(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 November 2012 (01.11.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/146384 A1

(51) International Patent Classification:
C21D 1/673 (2006.01) *C22C 38/38* (2006.01)
C21D 9/48 (2006.01) *C22C 38/58* (2006.01)
C22C 38/02 (2006.01) *B32B 15/01* (2006.01)
C22C 38/04 (2006.01)

(21) International Application Number:
PCT/EP2012/001822

(22) International Filing Date:
27 April 2012 (27.04.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11003444.4 27 April 2011 (27.04.2011) EP

(71) Applicant *(for all designated States except US)*: **TATA STEEL NEDERLAND TECHNOLOGY B.V.** [NL/NL]; P.O. Box 10000, NL-1970 CA Ijmuiden (NL).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **LAHAYE, Christiaan Theodorus Wilhelmus** [NL/NL]; Tata Steel Nederland Technology BV, Group Intellectual Property Services, PO Box 10000, NL-1970 CA IJmuiden (NL). **SCHOUWS, Albertus Johannes** [NL/NL]; Tata Steel Nederland Technology BV, Group Intellectual Property Services, PO Box 10000, NL-1970 CA IJmuiden (NL).

(74) Agent: **KRUIT, Jan**; Tata Steel Nederland Technology B.V., Group Intellectual Property Services, P.O. Box 10000, NL-1970 CA IJmuiden (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: A STEEL STRIP COMPOSITE AND A METHOD OF MAKING THE SAME

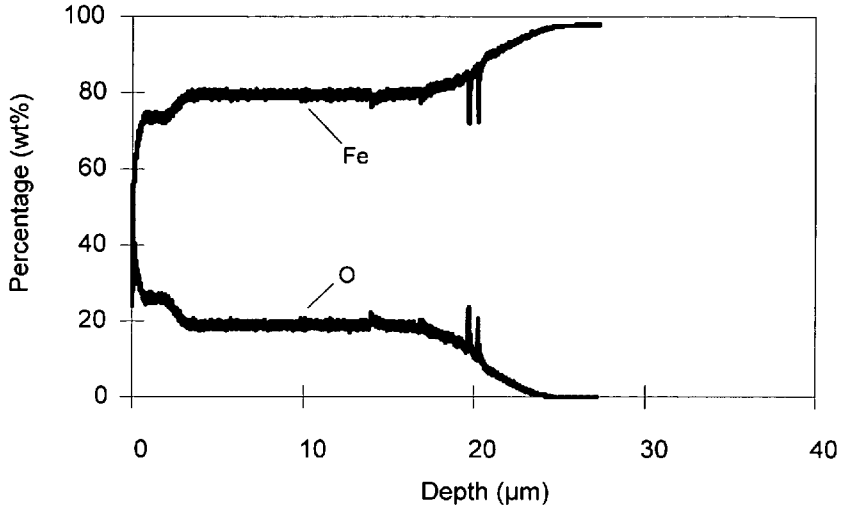

Figure 2

(57) Abstract: A hot-formable steel strip, sheet or blank which comprises of a steel substrate and oxidation resistant metallic clad layer one or both sides of the steel substrate.

WO 2012/146384 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A STEEL STRIP COMPOSITE AND A METHOD OF MAKING THE SAME

FIELD OF THE INVENTION

The present invention relates to a hot-formable steel strip, sheet or blank, a method for the manufacture of the hot-formable steel strip sheet or blank and the use of the hot-formable steel strip, sheet or blank in hot-forming. The present invention further relates to a process for manufacturing a hot-formed part and the hot-formed part thus formed.

BACKGROUND TO THE INVENTION

The use of hot-formed high strength steels for structural parts in automobiles and motor vehicles in general has increased in recent years due to the high mechanical properties of such steels. By hot-forming, the manufacturer is able to produce parts having superior shape complexity and strength.

Hot-forming is usually performed by providing a steel sheet blank, heating the blank in a heating furnace to a temperature between 800 and 1200°C, placing the heated blank in a hot forming press, forming the blank into a part in the hot forming press and hardening the hot formed part.

High temperature oxidation at the steel surface is a common problem which reduces the spot weldability of the part and adversely affects the appearance of the part after paint baking. Uncoated blanks are therefore hot-formed under inert conditions to reduce oxidation and decarburisation of the steel during the heating and hot-forming of the blank. Nevertheless, when the blank is transferred from the heating furnace to the hot-forming press, oxidation of the blank can occur meaning the part must be de-scaled after hot-forming.

In an attempt to minimise oxidation and decarburisation still further, steel sheets are now provided with protective metallic coatings. Common protective coatings are based on zinc, zinc alloys, aluminium-silicon or organic coatings.

Zinc coated steel sheets are provided as hot dip galvanized steel sheets. These sheets are provided and subsequently subjected to a heat treatment between 800 and 1200 °C in the heating furnace of the hot-forming line. During the heat treatment a diffusion layer (zinc-iron alloy) and a thin layer of zinc oxide are formed. Although the

diffusion layer provides protection against high temperature oxidation of the substrate and ensures good adhesion between the zinc coating and the substrate, the thin layer of zinc oxide has a negative impact on spot weldability. An additional process step to remove the zinc oxide layer is therefore required if hot-dip galvanised steel sheets are to be spot welded.

Al-Si coatings also rely on the formation of a diffusion layer to prevent against high temperature oxidation, which diffusion layer comprises oxides of aluminium and silicon. When zinc or Al-Si coated substrates are subjected to the heat treatment prior to hot-forming, it is typical to limit the heating rate to between 5 and 10 ˚C/s; otherwise a solid-liquid transition may occur causing the zinc or aluminium to drip from the substrate or even evaporate, both of which are undesirable.

