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**Datasheet for the decision
of 23 October 2025**

Case Number: T 1656/23 - 3.3.05

Application Number: 17819095.5

Publication Number: 3476968

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C21D1/74, C21D8/02, C23C2/06,
C23C2/40

Language of the proceedings: EN

Title of invention:
LOW-DENSITY HOT-DIPPED STEEL AND MANUFACTURING METHOD THEREFOR

Patent Proprietor:
Baoshan Iron & Steel Co., Ltd.

Opponent:
ArcelorMittal

Headword:
Steel/BAOSHAN

Relevant legal provisions:
EPC Art. 54, 56, 83, 123(2)
RPBA 2020 Art. 12(4), 12(6)

Keyword:

Late-filed objection - admitted in first-instance proceedings
(no) - admitted (no)

Sufficiency of disclosure - main request (yes) - enabling
disclosure (yes)

Novelty - main request (yes)

Inventive step - main request (yes)

Decisions cited:

G 0007/93

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

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Case Number: T 1656/23 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 23 October 2025

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Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 27 July 2023
rejecting the opposition filed against European
patent No. 3476968 pursuant to Article 101(2)
EPC.**

Composition of the Board:

Chairman G. Glod
Members: T. Burkhardt
S. Fernández de Córdoba

Summary of Facts and Submissions

I. The opponent's (appellant's) appeal is against the opposition division's decision to reject the opposition against European patent No. 3 476 968 B.

II. Of the documents discussed at the opposition stage, the following are relevant to the present decision:

- D1 WO 2008/145872 A1
- D1a US 2010/0300585 A1
- D2 A. Ollivier Leduc, "Étude des mécanismes de germination et de croissance d'oxydes sélectifs sur un acier ferritique", PhD thesis, 2009
- D3 A.R. Marder, "The metallurgy of zinc-coated steel", Progress in Materials Science 45, 2000, 191-271
- D5 X.C. Xiong et al., "Properties assessment of the first industrial coils of low-density duplex δ -TRIP steel", Materials Science and Technology, 2016, 1-6
- D6 R. Sagl et al., "Tailoring of oxide morphology and crystallinity on advanced high-strength steel surfaces prior hot-dip galvanizing", Acta Materialia, 72, 2014, 192-9
- D10 I. Zuazo, "Low-Density Steels: Complex Metallurgy for Automotive Applications", JOM, 66(9), 2014, 1747-58
- D11 X. Jin et al., "Effect of Dew Point on Galvanizability in 4 Mass% Al Added Low Density Steel", ISIJ International, 2018, 1-8
- D12 S.K. Lee et al., "Effects of Dew Point on Selective Oxidation of TRIP Steels Containing

Si, Mn, and B", *Met. Mater. Int.*, 17(2), 2011,
251-7

D13 galvanising tests provided by the appellant,
pages 1-4

D14 declaration by X. Jin dated 5 June 2023

III. The opposition division concluded *inter alia* that

- document D13 was to be admitted, whereas document D14 was to be disregarded
- an objection under Article 123(2) EPC was to be disregarded
- the patent in suit met the requirements of Articles 83, 54 and 56 EPC.

IV. Claims 1 and 20 of the main request (granted version) read as follows:

"1. A low-density hot dip galvanized steel, comprising a steel substrate, a coating layer, and an interface layer, wherein the steel substrate is located at a core portion of the steel, the coating layer is located on a surface of the steel substrate, and the interface layer is disposed between the steel substrate and the coating layer, wherein the interface layer comprises iron particles dispersed on the steel substrate and covering the steel substrate thereby being disposed in an iron particle layer, wherein the iron particles are covered by a first inhibition layer; the steel substrate has an internal oxidized layer in a portion adjacent to the iron particle layer, the internal oxidized layer containing oxides of Al; the low-density hot dip galvanized steel contains element Al in a mass percentage of 3.0% to 7.0%."

