

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) To Chairmen
- (D) No distribution

DECISION
of 28 May 2004

Case Number: T 0021/01 - 3.2.2

Application Number: 91114388.1

Publication Number: 0473122

IPC: C22F 1/057

Language of the proceedings: EN

Title of invention:
Damage tolerant aluminium alloy sheet for aircraft skin

Patentee:
Alcoa Inc.

Opponent:
PECHINEY

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Case Number: T 0021/01 - 3.2.2

DECISION
of the Technical Board of Appeal 3.2.2
of 28 May 2004

Appellant:
(Opponent)

PECHINEY
10 Place des Vosges
La Défense 5
F-92400 Courbevoie (FR)

Representative:

Mougeot, Jean-Claude
PECHINEY
Immeuble "SIS"
217, cours Lafayette
F-69451 Lyon Cedex 06 (FR)

Respondent:

Alcoa Inc.
201 Isabella Street
Pittsburgh, PA 15212-5858 (US)

Representative:

Bergen, Klaus, Dipl.-Ing.
Patentanwalt
Postfach 11 01 23
D-40501 Düsseldorf (DE)

Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office posted
18 October 2000 concerning maintenance of
European patent No. 0473122 in amended form.

Composition of the Board:

Chairman: W. D. Weiß
Members: S. S. Chowdhury
E. J. Dufrasne

Summary of Facts and Submissions

- I. European patent application 91 114 388.1 matured into European patent No. 0 473 122.

The decision of the opposition division rejecting an opposition against the patent filed under Article 99 EPC was dispatched on 18 October 2000.

The patent had been opposed on the grounds that its subject-matter lacked novelty or at least did not involve an inventive step.

- II. On 22 December 2000 the appellant (Pechiney) filed an appeal against this decision and paid the appeal fee on the same day. The statement of grounds of appeal was received on 26 February 2001.

- III. The following documents were relied upon during the appeal proceedings:

D1: EP-A-0 038 605

D3: M. V. Hyatt "Program to improve the fracture toughness and fatigue resistance of aluminum sheet and plate for airframe applications", Technical Report AFML-TR-73-224, Sept. 1973

D4: J. T. Staley "Microstructure and Toughness of High-Strength Aluminum Alloys" in "Properties Related to Fracture-Toughness", ASTM STP 605, ASTM, 1976, pp. 71-103

D7: J. E. Hatch, "Aluminum Properties and Physical Metallurgy", Vol. 1, Examining division. 1, ASM, 1984, pp. 372-373

- D8: Proceedings of the First International Conference on Fracture, Sendai, Japan, Vol. 2, pp. 995-1038, 12.-17.9.1964. Carman et al.
- D9: Proceedings of International Conference on Recent Advances in Science and Engineering of Light Metals, The Japan Institute of Light Metals, Tokyo, Oct. 1991, pp. 273-280, Hyatt et al.
- D13: US-A-5 213 639
- D14: Metals Handbook, Ninth Edition, vol. 4, Heat Treating, 1981, pp. 667, 681
- D15: Altenpohl, "Aluminium und Aluminiumlegierungen", Springer Verlag, 1965, pp. 718-719, 744-747.

Oral proceedings (Article 116 EPC) took place on 28 May 2004.

IV. Requests

The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0 473 122 be revoked.

The respondent (patentee) requested that the appeal be dismissed or that the patent be maintained in amended form based on the first or second auxiliary request.

V. Claim 1 according to the main request reads:

"A method of producing an aluminum base alloy sheet product having a cladding thereon of aluminum comprising:

(a) providing a body of an aluminum base alloy containing 4.0 to 4.5 wt.% Cu, 1 .2 to 1.5 wt.% Mg, 0.4 to 0.6 wt.% Mn, 0.12 wt.% max. Fe, 0.1 wt.% max. Si,

the remainder aluminum, optionally 0.2 wt% max. Zn, 0.2 wt% max. Cr, 0.5 wt% max. Zr, and impurities;

(b) hot rolling the body to a slab,

(c) heating said slab to a temperature within the range of 488 to 507°C (910 to 945°F) for a period from 1 to 40 hours to dissolve soluble constituents;

(d) hot rolling the slab within a temperature range of 315 to 482°C (600 to 900°F) to a sheet product;

(e) heating for solution heat treating within a temperature range of 488 to 507°C (910 to 945°F) for up to 60 minutes;

(f) rapid cooling; and

(g) aging to produce a sheet product having high strength and improved levels of fracture toughness and resistance to fatigue crack growth, wherein that sheet having a minimum long transverse yield strength of 275 MPa (40 ksi (thousand pounds per square inch)) and

a minimum T-L fracture toughness of 154 MPa√m (140

ks√inch) measured using a 40 cm (16-inch) wide, 118 cm (44-inch) long panel."

