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# Datasheet for the decision of 17 October 2013

**Case Number:** T 1205/11 - 3.2.08

**Application Number:** 05028528.7

**Publication Number:** 1676933

**IPC:** C22C 38/02, C22C 38/04

**Language of the proceedings:** EN

**Title of invention:**
High strenght thin steel sheet having high hydrogen embrittlement resisting property and high workability

**Applicant:**
Kabushiki Kaisha Kobe Seiko Sho (Kobe Steel, Ltd.)

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 54

**Keyword:**
-

**Decisions cited:**
-

**Catchword:**
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Beschwerdekammern | Boards of Appeal | Chambres de recours

**Case Number:** T 1205/11 - 3.2.08

# D E C I S I O N
**of the Technical Board of Appeal 3.2.08**
**of 17 October 2013**

**Appellant:** (Applicant)
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**Decision under appeal:**
**Decision of the Examining Division of the European Patent Office posted 7 December 2010 refusing European patent application No. 05028528.7 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman:** T. Kriner
**Members:** R. Ries
D. T. Keeling

## Summary of Facts and Submissions

I. In it decision dated 7 December 2010 refusing European patent application No. 05028528.7, the examining division held that the subject matter of claim 1 of the main, first and second auxiliary requests then on file lacked novelty over the technical disclosure of either documents

D2: EP-A-1 553 202, which represents prior art pursuant to Article 54(3) EPC;

D5': T. Hojo, Sung-Mo Song, Koichi Sugimoto, Akihito Nagasaka, Shushi Ikeda, Hiroshi Akamizu and Masami Mayuzumi: "The Hydrogen-Embrittlement of Ultrahigh Strength Low Alloy TRIP-aided Steels", Tetsu to Hagané Vol. 90 (2004), No. 3. pages 177 to 182; (Received: October 2003); Tranlation into English of the original document;

D6: Koh-ichi Sugimoto, Shun-ichi Hashimoto, Shu-shi Ikeda: "Ultra High-Strength Low-Alloy TRIP-Aided Sheet Steels with Bainitic Ferrite Matrix", International Conference on Advanced High Strength Sheet Steels for Automotive Applications Proceedings, June 6-9, 2004, Winter Park, Colorado, Association for Iron and Steel Technology, pages 63 to 70.

II. On 31 January 2011 the appellant (applicant) lodged an appeal against the decision of the examining division and paid the appeal fee on the same day. The statement setting out the grounds of appeal was received on 28 March 2011.

III. In an official communication annexed to the summons to oral proceedings, the Board gave its provisional view on the case. Specifically, the claims of all requests enclosed with the grounds of appeal were considered to lack novelty over document D2 (Article 54 EPC).

IV. Oral proceedings were held on 17 October 2013.
The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the single claim of the request filed during the oral proceedings on 17 October 2013.

The single claim of this request reads as follows:

"A high strength thin steel sheet having high hydrogen embrittlement resisting property, which comprises:
C: higher than 0.3 up to 0.60%;
Si: 1.0 to 3.0%;
Mn: 1.0 to 3.5%;
P: 0.15% or less;
S: 0.02% or less;
Al: 0.2 to 1.5%;
which optionally further comprises
Cu: 0.003 to 0.5% and/or Ni: 0.003 to 1.0% as optional elements;
Ti and/or V: 0.003 to 1.0% as optional elements,
Mo: 1.0% or less (higher than 0%) and Nb: 0.1% or less (higher than 0%) as optional elements;
B: 0.0002 to 0.01% as an optional element;
at least one element selected from the group consisting of:
Ca: 0.0005 to 0.005%;
Mg: 0.0005 to 0.01%; and

REM: 0.0005 to 0.01% as optional elements; and
Zr 0.003 to 1.0% as an optional element,
in terms of percentage by weight, with balance of iron and inevitable impurities;
wherein the metal structure after stretch forming operation with elongation of 3% consists of:
residual austenite: 3% by area or more in proportion of the entire structure;
binary phase of bainitic ferrite and martensite with the bainitic ferrite acting as the main phase: 90% or more in total;
while the mean axis ratio (major axis/minor axis) of said residual austenite grains is 5 or higher, and the steel has a tensile strength 1180 MPa or higher,
wherein the metal structure further satisfies the requirements that:
mean length of minor axes of said residual austenite grains is 1 µm or less; and
minimum distance between the residual austenite grains is 1 µm or less."

V. The appellant's arguments relevant to the present decision are summarized as follows:

The present application aimed at providing a high strength thin steel sheet having a high resistance to hydrogen embrittlement and corrosion and exhibited an improved workability under a tensile strength of 1180 MPa or higher. This objective was achieved by the thin steel sheet having the technical features of the the single claim. Specifically, the claimed steel sheet exhibited a microstructure consisting

(i) of a binary phase of bainitic ferrite and martensite in order to provide sufficiently high strength and
(ii) of lath-shaped residual austenite in the submicron order.
The latter phase substantially neutralized the hydrogen infiltrated from outside through atmospheric corrosion and thus contributed to the steel sheet's resistance to hydrogen embrittlement. In addition, the Al content of the steel sheet was controlled to fall within the range of 0.2 to 1.5% in order to further improve the steel sheet's resistance to hydrogen embrittlement and corrosion, as set out in paragraphs [0046] to [0049] of the A1 publication of the present application.

Document D2 disclosed ultra high-strength steel sheets having a microstructure comprising bainitic ferrite, polygonal ferrite and residual austenite. Although martensite was mentioned exemplarily as a further phase the microstructure of the known steel sheet may include, none of the examples given in D2 actually described the presence of martensite. Consequently, document D2 did not explicitly disclose a high-strength steel sheet which exhibited a microstructure comprising 90% or more in total of a binary phase of bainitic ferrite and martensite. Moreover, D2 failed to disclose a steel composition comprising aluminium in the claimed range of 0.2 to 0.5%.