It is an object of the present invention to provide a steel strip sheet or blank having reduced susceptibility to high temperature oxidation and decarburisation, particularly with respect to uncoated steel or zinc coated steel.

Another object of the present invention is to provide a steel strip, sheet or blank that can be heated very fast in a hot-forming line.

Another object of the invention to provide a steel strip or blank having good weldability properties after hot-forming.

A further objective is to provide a steel strip sheet or blank having excellent formability after hot forming.

A further object of the invention to provide a process for the manufacture of a steel strip, sheet or blank having reduced susceptibility to high temperature oxidation and decarburisation, which process substantially avoids the processing issues disclosed hereinabove.

The first aspect of the invention relates to a hot-formable steel strip, sheet or blank which comprises a steel substrate and an oxidation resistant metallic clad layer on one or both sides of the steel substrate. Preferably the oxidation resistant clad is adjacent to the steel substrate.

Advantageously the hot-formable steel strip, sheet or blank exhibits improved resistance against high temperature oxidation and decarburisation at the steel substrate surface. In this respect the steel, strip sheet or blank is substantially free of oxide scales after a heat-treatment between 800 and 1200°C. The substantial absence of oxide scales means that it is not necessary to remove oxide scales after the step of hot-forming, which is the case when uncoated steel strips are hot-formed. Although the formation of oxide scales is reduced when steel strips are coated with zinc, it is still necessary to remove the thin oxide layer characteristic of such protective coatings prior to the step of spot welding. A further advantage of the present invention is that the steel strip, sheet or blank is fully spot weldable because no deleterious oxide layer is formed as such.

Assessment of the steel strip, sheet or blank after the step of hot-forming similarly revealed the substantial absence of oxide scales at the steel substrate surface.

Hot-forming may be defined as a process which comprises the steps of heating a steel substrate in a heating furnace to a temperature above Ac1 in order to austenise the steel substrate, transferring the austenised steel substrate to a press and press quenching the steel substrate to obtain a formed part having a high tensile strength. In this embodiment the tooling between which the steel substrate is pressed has a lower temperature relative to the steel substrate that is being hot-formed.

In a preferred embodiment of the invention the steel substrate contains in weight %: 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 2.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, < 0.1 P, < 0.05 S, < 0.08 B, < 0,1 V, < 0.5 Mo, < 0.003 ppm Ca, optionally < 0.1 Nb, unavoidable impurities, the remainder being iron.

In a preferred embodiment of the invention the steel substrate contains in weight %: 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 0.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, < 0.1 P, < 0.05 S, 0.0005 - 0.08 B, optionally < 0.1 Nb and/or < 0,1 V, preferably 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 0.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, < 0.1 P, < 0.05 S, 0.0005 - 0.015 B, optionally < 0.1 Nb and/or < 0,1 V unavoidable impurities, the remainder being iron. These steel types are suitable for hot forming. Usually the amount of boron is between 0.001 and 0.005 weight%.

In a preferred embodiment of the invention the steel substrate contains in weight %: 0.15 - 0.45 C, 1.0 - 3.0 Mn, 1.0 - 2.5 Si, < 2.5 Al, < 1.0 Cr, < 0.06 P, < 0.03 S, < 0.5

Mo, < 0.1 Ti or < 0.1 V and < 0.003 ppm Ca, preferably 0.2 - 0.4 C, 1.5 - 2.5 Mn, 1.4 - 2.0 Si, < 0.6 Al, < 1.0 Cr, < 0.06 P, <0.03 S, < 0.5 Mo, < 0.1 Ti or < 0.1 V and < 0.003 ppm Ca, unavoidable impurities, the remainder being iron.

In a preferred embodiment of the invention the oxidation resistant metallic clad layer contains in weight %: < 0.15 C , 0.2 - 5 Mn , < 2 Si , < 2 Al , 5 - 30 Cr, optionally 15 - 25 Ni, and unavoidable impurities, the remainder being iron.

Although other steel compositions are possible, it has been found that the above steel compositions give very good results in most cases.

In a preferred embodiment of the invention the steel substrate is a hot-formable steel substrate, which comprises an advanced high strength steel or ultra high strength steel. Suitable steels include dual phase (DP) steel, transformation induced plasticity (TRIP) steel, TRIP assisted dual phase (TADP) steel and twinning induced plasticity (TWIP) steel. Preferably the TWIP steel contains in weight % between 10 and 40 % manganese, preferably between 12 and 25 % manganese and up to 10 % aluminium. The hot-formable steel strip, sheet or blank comprising any one the above steels exhibits improved strength and ductility characteristics relative to other high strength steels and carbon steels.

In a preferred embodiment of the invention the oxidation resistant clad layer is a stainless steel. Advantageously the inventors found that a stainless steel clad layer did not oxidise during the heat treatment between 800 and 1200°C or when transferring the hot-formable steel strip, sheet or blank to the hot-forming press. The clad stainless steel did not delaminate from the steel substrate and did not show any signs of cracking following the heat treatment and the step of hot-forming.

In a preferred embodiment of the invention the oxidation resistant clad layer is a stainless steel selected from the group consisting of martensitic stainless steel, ferritic stainless steel and austenitic stainless steel.

