleged. In the table set out in paragraph 7.3 above, only a single etched sample was found to have a particle distribution of 10,000 per square mm, i.e. a single value which just touches the end limit of Claim 1 in suit. However, looking at that table, it appears that what was examined was a number of samples from the products containing respectively 0.71, 0.77, and 0.81% Cr. Thus the final three results taken together do not show that a single product was demonstrated to have a particle density of 10,000. Instead, three samples were taken, and the respective test results of 15,000, 17,000 and 10,000 suggest that the single product in question had a particle density of the order of their average, i.e. 14,000 particles per square mm.

9.2 Accordingly, the alleged prior public use of a product in accordance with the alleged invention of Claim 1 in suit has not been established.

9.3 With regard to the amended Claim 2, there being no prior document which discloses or suggests any advantage in the rapid cooling rate during casting specified in this claim, it follows that the objections to its validity fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

S. Fabiani

The Chairman:

H. Seidenschwarz

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