Claim 1 according to the first auxiliary request reads:

"A method of producing an aluminum base alloy sheet product comprising:

(a) providing a body of an aluminum base alloy containing 4.0 to 4.5 wt.% Cu, 1.2 to 1.5 wt.% Mg, 0.4 to 0.6 wt.% Mn, 0.12 wt.% max. Fe, 0.1 wt.% max. Si, the remainder aluminum, optionally 0.2 wt% max. Zn, 0.2 wt% max. Cr, 0.5 wt% max. Zr, and impurities;

(b) hot rolling the body to a slab, the body or slab having a cladding of aluminum thereon;

(c) heating said slab to a temperature within the range of 488 to 507°C (910 to 945°F) for a period from 1 to 40 hours to dissolve soluble constituents;

(d) hot rolling the slab within a temperature range of 315 to 482°C (600 to 900°F) to a sheet product;

(e) heating for solution heat treating within a temperature range of 488 to 507°C (910 to 945°F) for up to 60 minutes;

(f) rapid cooling; and

(g) aging to produce a sheet product having high strength and improved levels of fracture toughness and resistance to fatigue crack growth, wherein that sheet having a minimum long transverse yield strength of 275 MPa (40 ksi (thousand pounds per square inch)) and a minimum T-L fracture toughness of 154 MPa√m (140 ks√inch) measured using a 40 cm (16-inch) wide, 118 cm (44-inch) long panel."

Claims 2 to 6 are dependent on claim 1.

VI. The parties submitted the following arguments:

Appellant

D3 dealt with two principal types of aluminum alloys, the 7075 and the 2024 alloys, and the latter's high-purity version had the same composition as the claimed alloy. The thermomechanical treatment (TMT) applied to the 7050 alloy was nearly identical to the TMT steps of claim 1, and D3 stated that this could also be applied to the 2024 alloy, in which case D14 indicated that higher temperatures should be used for

the solution heat treatment (SHT), which would render the TMT indistinguishable from that of the claim. A lower temperature than that necessary for SHT was used in the intermediate heating step in D3 to avoid brittleness during hot rolling.

The adverse effects of intermetallic compounds was known in the prior art as was the use of SHT to reduce the volume fraction of the intermetallic compounds. Given that these mechanisms and effects were known at the priority date of the patent, the person skilled in the art would have applied the known principles and not the actual temperatures from a given prior art process, and there could be no invention in optimising the parameters used to carry out the SHT for a particular alloy.

The high value of fracture toughness of the alloy of the patent in suit was due to the lower contents of Fe and Si in the alloy used as compared to the comparative alloy, and not due to the SHT step of the claim. Moreover, the mechanical properties achieved in the patent were comparable with those achieved in D3, Table 6.

The short time of SHT in step (e) of the claim was governed by the need to suppress the diffusion of Cu into the cladding which was taught in D15. There were only two parameters to play with in the SHT step, one could either decrease the time as taught by D15 or increase the temperature, as in the claimed method.

Respondent

The process of D3 was unsuitable for producing thin sheets since the 9 hour heating time for the SHT would cause the sheet to oxidise and deform, and also cause Cu diffusion into a cladding if provided. As the patent states, it is important for the intermediate heating step to be performed at a temperature above the solvus temperature, whereas the corresponding step in D3 was performed at a lower temperature. On the other hand the second SHT step should be performed for a short time according to claim 1 but was 9 hours long in D3. The conclusion of D3 was that it was better to lower the Cu content in order to reduce the solvus temperature, but this sacrificed the alloy's strength. D7 (page 372) also recommended the use of low temperatures for TMT.

In manufacturing aluminum alloy, in addition to the composition the other process variables were the steps of the TMT, the temperature, and the time, and a large number of combinations of these parameters was possible, from which the combination selected in the patent were not envisaged in the prior art. The present temperature parameter for the intermediate heating step was found by accident, and was responsible for the good resistance to fatigue crack growth achieved. The use of the steps of claim 1 meant that the initial step of homogenisation could be dispensed with, it was even preferable to omit this step, which was a cost saving advantage.

The mechanical properties recited in claim 1 were also a distinguishing feature over D3 since the fracture toughness values given in Table 6 of D3 could not be

compared with the values of the patent owing to the use of panels of different width used for the tests in D3 and in the patent, and to the fact that claim 1 referred to the T-L value and in D3 the data were for the longitudinal grain direction.

Reasons for the Decision

1. The appeal is admissible.

Main request

Claim 1 relates to a method of producing an aluminum base alloy sheet product having a cladding thereon of aluminum, but the claim does not specify at which stage the cladding is applied. The application as originally filed stated that the ingot or slab of the alloy of the invention may be provided with a cladding and then processed in accordance with the invention (A1 document, page 3, lines 41 and 42), that for purposes of the present invention, it is preferred to hot roll the clad ingot without homogenizing (page 3, line 55), and that in clad products, the temperature and duration of the reheat is very important for another reason (page 4, line 19). Original claim 10 defines the feature that said body of an aluminum base alloy has a cladding thereon of aluminum.

