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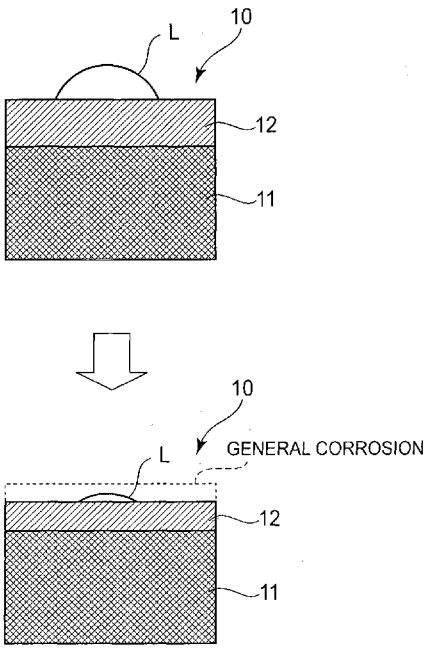
[Continued on next page]

(54) Title: STAINLESS STEEL AND METHOD OF MANUFACTURING THE SAME

FIG. 1



(57) Abstract: A stainless steel that includes chromium and other alloying element as a plurality of alloying elements including: a base material layer including chromium of a specified chromium content necessary for forming a passive film or more; and a superficial layer including chromium at a lower chromium content than the chromium content contained in the base material layer, and the superficial layer including the other alloying elements at a same content of the other alloying element as the content of the other alloying element contained in the base material layer.

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INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B15/01 B32B15/00 C21D8/02 C21D8/04 C21D9/46
C23C8/04 C23C8/26 C23C8/80 C23C10/08 C23C10/60
C22C38/18 C22C38/22 C22C38/28 C22C38/40 C22C38/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C21D C23C C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 840 237 A1 (SUMITOMO METAL IND [JP] NIPPON STEEL & SUMITOMO METAL [JP]) 3 October 2007 (2007-10-03) the whole document	1-5
X	EP 1 498 508 A1 (SUMITOMO METAL IND [JP]) 19 January 2005 (2005-01-19)	1-7,9
Y	the whole document	6
X	US 2003/000611 A1 (TAKAHASHI SUSUMU [JP]) 2 January 2003 (2003-01-02)	7
A	the whole document	9
Y	JP 2013 053769 A (TOYOTA MOTOR CORP) 21 March 2013 (2013-03-21) paragraph [0079] - paragraph [0081]	6

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2015	27/08/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Teppo, Kirsi-Marja

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/000473

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP H04 131321 A (TOSHIBA CORP) 6 May 1992 (1992-05-06) cited in the application abstract -----	7,9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2014/000473

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

1-7, 9

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2

These claims are directed to a stainless steel that contains chromium and other alloying element as a plurality of alloying elements, the stainless steel comprising:a base material layer including chromium at a specified chromium content necessary for forming a passive film or more; and a superficial layer including chromium at a lower chromium content than the chromium content contained in the base material layer, and the superficial layer including the other alloying element at a same content of the other alloying element as the content of the other alloying element contained in the base material layer.

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2. claims: 3-6

These claims are directed to a stainless steel comprising:a base material layer including chromium and other alloying element as a plurality of alloying elements; and a superficial layer that includes the chromium and the other alloying element as a plurality of alloying elements, the chromium content contained in the superficial layer being less than the specified chromium content necessary for forming a passive film, a difference between the chromium content contained in the base material layer and the chromium content contained in the superficial layer being larger than a difference between the content of the other alloying element contained in the base material layer and the content of the other alloying element contained in the superficial layer.

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3. claims: 7, 9

This claim is directed to a method of manufacturing a stainless steel, the method comprising:preparing a stainless steel raw material that includes a base material layer and a superficial layer, both of which include chromium and other alloying element as a plurality of alloying elements; disposing at least the superficial layer of the stainless steel raw material under a low pressure environment, the low pressure environment is an environment of lower pressure than atmospheric pressure; and heating at least the superficial layer of the stainless steel raw material to a treatment temperature, the treatment temperature is higher than a vaporizing temperature of the chromium under the low pressure environment and lower than a vaporizing temperature of the other alloying element under the low pressure environment.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

4. claim: 8

These claims are directed to a method of manufacturing a stainless steel comprising:preparing a stainless steel raw material that includes a base material layer and a superficial layer, both of which include chromium and other alloying element as a plurality of alloying elements; heating at least the superficial layer of the stainless steel raw material at a predetermined temperature; and exposing at least the superficial layer of the stainless steel raw material under an environment that is an environment of lower vapor pressure than the vapor pressure of the chromium at the predetermined temperature and higher vapor pressure than the vapor pressure of the other alloying element at the predetermined temperature.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2014/000473

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EP 1840237 A1	03-10-2007	AU 2004325491 A1	15-06-2006
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