Martensitic stainless steels in accordance with the invention comprise the following composition in weight %: 0.01 - 0.15 C, 10.0 - 30.0 Cr, 1.0 - 30 Ni, optionally 0 - 5.0 Cu, 0 - 2.5 Si, 0 -2.5 Al, 0 - 10.0 Mn and 0 - 10.0 Mo, the remainder being iron and unavoidable impurities. Other elements including N, Nb, Ti, Ce, S and W can also be present but only in small amounts. Although martensitic stainless steels afford high

temperature oxidation resistance they are less oxidation resistant when compared to their ferritic and austenitic counterparts. On the other hand martensitic stainless steels are extremely strong and tough making such steels highly machinable.

Ferritic stainless steels in accordance with the invention comprise the following composition in weight %: 0.01 - 0.15 C, 5.0 - 25.0 Cr, optionally 0 - 3.0 Ni, 0 - 2.0 Al, 0 - 1.0 N and 0 - 5 Mo, the remainder being iron and unavoidable impurities. Other elements including Nb, Cu, Ti, Si, Mn, Ce, S, W can also be present but only in small amounts. Ferritic stainless steels generally have better engineering properties than austenitic grades, but have reduced oxidation resistance, due to the lower chromium and nickel content. They are usually less expensive than austenitic stainless steels for that reason.

Austenitic stainless steels used in accordance with the invention comprise the following composition in weight %: 0.01 - 0.15 C, 5.0 - 25.0 Cr, optionally 0 -20.0 Ni, 0.02 - 2.0 N and 0 -2.0 Mo, the remainder being iron and inevitable impurities. Other elements including S and Mn can also be present but only in small amounts. Austenitic steels are less susceptible to cracking when compared to martensitic steels and also offer excellent high temperature oxidation resistance by virtue of the high alloy contents that are used. Suitable stainless steel grades include stainless 316 and 304.

In a preferred embodiment of the invention the oxidation resistant clad layer is titanium, aluminium or copper. Advantageously the inventors found that such clad layers reduce the formation of deleterious oxides during annealing or when transferring the hot-formable steel strip, sheet or blank to the hot-forming press. The hot-formed part also showed no signs of oxide scale formation.

In a preferred embodiment of the invention the hot-formable steel strip, sheet or blank has a thickness between 0.5 and 10 mm, preferably between 0.5 and 4 mm and more preferably between 0.5 and 2.5 mm.

In a preferred embodiment of the invention the oxidation resistant metallic clad layer comprises 0.25 - 20 %, preferably 0.25 - 10 % and more preferably 0.25 - 6 % of the total thickness of the hot-formable steel strip, sheet or blank. The thickness of the oxidation resistant clad layer should not exceed 20 % since this will compromise the overall strength of the hot-formable steel strip, sheet or blank. On the other hand the thickness of the clad layer should not be less than 0.25% of the total thickness of the

hot-formable steel strip, sheet or blank otherwise the effectiveness of the clad layer against high temperature oxidation will be compromised.

In a preferred embodiment of the invention the steel substrate has a tensile strength between 500 - 800 MPa before hot-forming. Steel strips, sheets or blanks having such a tensile strength ensures that the hot-formable strip, sheet or blank is able to withstand the mechanical forces of the hot-forming process. Moreover, the corresponding hardened hot-formed part which is produced during hot-forming will exhibit a tensile strength between 1200 and 2000 MPa, which is largely dependent on the initial strength of the steel substrate.

According to a second aspect of the invention there is provided a process for the manufacture of a hot-formable steel strip, sheet of blank, which comprises the steps of providing a steel substrate and an oxidation resistant metallic layer, providing the oxidation resistant metallic layer on one or both sides of the steel substrate to form a stack package and roll bonding the stack package.

Al-Si and zinc based protective coatings rely on Fe diffusion to make the coating thermally stable and suitable for subsequent processing steps such as hot-forming. The formation of such diffusion layers is the limiting factor in the process window for Al-Si and zinc based coated products. In this respect a heating rate between 5 and 10 ˚C/s is used when heating such coated steel substrates to above the austenisation temperature prior to hot-forming. Heating rates above 10 ˚C/s can result in zinc or aluminium undergoing a solid-liquid transition that may cause zinc or aluminium to drip from the substrate or even evaporate.

In contrast, the present invention is provided with an oxidation resistant metallic clad layer, which clad layer is provided by roll bonding. Metallic clad layers provided by roll bonding are advantageous since heating rates of 15 ˚C/s or above can be used to reach the austenisation temperature. A heating rate between 50 and 100 ˚C can even be used, meaning that the coated substrate will no longer be the limiting factor of the process, rather the heating technology. This is made possible because the protective properties of the oxidation resistant metallic clad layer are not reliant on the formation of a diffusion layer.

Another advantage of the present invention is that roll bonding avoids the issues associated with zinc melting and vaporising together with the issue of liquid steel

embrittlement. The oxidation resistant metallic clad layer is also fully paintable and weldable. Advantageously, prior to the step of welding, it is not necessary to remove an oxide layer from the metallic clad layer. Such a step is required when conventional zinc coatings are used.

In a preferred embodiment of the invention the hot-formable steel strip, sheet or blank is in full hard condition.

In order to coat the substrate with zinc or Al-Si, it is necessary to heat steel strips to at least 450°C prior to providing the Al-Si or zinc based coatings. In the process of the present invention this step is avoided. As a consequence the hot-formable steel, strip sheet or blank can be supplied to the hot-forming manufacturer in full-hard condition. By full hard condition it is meant that the hot-formable steel strip, sheet or blank has not been annealed prior to subjecting the steel strip, sheet or blank to the heat treatment prior to hot-forming.

