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**Datasheet for the decision
of 17 October 2013**

Case Number: T 1462/11 - 3.2.08
Application Number: 05028444.7
Publication Number: 1676932
IPC: C22C 38/02, C22C 38/04
Language of the proceedings: EN

Title of invention:

High strength thin steel sheet having high hydrogen embrittlement resisting property

Applicant:

Kabushiki Kaisha Kobe Seiko Sho (Kobe Steel, Ltd.)

Headword:

-

Relevant legal provisions:

EPC Art. 54

Keyword:

"Novelty (yes) after amendment"

Decisions cited:

-

Catchword:

-



Case Number: T 1462/11 - 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 3 December 2010
refusing European patent application
No. 05028444.7 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 its decision dated 3 December 2010 refusing European patent application No. 05028444.7, 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

D1: Koh-ichi Sugimoto, T. Iida, J. Sakaguchi, T. Kashima: "Retrained Austenite Characteristics and Tensile Properties in a TRIP Type Bainitic Steel", ISIJ, vol. 40, No. 9, pages 902 to 908;

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

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 (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 sole request submitted during the oral proceedings on 17 October 2013.

The claim of this request read as follows:

" A high strength thin steel sheet having high hydrogen embrittlement resisting property, which comprises:

C: 0.10 to 0.25%;

Si: 1.2 to 2.5%;

Mn: 1.2 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 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 phase 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 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, corrosion and an improved
workability under a tensile strength of 1180 MPa or
higher. This objective was achieved by the technical
features of the thin steel sheet set out in claim 1.
Specifically, the claimed steel sheet exhibited a
binary phase structure consisting of bainitic ferrite
and martensite in order to provide sufficiently high
strength. In addition, the microstructure of the
claimed steel sheet included lath-shaped residual
austenite in the submicron order, a phase which

substantially neutralized the hydrogen infiltrated from outside through atmospheric corrosion and thus contributed to the steel sheet's resistance to hydrogen embrittlement. Moreover, the Al content of the steel sheet was controlled to be 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 reflected in paragraphs [0046] to [0049] of the A1 publication of the application.

Document D2 disclosed ultra high-strength steel sheet 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 mentioned 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 range of 0.2 to 0.5%.

Turning to document D1, the TRIP type bainitic steel sheet (TB-steel) exhibited a binary structure of bainitic ferrite and martensite structure only after austempering at the M_s -temperature or higher (450°C in the example). By contrast, austempering below the M_s -temperature (375°C in the example) did not result in a binary bainitic ferrite and martensite structure. However, as it was evident from Figures 7a and 8a of D1, the TB steel sheet austempered at 450°C did not achieve a tensile strength (TS) of 1180 MPa or higher, as

required by the steel sheet claimed in the present application.

Document D6 disclosed that TRIP-aided steel sheet with a bainitic ferrite matrix and inter-lath retained austenite films (called BF steel) was obtained after austempering at temperatures higher than M_s . As shown in Figure 5a of D6, the 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 submitted at the oral proceedings was therefore novel over the disclosure of any of documents D2, D1 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 give an individual range for Al by specifying lower and upper limits. Rather more, the presence of Si+Al is limited in total to 0.5 to 3%. 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 0.3% C and 0.5% Si which both fall outside the composition set out in the claim of the present application. As reflected in paragraphs [0049] and [0050] of the A1 publication, Al as an alloying element in the range of 0.2 to 1.5% effectively adds to improving the steel sheet's resistance to corrosion and hydrogen embrittlement. Consequently, Al has been added on purpose to improve the sheet's anti-corrosion properties.

- 2.2 Document D1 discloses a TRIP type bainitic (TB) steel sheet consisting of 0.20% C, 1.51% Si, 1.51%, 0.015% P, 0.0011% S, 0.040% Al, 0.0021% N, balance iron and unavoidable impurities (D1, page 902, point 2. Experimental procedure). Hence, the compositional requirement of the claimed steel sheet of 0.2% Al to 1.5% Al is not met by the steel sheet disclosed in document D1.

If the steel sheet of D1 is austempered at temperatures higher than the martensite-start temperature ($M_s = 417^\circ\text{C}$), quasi ferrite and blocky martensite phases coexist with coarsened retained austenite films (between 8 and 12 vol%) and a bainitic ferrite matrix (D1, page 903, column 2, point 3.1: Results). It is however evident from Figures 7a and 8a of D2, the TB steel sheet austempered at 450°C (= above M_s) does not exhibit a TS of 1180 MPa or higher, as required for the steel sheet according to the single claim now on file.

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 steel composition comprises 0.20% C, 1.51% Si, 1.51% Mn, balance iron and does not include Al as an alloying element. This steel composition is therefore different from that claimed in the present application with respect to the aluminium content (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 silicon content of the known steel sheet falls outside the claimed steel composition. (D6, text in Figures 13 to 16). The composition of the claimed steel sheet differs therefore from D6 by the aluminium and silicon contents.

Only when 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). As it is however apparent from Figure 5, 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 documents D2, D1 and D6, respectively.

3. Since the single claim of the 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 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