"20. A method for manufacturing the low-density hot dip galvanized steel of any one of claims 1 to 19, comprising the steps of:

- (1) manufacturing a strip steel;
- (2) continuous annealing of the strip steel by heating to a soaking temperature of 750-950 °C and then holding it for 30-600 s, wherein the dew point of the annealing atmosphere is -15 °C ~ 20 °C;
- (3) hot dipping;

wherein in the step (2), the atmosphere of a heating section and a holding section is a mixed gas of N₂ and H₂, wherein the volume content of H₂ is 0.5~20%."

Dependent claims 2 to 19 and 21 to 23 relate to preferred embodiments.

- V. The arguments put forward by the appellant during the appeal proceedings, where relevant to the present decision, can be summarised as follows.

Document D14 was to be disregarded.

The objection under Article 123(2) EPC was to be considered.

Neither independent claims 1 and 20 nor dependent claims 5, 6, 10 and 13 to 15 met the requirements of Article 83 EPC.

The subject-matter of at least independent claims 1 and 20 lacked novelty over D1/D1a viewed in combination with D2.

The subject-matter of at least independent claims 1 and 20 lacked inventive step starting from D1 or D5.

VI. The respondent's (patent proprietor's) arguments at the appeal stage are reflected in the reasons below.

VII. The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondent requested that the appeal be dismissed. As an auxiliary measure, it requested that the patent be maintained in amended form on the basis of one of auxiliary requests I to III re-submitted with its reply to the appeal.

Reasons for the Decision

1. Admission of documents D13, D14 and of new experimental evidence

1.1 Document D13

The respondent conditionally requested that this document not be admitted.

D13 contains the results of experiments to allegedly prove that the patent in suit does not meet the requirements of Article 83 EPC.

D13 was filed before the summons to oral proceedings at the opposition stage, about one year before the oral proceedings, and was admitted by the opposition division because of its *prima facie* relevance.

Under the present circumstances, there is no legal basis for disregarding this document, which was correctly admitted - taking the right principles into

account and exercising its discretion in a reasonable way - by the opposition division (Case Law of the Boards of Appeal, 11th edition, 2025 ["Case Law"], V.A. 3.4.3). This document thus remains part of the proceedings.

1.2 Document D14

The respondent submitted D14 about two weeks before the oral proceedings at the opposition stage.

Because of lack of *prima facie* relevance of this expert declaration, the opposition division disregarded it.

The respondent requested that this document be considered, since it provided further insights into the phenomena underlying the invention. In addition, it included comments on D13.

However, no indication that the opposition division had not exercised its discretion in accordance with the correct principles, or that it had exercised it in an unreasonable way, and had thus exceeded the proper limits of its discretion (Case Law, V.A.3.4.1 b)) could be identified.

Consequently, D14 is not part of the present proceedings.

1.3 Additional experiments provided by the respondent

With its reply to the appeal, the respondent provided three additional series of experiments to prove that

iron particles are formed over the entire scope of claim 20 of the patent.

However, as sufficiency can be acknowledged anyway (see point 3. below), the question of admission of these new experimental data can be left unanswered.

Main request

The main request is the patent as granted.

For the reasons set out below, the main request meets the requirements of the EPC.

2. Article 100(c) in combination with Article 123(2) EPC: admission of the objection

The appellant substantiated this objection at the opposition stage only after the summons to oral proceedings.

The opposition division did not admit this new ground for opposition. In its view, the multiple references in the description as filed to "the present invention" made it clear on a *prima facie* level that the subject-matter of the dependent claims as filed related to the same invention although the corresponding dependent claims as filed only referred back to claim 1 (point II.2.3 of the decision).

The appellant argued that there were clear reasons - namely, in the form of the dependent claims depending only on claim 1 - why the requirements of Article 123(2) had possibly not been met and that the opposition division should have taken an in-depth look

into this issue instead of not admitting this ground for opposition.

However, this is not convincing. It was within the discretion of the opposition division to assess whether the elements before it called into doubt, on a *prima facie* level, the compliance with Article 123(2) EPC.

Hence no indication that the opposition division had not exercised its discretion in accordance with the right principles, or that it had exercised it in an unreasonable way, and had thus exceeded the proper limits of its discretion (G 7/93, OJ EPO 1994, 775, Reasons 2.6) could be identified.

Article 100(c) EPC is not part of the appeal proceedings.