In a preferred embodiment of the invention the steel substrate and the oxidation resistant metallic layer are deoxidised and cleaned prior to forming the stack package. By cleaning before stacking, inter-metallic particles which could lead to brittleness in the hot-formable steel strip, sheet or blank are significantly reduced or avoided.

In a preferred embodiment of the invention the stack package is circumferentially welded before the step of roll bonding. By circumferentially welding the steel substrate and the oxidation resistant metallic layer together, oxygen is prevented from contacting the interface therebetween, which would result in the formation of deleterious oxides at said interface.

In a preferred embodiment of the invention the roll bonding is hot roll bonding or hot roll bonding followed by cold roll bonding. In hot roll bonding the stack package is heated and hot-rolled between 1250°C and 800°C. The temperature after the final hot-rolling pass should be above the austenitic Ac1 temperature. The steel strip, sheet or blank thus produced has an approximate thickness of 3 - 4 mm, which is then subjected to a controlled cooling to a coiling temperature in order to control phase transformations in the steel. The steel strip, sheet or blank can subsequently be cold rolled. In this connection it is possible to form the metallic bond between the steel substrate and the oxidation resistant metallic clad layer during the cold rolling step rather than during hot-rolling step. By subjecting the steel strip, sheet or blank to a cold

rolling step a full hard product having a thickness between 0.3 and 2.5 mm, preferably between 1 and 2 mm can be formed.

According to a third aspect of the invention the hot-formable steel strip, sheet or blank of the first aspect of the invention is used for hot-forming to form a part. The hot-formable steel strip, sheet or blank is heated to a temperature between 800 and 1200°C in a heating furnace and subsequently transferred to a hot-forming press to be hot-formed. Advantageously, oxide scales are absent from the hot-formable steel strip, sheet or blank upon entering the hot-forming press and after the step of hot-forming. Both direct and indirect hot-forming processes are applicable to the invention. Indirect hot-forming includes a step of pre-forming the hot-formable steel strip, sheet or blank in a pre-forming press prior to being transferred to the heating furnace.

According to a fourth aspect of the invention there is provided a process for producing a hot-formed part which comprises the steps of:

- providing the hot-formable steel strip, sheet or blank according to the first aspect of the invention;
- heating the hot-formable steel strip, sheet or blank to a temperature between 800 and 1200 °C;
- hot-forming the hot-formable steel strip, sheet or blank to produce the hot-formed part.

In a preferred embodiment of the invention the hot-formable steel strip, sheet or blank is heated at a rate of 15°C or above. This has the advantage that the time required to reach the austenisation temperature is reduced relative to substrates provided with Al-Si or zinc based protective coatings.

In a preferred embodiment of the invention the hot-formed part produced according to the fourth aspect of the invention has a tensile strength above 1000 MPa, preferably between 1200 and 2000 MPa. This has the advantage that such parts are particularly suitable for use in the automotive sector.

Use of the hot-formed part produced according to the fourth aspect of the invention as an automotive part.

EXAMPLES

Table 1 shows alloy compositions of steel substrates (A) and alloy compositions of oxidation resistant clad layers (B and C) used in accordance with the invention. Steel compositions B and C relate to a stainless steel (austenitic grade EN1.4841) and (ferritic grade EN1.4742) respectively.

Figure 1 shows a cross section of a hot-formable steel strip, sheet or blank (1) according to the invention wherein a steel substrate (3) is disposed between two oxidation resistant clad layers (2).

Figures 2-5 correspond to Glow discharge optical emission spectrometry (GDOES) depth profiles taken after the step subjecting the steel strips to a heat treatment of 900 °C. The technique of GDOES is well known to those skilled in the field of surface analysis.

Figure 2 is a comparative example (1) that shows the depth profile for an uncoated steel strip substrate (A). The presence of an oxide layer is clearly visible up to a depth of approximately 24 µm after the heat treatment.

Figure 3 is a comparative example (2) that shows the depth profile for a hot-dip galvanised steel strip substrate (A). The presence of an oxide layer is clearly visible up to a depth of approximately 8 µm after the heat treatment.

Figure 4 is a depth profile for a hot-formable steel strip according to the invention, which steel strip consists of a steel substrate (A) disposed between two stainless steel strips (B). It is clear from Figure 4 that the thickness of the oxide layer is significantly reduced relative to the oxide layers of comparative examples (1) and (2).

Figure 5 is a depth profile for a hot-formable steel strip according to the invention, which steel strip consists of a steel substrate (A) between two stainless steel strips (C). It is clear from Figure 5 that the thickness of the oxide layer is significantly reduced relative to the oxide layers of comparative examples (1) and (2). It is also apparent from Figure 4 and Figure 5 that varying the stainless steel strip composition does not significantly affect the thickness of the oxide layer.

Embodiments of the present invention will now be described by way of example. These examples are intended to enable those skilled in the art to practice the invention and do not in anyway limit the scope of the invention as defined by the claims.

According to an example a steel substrate (A) (3) is provided in the form of a cast block, hot-rolled at a temperature of 1250°C and break down rolled from 100 mm to a flat 32 mm plate. Two strips of stainless steel (B) (2) having a strip thickness of 4 mm are cut to a width of approximately 1 mm less than that of the steel plate. The contact surfaces of each substrate are brushed and milled before each side of the steel plate is provided with a layer of stainless steel, resulting in a 3-layer stack package. The different layers of the stack package are welded together by rectangular arc welding.