Document D5' was concerned with a TRIP-type bainitic ferrite steel sheet, the composition of which includes 0.045% Al (D5', Table 1; BF steel). With respect to the Al content, D5' was therefore concerned with a different steel composition. As further set out in D5',

page 7, lines 5 to 7, the known BF steel consisted of a parent phase of bainitic ferrite and a second phase which was chiefly retained austenite. Hence, D5' did not disclose a microstructure consisting of residual austenite and a binary phase of bainitic ferrite and martensite, as defined in the claim of the application.

Document D6 disclosed an ultra high-strength low-alloy TRIP aided steel sheet with a bainitic ferrite matrix and inter-lath retained austenite films (called BF steel) which comprised 0.2%C, 0.5% Si, 1.5% Mn, 1.0% Al, 0.05% Nb, 0.200% Mo (D6, Figure 13). However, the contents of C and Si are outside the claimed elemental ranges. As further shown in Figure 5a of D6, the known BF steel sheet austempered at 450°C (i.e. above $M_S$) did not reach a TS of 1180 MPa or higher as did the claimed steel sheet. Consequently, the BF steel sheet of D6 did not achieve a sufficiently high strength which was a consequence of the different heat treatment temperatures at 950°C or 1000°C used in this document.

The subject-matter of the single claim was therefore novel over the disclosure of any of documents D2, D5' and D6, respectively.

## Reasons for the Decision

1. The appeal is admissible.

2. Novelty; Article 54 EPC

2.1 Document D2, which represents prior art pursuant to Article 54(3) EPC, discloses an ultra high-strength

steel sheet having a tensile strength of 1180 MPa or higher and an excellent resistance to hydrogen embrittlement. The steel sheet consists of 0.06 to 0.6% C, 0.5 to 3% Si+Al, 0.5 to 3% Mn, 0.15% or lower of P, 0.025 or lower of S, further optional elements, the balance being iron and residual impurities. The structure of the steel sheet comprises 3% or more residual austenite, 30 to 95% lath-shaped bainitic ferrite, and optionally polygonal ferrite of 50% or lower including also 0%. The microstructure may further include up to 10% of other phases, for example martensite (D2, [0009], [0019], [0031], [0038[; [0040]].

As to Al as an alloying element, document D2 fails to specify lower and upper limits for the Al range. Rather more, the presence of Si and Al is limited in total to 0.5 to 3% Si+Al. It is further apparent from Table 2 of D2 that Al, if added, is present in an amount of 0.03% in all examples, except for example D which includes 0.5% Al. However, example D comprises 0.5% Si which falls outside the composition set out in the claim of the present application.
As reflected in paragraphs [0053] to [0055] of the A1 publication of the present application, Al in the claimed range effectively adds to improving the steel sheet's resistance to corrosion and hydrogen embrittlement. Consequently, Al as an alloying element in the claimed range has been added on purpose rather than by guesswork.

2.2 Document D5' is concerned with a detailed study on the hydrogen embrittlement of a TRIP-type bainitic ferrite steel consisting of 0.40%C, 1.49%Si, 1.50%Mn, 0.015%P, 0.0012%S, 0.045%Al, 0.0014%O, 0.0021% N, balance Fe and

residual impurities (D5', Table 1; BF-steel). It is evident that the known steel does not comprise Al in the range of 0.5 to 1.5% claimed in the present application. Moreover, D5' does not disclose a high strength thin steel sheet having a microstructure consisting of binary phase of bainitic ferrite and martensite of 90% or more in combination with lath-shaped residual austenite. Rather, the known BF steel of D5' consists of a parent phase of bainitic ferrite ($\alpha_{BF}$) and a second phase chiefly composed of retained austenite ($\gamma_R$) (D5', page 7, lines 5 to 7 and Figure 3).

2.3 Document D6 is concerned with ultra high strength low alloy TRIP-aided sheet steels having a bainitic ferrite matrix (D6, title). Two different steel compositions are investigated in this document: The first one comprises 0.20%C, 1.51% Si, 1.51% Mn, balance iron. This composition does not include Al as an alloying element and is therefore different from that claimed in the present application (D6, text in Figures 2 to 5).

The second steel composition comprises 0.2% C, 0.5% Si, 1.5% Mn, 1.0% Al, 0.05% Nb, the balance being Fe. However, the carbon and silicon contents of the known steel sheet fall outside the claimed steel composition. (D6, text in Figures 13 to 16). The composition of the claimed steel sheet therefore differs from D6 by the aluminium, carbon and silicon contents.

Only by austempering the known steel at temperatures higher than $M_s$ of the steel can a large amount of retained austenite together with a small amount of martensite plus bainitic ferrite be obtained (D6, page 64, lines 1 to 3). It is, however, apparent from

Figure 5 of D6 that the high strength of 1180 MPa required for the claimed steel sheet is not obtained when the known steel is austempered above the $M_s$ - temperature.

2.4 The subject matter of the single claim is therefore novel over the technical disclosure of either document D2, D5 and D6, respectively.

3. Since the single claim of the sole request submitted at the oral proceedings before the Board differs from the claims on which the decision of the examining division was based and given that the decision of refusal was exclusively based on the objection of lack of novelty, which has now been overcome, the Board considers it appropriate to set the impugned decision aside and to remit the case to the department of first instance for examination of the further requirements of the EPC.

**Order**

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

1. The decision under appeal is set aside.

2. The case is remitted to the examining division for further prosecution on the basis of the sole request filed at the oral proceedings.

The Registrar: The Chairman:

V. Commare T. Kriner