3. Article 100(b) EPC in combination with Article 83 EPC

For the reasons set out below, the invention is sufficiently disclosed.

3.1 Claims 1 and 20

The appellant was of the opinion that the invention was insufficiently disclosed, since the skilled person could not carry out the invention without undue burden. There was insufficient teaching in the patent on how to form an iron particle layer over the entire scope claimed. This was shown by **D12** and the experiments of **D13**. Claim 1 had no limitations with regard to the Mn and Si contents, but Figures 11 to 14 of D12 showed that the external or internal oxidation of Mn and Si hindered the formation of an iron particle layer. The

alloy used in D13 had a concentration in accordance with claim 1 of the patent and was prepared in accordance with the method steps of claim 20 of the patent. However, no iron particulate layer was formed. Moreover, it was not proven that the examples of the patent had an interface layer with an iron particle layer and inhibition layers. It was unclear how Figure 2 of the patent was obtained. The appellant also argued that the alloy had to contain Mn, as indicated by dependent claim 2.

Referring to paragraph [0067] of the patent, the appellant argued that an aluminium oxide layer on the surface of the steel was detrimental to its wettability by a galvanising bath. Hence such an oxide layer should be avoided by shifting oxidation of the alloying elements to the inside of the steel. Instead, an iron particle layer on the surface should be formed. However, claim 1 only limited the Al content and not that of other alloying elements that were also prone to forming such an oxide layer on the steel surface. The skilled person knew for example that Mn, Si, Cr or Ti were also easily oxidised. This was shown by the literature review of PhD thesis **D2** (see pages 7 and 14). In line with this, the description advocated in paragraphs [0035] and [0074] a narrow range of alloy compositions, which was complied with in all the inventive examples of the patent. Since, by contrast, claim 1 did not limit the concentrations of these other alloying compounds (in particular Mn and Si), the skilled person was not in a position to arrive at steels with the claimed iron particle layer over the breadth of the claims.

This is not convincing. It is firstly noted that claims 1 and 20 require the presence of an iron

particle layer. This means that the composition has to be chosen such that said layer is obtained. The claim does not require that such a layer be obtained for any concentration of alloying elements. Consequently, compositions that do not allow such a layer to be formed, e.g. since they result in an oxide layer at the steel surface, are excluded by claims 1 and 20.

The patent contains extensive information on the concept of the invention:

- It contains 16 inventive examples, i.e. examples A1 to A16, based on three different alloys (Component I to Component III).
- It provides information as to the different alloy components, their respective roles and preferential ranges (paragraphs [0035] to [0042], as well as paragraph [0074]).
- Information on the effect of the operating conditions (such as the dew point) on the location of Al oxidation (external or internal oxidation) and the formation of the iron particle layer on the steel surface resulting therefrom (see paragraphs [0048] and [0049]) is also provided. Figure 3 shows exemplary locations of Al oxidation.
- The patent explains both the negative impact of an oxide layer and the positive impact of an iron particle layer on the steel surface on wettability of the steel by a galvanising bath (e.g. paragraphs [0007] and [0067]).
- Figure 2 shows the metallographic structure according to the invention (paragraphs [0069] and [0072]). There is no reason to assume that this figure was not obtained with an alloy having a composition and a method of manufacturing in line with the examples of the patent in suit.

- The patent in suit systematically opposes Examples A1 to A16 and Comparative Examples B1 to B6. There is thus no reason to doubt that Examples A1 to A16 have the claimed iron particle layers. This is confirmed by paragraph [0084], which states that the "Examples" (thereby referring to Examples A1 to A16) "ha[ve] an iron particle layer".
- The patent also mentions wettability problems relating to films of Si and Mn oxides (paragraph [0007]).

In view of this teaching, and since, as the appellant itself argues, the skilled person knows that there are also other elements besides Al that are easily oxidised, the skilled person would reduce the concentrations of other elements (such as Mn and Si) when faced with a situation where an iron particle layer is not formed when following method steps (1) to (3) of claim 20.

D12 is of no relevance, since the alloy does not contain Al, which as explained before is a crucial component of the present invention.