The welded 3-layer stack package is then heated to a temperature of 1250°C for 30 minutes before being hot-rolled in six passes 27-17.8-12-8-6-4mm, the final pass being performed at a temperature of 880°C. The welded and hot-rolled stack package is then cooled at a rate of 30°C/s from 840°C to 600°C using a table simulation and cooled to room temperature using a warm coil simulation. The steel strip thus formed is then pickled and cold-rolled to 1.5 mm in steps of 0.5 mm per pass to form a hot-formable steel strip (1) suitable for hot-forming.

The hot-formable steel strip (1) is then cut into strip blanks and transferred to a heating furnace, each strip blank is heated to 900°C. The hot steel strip is subsequently transferred to a hot-forming press where it is hot-formed to obtain a hot-formed part. Hardened hot-formed parts obtained by hot-forming steel strips (1) according to the invention have tensile and yield strengths in excess of 1500 and 1000 MPa respectively.

CLAIMS

1. A hot-formable steel strip, sheet or blank which comprises a steel substrate and an oxidation resistant metallic clad layer on one or both sides of the steel substrate.

2. A hot-formable steel strip, sheet or blank according to claim 1 wherein the steel substrate contains in weight % 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 2.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, , < 0.1 P, < 0.05 S, < 0.08 B, < 0,1 V, < 0.5 Mo, < 0.003 ppm Ca, optionally < 0.1 Nb , unavoidable impurities, the remainder being iron.

3. A hot-formable steel strip, sheet or blank according to claim 1 or claim 2 wherein the steel substrate contains in weight % 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 0.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, < 0.1 P, < 0.05 S, 0.0005 - 0.08 B, optionally < 0.1 Nb and/or < 0,1 V, preferably 0.15 - 0.5 C, 0.5 - 3.0 Mn, 0.1 - 0.5 Si, < 0.1 Al, < 1.0 Cr, < 0.2 Ti, < 0.1 P, < 0.05 S, 0.0005 - 0.015 B, optionally < 0.1 Nb and/or < 0,1 V unavoidable impurities, the remainder being iron.

4. A hot-formable steel strip, sheet or blank according to claim 1 or claim 2 wherein the steel substrate contains in weight % 0.15 - 0.45 C, 1.0 - 3.0 Mn, 1.0 - 2.5 Si, < 0.6 Al, < 1.0 Cr, < 0.06 P, <0.03 S, < 0.5 Mo, < 0.1 Ti or < 0.1 V and < 0.003 ppm Ca, preferably 0.2 - 0.4 C, 1.5 - 2.5 Mn, 1.4 - 2.0 Si, < 0.6 Al, < 1.0 Cr, < 0.06 P, <0.03 S, < 0.5 Mo, < 0.1 Ti or < 0.1 V and < 0.003 ppm Ca, unavoidable impurities, the remainder being iron.

5. A hot-formable steel strip, sheet or blank according to any one of claims 1-4 wherein the oxidation resistant metallic clad layer contains in weight % < 0.15 C , 0.2 - 5 Mn , < 2 Si , < 2 Al , 5 - 30 Cr, optionally 15 - 25 Ni, and unavoidable impurities, the remainder being iron.

6. A hot-formable steel strip, sheet or blank according to claim 1 wherein the steel substrate is a hot-formable steel substrate, preferably an advanced high strength steel or an ultra high strength steel.

7. A hot-formable steel strip, sheet or blank according to any one of the preceding claims wherein the oxidation resistant clad material is adjacent to the steel substrate.

8. A hot-formable steel strip, sheet or blank according to any one of claims 1-7 wherein the oxidation resistant metallic clad layer is a stainless steel.

9. A hot-formable steel strip, sheet or blank according to claim 8 wherein the stainless steel is selected from the group consisting of martensitic stainless steel, ferritic stainless steel and austenitic stainless steel.

10. A hot-formable steel strip, sheet or blank according to any one of claims 1-7 wherein the oxidation resistant metallic clad is titanium, aluminium or copper.

11. A hot-formable steel strip, sheet or blank according to any one of the preceding claims having a thickness between 0.5 and 10 mm, preferably between 0.5 and 4 mm and more preferably between 0.5 and 2.5 mm.

12. A hot-formable steel strip, sheet or blank according to any one of the preceding claims wherein the metallic clad comprises 0.25 - 20%, preferably 0.25 - 10% and more preferably 0.25 - 6 % of the total thickness of the steel strip composite.

13. A hot-formable steel strip, sheet or blank according to any one of the preceding claims having a tensile strength between 500 and 800 MPa before hot-forming.

14. A process for the manufacture of a hot-formable steel strip, sheet of blank according to any one of claims 1-13, which comprises the steps of providing a steel substrate and an oxidation resistant metallic layer, providing the oxidation resistant metallic layer on one or both sides of the steel substrate to form a stack package and roll bonding the stack package.

15. A process for the manufacture of a hot-formable steel strip, sheet of blank according to claim 14 wherein the steel substrate and the oxidation resistant metallic layer are deoxidised and cleaned prior to forming the stack package.

16. A process for the manufacture of a hot-formable steel strip, sheet of blank according to claim 14 or claim 15 wherein the stack package is circumferentially welded before the step of roll bonding.

17. A process for the manufacture of a hot-formable steel strip, sheet of blank according to any one of claims 14-16 wherein the roll bonding is hot roll bonding or hot roll bonding followed by cold roll bonding.