These passages are understood to mean that a cladding may be provided or it may be omitted, but that if it is provided, then the cladding is provided on the ingot or slab before the process steps of the invention are

performed on it. Nowhere does the application say that the cladding may be applied at a later stage.

In so far as claim 1 does not specify at which stage the cladding is applied it is not supported by the original disclosure and is not allowable under Article 123(2) EPC, accordingly.

First auxiliary request

2. *Amendments*

Claim 1 includes the limitation that the body or slab which is hot-rolled at step (b) has a cladding of aluminum thereon, which renders the claim fairly supported by the original disclosure in this respect, so no objection arises under Article 123(2) EPC.

Moreover, compared to claim 1 of the application as originally filed, claim 1 defines the composition and process parameters more narrowly, drawing on support from original claims 5, 8, and 10, and parts of the description (page 3, lines 2 to 4, page 4, lines 9 to 11, and page 6, line 18 and 19 of the A1 publication).

Claim 1 is also narrower in scope as compared with claim 1 as granted since the amended claim includes the cladding as a feature thereof, which was absent from the granted claim 1.

The claim meets the requirements of Article 123(2) and (3) EPC accordingly.

3. *Novelty*

This was not an issue in the decision of the first instance or at the appeal stage, a finding with which the Board concurs.

4. *Inventive step*

4.1 The patent in suit relates to a method of producing aluminum base alloy sheet products having a cladding thereon, the alloys having a high level of damage tolerance and being for use in aircraft applications. In addition to strength and corrosion resistance, the important properties in this respect are the resistance to fatigue crack growth and fracture toughness.

4.2 The closest prior art document is D3 which discloses a method of producing an aluminum base alloy sheet product of the same type of aluminum alloy as used in the patent and whose aim is also to produce a high strength aluminum base alloy having good fatigue properties and a high value of fracture toughness (D3: Introduction, page 1). In one example a body of an aluminum base alloy 2024 is provided which (see Table 7 on page 24) comprises 3.8-4.9 wt.% Cu, 1.2 to 1.8wt.% Mg, and 0.3 to 0.9 wt.% Mn. The high-purity version of this alloy contains (see page 21, fourth paragraph) maximum residual impurity contents of Fe and Si of 0.025%. The remainder of the alloy 2024 is aluminum. The ranges of the constituents of the high-purity alloy overlap with the ranges of the constituents of claim 1 of the patent in suit. An ingot of this alloy in D3 is subjected to a thermomechanical heat treatment (TMT).

Page 20, second paragraph of D3 describes the steps of a TMT as applied to a 7000-series alloy (this part of the description of D3 applies to the 7000 series alloys since the cited paragraph on page 20 fall under the heading of § 2.2 on page 8, which relates to the 7000 series alloys), wherein the ingot, after pre-heating, is hot-rolled at 400°C to a slab, the slab is heated to a temperature within the range of 460-466°C for 10 hours, hot-rolled at a temperature of 400°C to a sheet product, and the sheet product is subjected to solution heat treatment (SHT) at 477-482°C for 9 hours, quenched, and aged.

The above-described TMT scheme applied to a 7000-series alloy may also be applied to a 2000-series alloy (page 26, § 2.3.2). The person skilled in the art knows from standard textbooks, however, for example from D14, what the solution heating temperature for a given alloy should be, and set the minimum temperature for solution heating temperature according to the alloy being treated. He would set this temperature about 20°C higher for the alloy 2024, and this feature is not considered to constitute a difference between the method of claim 1 at issue and the method of D3 as applied to the 2024 alloy, accordingly.

4.3 The differences between the method of claim 1 of the patent in suit and that of D3, therefore, are the following:

- (i) The claimed method produces a clad sheet, wherein the cladding is provided on the slab.

(ii) According to claim 1 the heating step between the two hot-rolling steps in D3 is carried out at the solution heating temperature so as to dissolve soluble constituents, whereas in document D3 this heating step is carried out at a temperature below the solution heating temperature of the alloy.

Thus D3 describes the steps: (b) hot-rolling, (c) pre-heating at a temperature below the solution heating temperature, (d) hot-rolling, and (e) heating at a temperature above the solvus temperature for solution heat treatment, which correspond respectively to the steps (b) to (e) of claim 1 except for the temperature difference of the respective steps (c).

(iii) The solution heat treatment time after the second hot roll should be up to 60 minutes according to claim 1, but is 9 hours in the method employed in D3.

(iv) The mechanical properties of the product. In this respect see point 4.7 below.