The tests of **D13** were carried out using method steps in accordance with steps (1) to (3) of claim 20, but an iron particle layer was not formed. The alloy used had a composition that, while being within the composition ranges of claim 1, is outside the ranges of paragraph [0074] of the patent in suit. For instance, the C concentration is lower and the Mn concentration is higher. As explained above, the skilled person would try to reduce the Mn content to arrive at an iron particle layer. Under these circumstances, D13 is not sufficient to prove that the invention is not sufficiently disclosed.

With regard to Mn, the patent in suit explains its role and suitable concentration ranges (paragraph [0038]) and dependent claim 2 specifies that the oxidised layer preferably comprises oxides of Mn. There is hence no reason to doubt that the invention can be carried out.

3.2 Dependent claims

The appellant alleges that the patent did not provide enough teaching to realise the invention of dependent claims 5, 6, 10 and 13 to 15.

However, the appellant has not shown, e.g. by its own experiments, that the skilled person was not able - with the teaching of the patent (see point 3.1 above) and their common general knowledge - to produce a steel sheet with:

- the thickness of the interface layer of claim 5
- the iron particle size of claim 6
- the relative thicknesses of the first and second inhibition layers of claim 10
- the microstructure of claims 13 to 15

In this regard, reference is also made to the teaching of paragraphs [0035] to [0039] of the patent, which explains the influence of different elements on microstructure, and to paragraph [0072], which explains the reaction mechanisms behind the formation of the first and second inhibition layers.

It is additionally noted that:

- The first sentence of the passage on page 1749 of **D10** (first full paragraph of left-hand column) only relates to binary Fe-Al alloys. Moreover, D10 does not relate to hot dip galvanised steel sheets. Paragraphs [0037]

to [0039] of the patent discuss the respective roles of e.g. C, Mn and Al on the microstructure. D10 can thus not prove that the skilled person cannot achieve the microstructure required by claim 13.

- **D11** indicates that the dew point has an important influence on the formation of the required iron particle layer. This in turn has an influence on the reaction between the galvanising solution on the one hand and the iron particles and substrate on the other hand to form an Fe-Al-Zn inhibition layer (see abstract of D11). Figure 10 of D11 corresponds to an isolated experiment. It is difficult to draw a conclusion on the thicknesses of a first and a second inhibition layer. Under these circumstances, Figure 10 of D11 cannot prove in a generalised way that the skilled person would not be able to form a second inhibition layer (between the iron particles) that is thinner than the first inhibition layer (which covers the iron particles).

There is thus no convincing evidence that the skilled person cannot carry out the invention in accordance with these dependent claims.

4. Article 100(a) EPC in combination with Article 54 EPC

In the appellant's view, **D1/D1a**, viewed in combination with **D2**, anticipated the subject-matter of at least claims 1 and 20.

The appellant does not contest that D1/D1a:

- generally discloses an overlapping Al concentration range (D1a: paragraph [0015]), and preferably an Al concentration above the claimed range (D1a: paragraph [0019])

- discloses a broader dew point range (D1a: paragraph [0117])
- is silent on the holding time during annealing
- is silent on the annealing atmosphere

In its view, D1/D1a implicitly disclosed the claimed features.

This is, however, not convincing.

Regarding PhD thesis **D2**, it is debatable whether this document illustrates the common general knowledge. The fourth paragraph on page 7 (point 1.1) relates to a bibliographic review and cannot prove that the composition of the atmosphere of D1/D1a during annealing is necessarily in the claimed range. Moreover, only iron oxide (with no other components being present) is used in Figure 1.9 of D2. It is known that the presence of further components has an influence on the position of equilibrium curves in a phase diagram. Consequently it cannot be concluded that Figure 1.9 would also apply to a multi-component alloy. Therefore, even when considering D2, it has not been proven that the dew point used for the multi-component alloys of D1/D1a is necessarily within the ranges of claim 20. The holding time disclosed in D2 (page 10, figure 1.3) only corresponds to a typical profile ("profil classique"), which is not necessarily the holding time used in D1/D1a.