18. A process for producing a hot-formed part which comprises the steps of:
    - providing the hot-formable steel strip, sheet or blank according to any one of claims 1-13;
    - heating the hot-formable steel strip, sheet or blank to a temperature between 800 and 1200 °C;
    - hot-forming the hot-formable steel strip, sheet or blank to produce the hot-formed part.

19. A process according to claim 18 wherein the hot-formable steel strip, sheet or blank is heated at a rate of 15 °C/s or above.

20. Hot-formed part produced according to the process of claim 18 or claim 19 wherein the part has a tensile strength above 1000 MPa, preferably between 1200 and 2000 MPa.

21. Use of the hot-formed part produced according to claim 20 as an automotive part.

22. Use of the hot-formable steel strip, sheet or blank produced according to any one of claims 1-13 for hot-forming.

	Steel Composition		
Element	A	B	C
C	0.21	0.077	0.047
Mn	1.27	0.43	1.75
Si	0.18	1.1	0.51
Al	0.031	1.1	<0.05
Cr	0.18	17.5	24.7
Ti	0.018	-	-
Cu	0.014	0.06	0.06
Ni	0.02	0.24	19.6
N	0.005	-	
P	0.012	0.03	0.02
S	0.001	<0.001	0.001
B	0.002	-	-
Mo	-	0.03	0.06