4.4 The appellant argued that D14 teaches that, in going from the 7000-series alloys to the 2024 alloy in D3, not only should the temperature for the solution heat treatment be raised by about 20°C, but the homogenisation temperature and the pre-heating temperature should also be raised by this amount, so that the difference (ii) above cannot really be considered as a difference between D3 and the method of claim 1.

The Board does not accept this argument since the effects of the three heating steps, homogenisation and pre-heating on one hand, and solution heat treatment on the other hand, are clearly different in D3, for which different temperatures are selected, and for which reason they are termed differently.

- 4.5 It was well known in the prior art that large intermetallic compounds formed during solidification and heat treatment of alloys will lower the fracture toughness of the alloys, and that SHT (solution heat treatment) will alleviate this problem by dissolving soluble constituents.

Thus, D1 states (page 5, lines 14 to 24) that large intermetallic compounds (for example CuAl_2 and CuMgAl_2 , see last part of page 5) formed during solidification, fabrication and heat treatment will lower the fracture toughness, and that the alloy after hot-working is solution heat treated at the temperature on the order of 920°F for a time sufficient for solution effects to approach equilibrium. D3 (page 20, second paragraph and page 26, § 2.3.2) states that SHT minimises the volume fractions of soluble intermetallic phases in the final rolled materials and improves their toughness. The step of solution heat treatment for dissolving soluble phases is also described in D14, page 676, right column.

- 4.6 However, what is not disclosed in D3 or in any other prior art document is the sequence of steps: hot-rolling, heating for solution heating treatment, hot-rolling, and heating again for solution heating

treatment, wherein both the SHT steps are performed at a temperature above the solvus temperature.

The respondent argued that there was some interaction, which was not properly understood, between the hot-rolling step and the step of heating for solution heating treatment, which gave rise to the present mechanical properties, and that the combination of steps of D3 would not yield these properties. The combination of the steps of D3 failed to employ a SHT step between the hot-rolling steps, which proved to be crucial for achieving the desired properties.

- 4.7 These arguments are plausible since the product resulting from the claimed method has a high strength and improved levels of fracture toughness and resistance to fatigue crack growth. This is shown by the comparison in the patent specification between the Example on page 5 and a test sample using a conventional 2024-T3 alloy.

While the lower contents of Si and Fe in the Example as compared with the levels of these elements in the comparative example would affect the mechanical properties somewhat, this is a secondary effect, the primary cause of the improved properties indeed being the effective removal of the constituent phases such as CuAl_2 and CuMgAl_2 . Figures 3 and 4 of the patent show differential scanning calorimetry curves with peaks in the temperature range of 500 to 530°C indicative of the amount of these constituent phases which contribute to the lowering of fracture toughness and resistance to fatigue crack growth. The new product (Fig. 4) has a much smaller peak indicating that the volume fraction

of such constituent has been significantly reduced owing to the removal of the constituent phases.

The appellant attempted to show that there was no significant improvement of these properties as compared with D3, but the comparison is not meaningful since the method of measuring is different in the two cases and there is no simple correlation between them. The tests in D3 use panels of different width (20-in) to that in the patent (16-in), and claim 1 refers to the T-L value whereas in D3 the data are for the longitudinal grain direction.

- 4.8 As stated above, the respondent emphasised that it was important that the heating step after each hot-rolling step be performed at a temperature high enough to effect SHT. By contrast, the lower temperature used in D3 after the first hot-rolling step would be detrimental. As stated in the patent (page 4, lines 35 to 40) if the reheating operation is performed at a temperature lower than 482°C (900°F), for example, 454°C (850°F), this can leave large volumes of coarse undissolved CuAl_2 and CuMgAl_2 particles, for example, which particles can have an adverse effect on the fatigue crack growth resistance in the final product. In fact, if the reheat is below the solvus temperature, these particles can even grow in size. It is the presence of such constituent particles which can limit crack propagation resistance in the final sheet product.
- 4.9 An indication that the present patent does not follow naturally from the teaching of D3 is that in D3 the method used to improve the mechanical properties took a different route. D3 teaches that the Cu content should

be reduced to decrease volume fraction of undissolved CuAl_2 particles (D3, page 23, first paragraph, and page 51), and also to decrease the solvus temperature. The patent in suit follows a different route not suggested in the prior art.

For the above reasons the method of claim 1 involves an inventive step.

Order

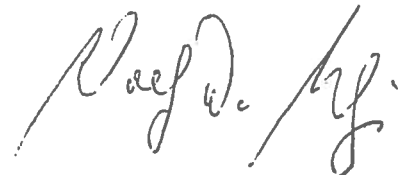
For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in amended form on the basis of claims 1 to 6 and the description pages 2 to 6 according to the first auxiliary request as submitted at the oral proceedings and Figures 1 to 4 as granted.

The Registrar

The Chairman


V. Commare



W. D. Weiß

M
25 June 2004