Consequently, D1/D1a - even when considering the disclosure of D2 - does not directly and unambiguously disclose the subject-matter of independent method claim 20. There is hence also no direct and unambiguous disclosure that D1/D1a has the specific layer structure

(e.g. with an iron particle layer and an internal oxidised layer) required by claim 1.

At least for these reasons, the subject-matter of the dependent claims is also novel.

The requirements of Article 54 EPC are met.

5. Article 100(a) EPC in combination with Article 56 EPC

For the reasons set out below, the main request meets the requirements of Article 56 EPC when starting from D1/D1a or D5.

5.1 Starting from **D1/D1a**

5.1.1 The subject-matter of **claim 20** relates to a method for manufacturing a low-density hot dip galvanised steel.

D1/D1a discloses the features mentioned above (point 4.). It thus relates to the same technical field and is a suitable starting point for assessing inventive step.

According to the patent in suit, the problem to be solved is to provide a hot dip galvanised steel with low density, high strength and good galvanisability (paragraph [0009]). According to the patent proprietor, the formation of an internal oxidised Al layer and of an iron particulate layer at the sheet's surface (just below the coating) are consequences and core concepts underlying the present invention.

It is suggested to solve this problem by means of the method of manufacturing a hot dip galvanised steel of claim 20, which is characterised among other things by

- an Al content between 3.0% and 7.0%,
- a holding time between 30 s and 600 s,
- the claimed annealing atmosphere (mixed gas of N₂ and H₂, wherein the volume content of H₂ is 0.5~20%),
- a dew point range between -15 °C and +20 °C, and
- (via the dependency of claim 20 on claim 1) an iron particle layer between the substrate steel and the coating.

The examples of the patent show that this problem has been successfully solved by means of the inventive method (see Tables 1 to 3). Figure 2 shows the claimed layered structure, in particular iron particle layer 4.

The tests of **D13** cannot prove that the problem has not been successfully solved. Since the tests did not result in the required iron particulate layer, as argued by the appellant, they were not prepared in accordance with claim 20 (due to the dependency of claim 20 on claim 1).

Similarly, **D12** cannot prove that the problem posed has not been solved either. If Si or Mn prevented the formation of an iron particulate layer or of an inhibition layer, D12 would not be in accordance with claim 20.

In summary, the arguments of the appellant that the problem was not solved over the whole range claimed are not convincing, since the method has to be conducted such that a steel in accordance with claim 1 is obtained. If no such steel is obtained, the method is not in accordance with claim 20.

In the absence of an incentive in the available prior art (and in particular in **D2**) to solve the technical

problem posed by choosing, among other things, in the claimed ranges *in combination*:

- an Al concentration,
- an N₂/H₂ atmosphere,
- a dew point,
- a holding time, and
- an iron particle layer between the substrate steel and the coating

an inventive step over D1/D1a is to be acknowledged.

5.1.2 The same line of argument applies to **claim 1**, since the specific layering called for by claim 1 is obtained by the method of claim 20. It has the advantages set out above. No such structure is mentioned in D2.

5.2 Starting from **D5**

The reasoning with regard to D5 is analogous to that starting from D1/D1a.

It has not been disputed that D5 neither discloses the N₂/H₂ atmosphere nor the dew point in the claimed ranges.

Therefore it cannot be deduced that D5 necessarily has the layer structure required by claim 1 and indirectly by claim 20.

As for D1/D1a as starting point, **D13** and **D12** cannot prove that the problem underlying the patent (see above) is not solved over the entire claimed range when starting from D5.

In the absence of an incentive in the available prior art (and in particular in **D6**) to choose among other things *in combination* an N₂/H₂ atmosphere and a dew

point in the claimed ranges as well as to form an iron particle layer, an inventive step is to be acknowledged over D5.

D6 explains the relationship between the dew point and oxidation (page 192, right-hand column). However, D6 does not mention the claimed iron particle layer. Moreover, in view of the Al content of D6 (see Table 1 on page 193), which is different from that of D5, the skilled person would not consider D6 when starting from D5.

5.3 For these reasons, the subject-matter of the independent claims, and thereby also that of the dependent claims, involves an inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



C. Vodz

G. Glod

Decision electronically authenticated