Table 1

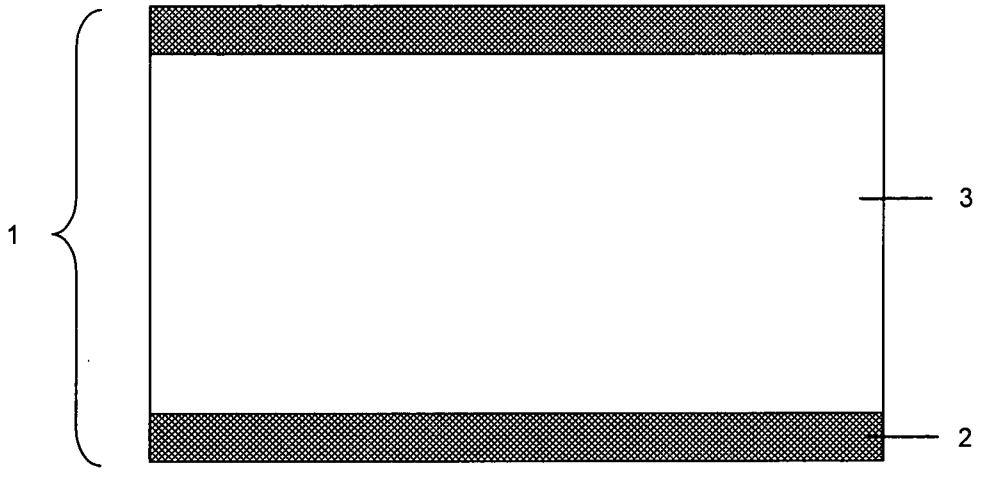

Figure 1

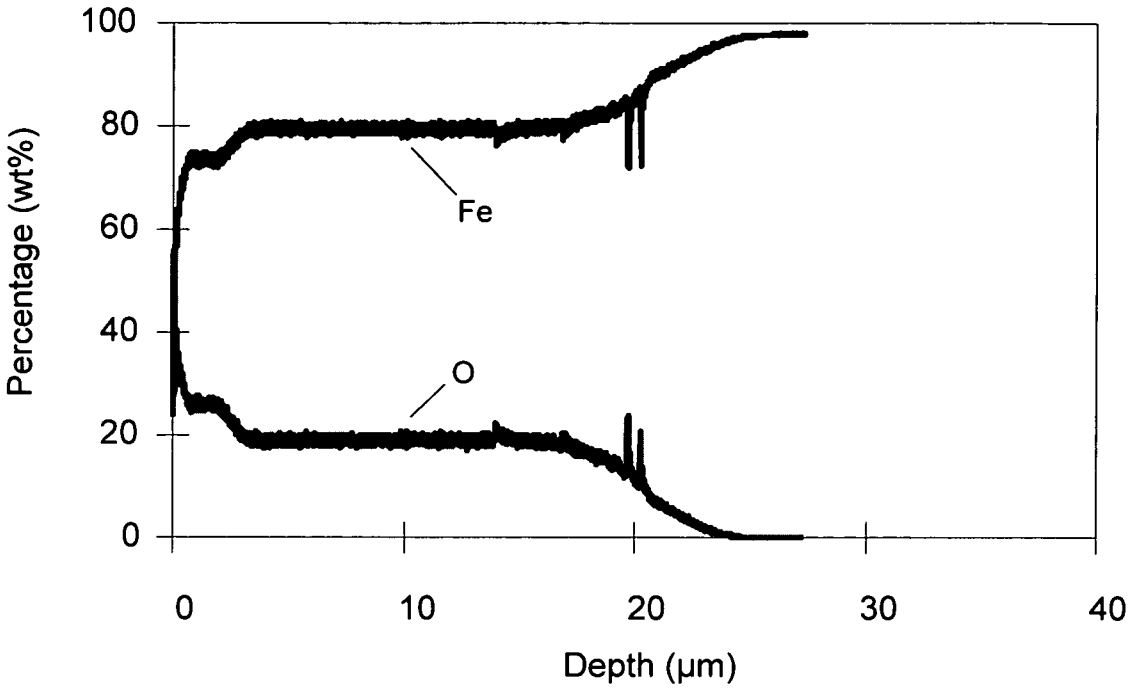

Figure 2

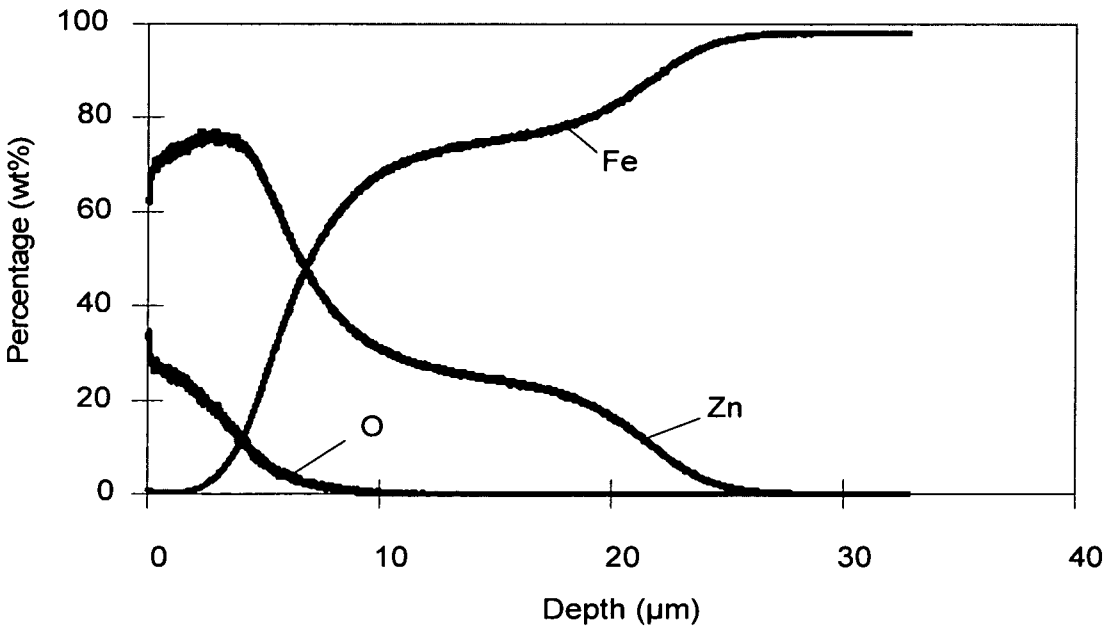

Figure 3

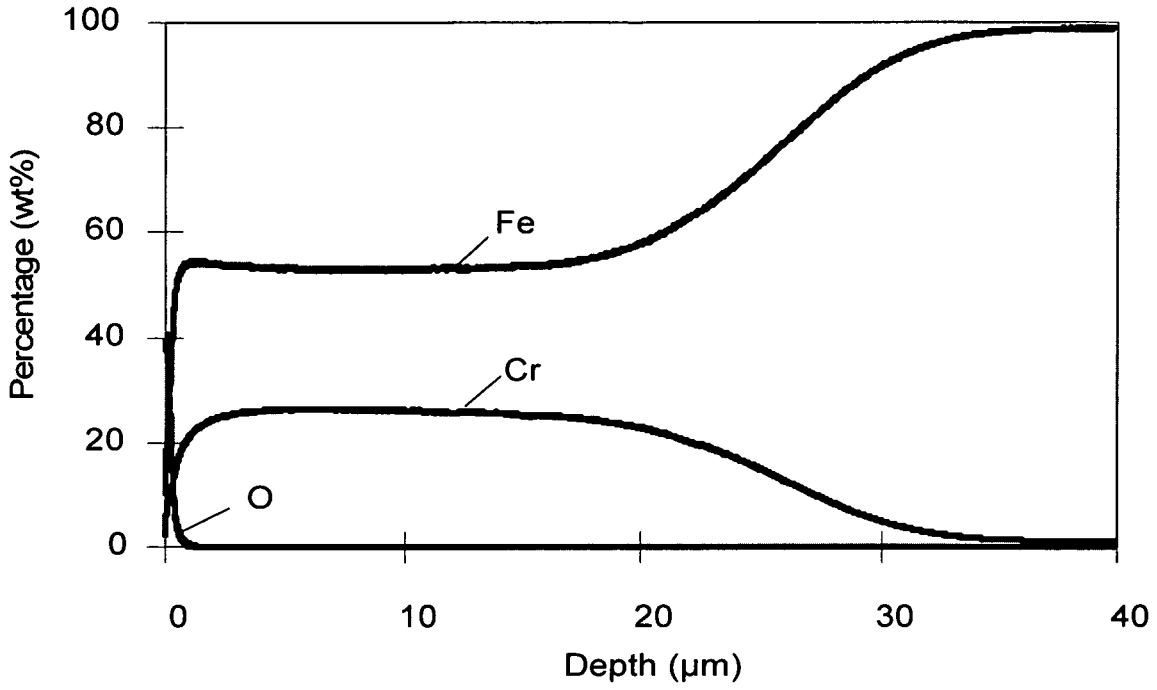

Figure 4

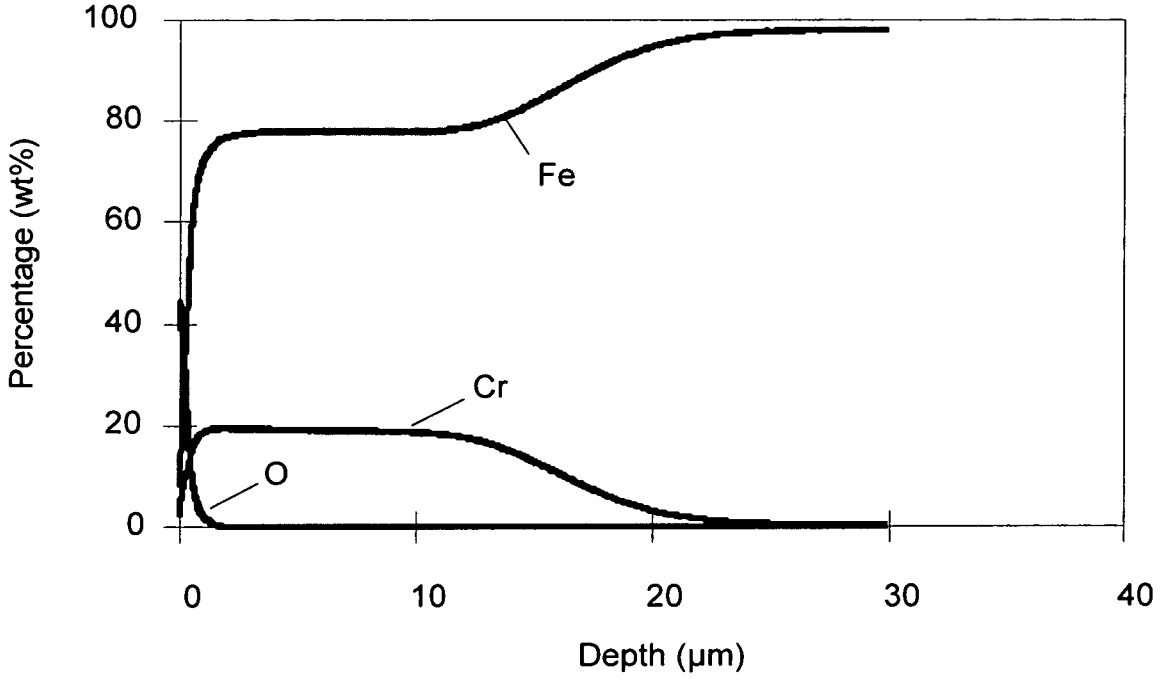

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/001822

A. CLASSIFICATION OF SUBJECT MATTER

INV. C21D1/673 C21D9/48 C22C38/02 C22C38/04 C22C38/38
C22C38/58 B32B15/01
ADD.

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 C22C B32B

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 2 228 459 A1 (THYSSENKRUPP STEEL EUROPE AG [DE]; THYSSENKRUPP TAILORED BLANKS G [DE]) 15 September 2010 (2010-09-15)	1-3,6-9, 13,20-22
A	paragraph [0005] - paragraph [0015] paragraph [0026] - paragraph [0030]; claims 1-4; figures 1-3b	11,12,16

X	JP 5 255758 A (KAWASAKI STEEL CORP) 5 October 1993 (1993-10-05)	1,8,9, 14,17,22
A	paragraph [0001] - paragraph [0007] paragraphs [0009], [0017]	2-5

X	JP 6 320253 A (NIPPON STEEL CORP) 22 November 1994 (1994-11-22)	1,5,8,9, 11,12
A	paragraph [0050] - paragraph [0052]; tables 1-2	22

	-/--	

[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
30 August 2012	06/09/2012

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	Lilimpakis, Emmanuel

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/001822

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 6 613 163 B1 (PFEIFENBRING KARLFRIED [DE] ET AL) 2 September 2003 (2003-09-02) column 4, line 45 - line 62 -----	1,9-12, 14,17 20,22
X	CN 101 402 267 A (CHANGZHOU CHANGSONG METAL COMP [CN]) 8 April 2009 (2009-04-08) the whole document -----	1,14,22
X	EP 0 355 046 A2 (ALLEGHENY LUDLUM CORP [US]) 21 February 1990 (1990-02-21) column 4, line 33 - column 5, line 6 -----	8,9,11, 12,14,17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/001822

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 2228459	A1	15-09-2010	AT	530674	T	15-11-2011
			EP	2228459	A1	15-09-2010
			ES	2375197	T3	27-02-2012
JP 5255758	A	05-10-1993	JP	2781285	B2	30-07-1998
			JP	5255758	A	05-10-1993
JP 6320253	A	22-11-1994	NONE			
US 6613163	B1	02-09-2003	AU	761334	B2	05-06-2003
			AU	3042200	A	24-07-2000
			BR	9916677	A	16-10-2001
			CA	2357663	A1	13-07-2000
			CN	1332807	A	23-01-2002
			EP	1153145	A1	14-11-2001
			EP	1253209	A2	30-10-2002
			JP	2003527479	A	16-09-2003
			MX	PA01006761	A	15-05-2003
			PL	349417	A1	29-07-2002
			RU	2216600	C2	20-11-2003
			US	6613163	B1	02-09-2003
			WO	0040765	A1	13-07-2000
CN 101402267	A	08-04-2009	NONE			
EP 0355046	A2	21-02-1990	BR	8903651	A	13-03-1990
			DE	68912683	D1	10-03-1994
			DE	68912683	T2	09-06-1994
			EP	0355046	A2	21-02-1990
			ES	2049322	T3	16-04-1994
			JP	2095842	A	06-04-1990
			JP	2525055	B2	14-08-1996
			MX	165060	B	20-10-1992
			US	4906305	A	06-03-1990