

POSCO Co., Ltd. (Petitioner)
v.
ArcelorMittal (Patent Owner)
Petitioner Demonstratives

Case Nos. IPR2025-00370 and IPR2025-00371
U.S. Patent Nos. 10,961,602 and 11,326,227
Before Hon. Barry L. Grossman, Brian D. Range, and Debra L. Dennett

Page 1 of 45



Demonstrative Exhibit – Not Evidence

Exhibit 1084
POSCO v. ArcelorMittal
IPR2025-00370
IPR2025-00371

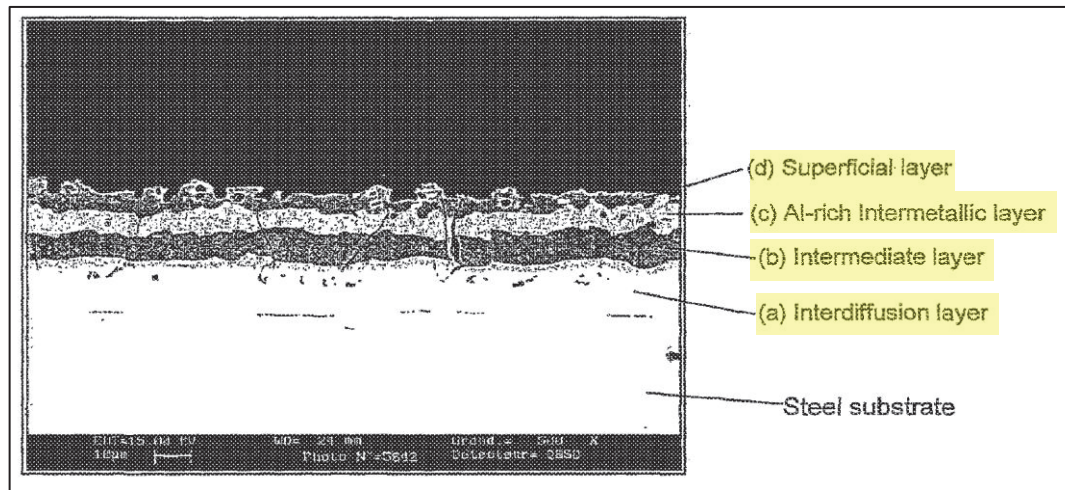
Table of Contents

The Challenged Patents	3
Grounds and Prior Art	6
Issue 1: Construction of “intermetallic layer”	12
Issue 2: The prior art discloses intermetallic layers	20
Issue 3: Motivations for combinations of Takagi/Suehiro + GMW14400/Cornette	25
Issue 4: Reasonable expectation of success and prior art enablement	31
Issue 5: Suehiro’s disclosure of a superficial layer	35
Issue 6: Prior art status of GMW14400, Suehiro, and Cornette	38
Issue 7: Dependent claims	42

The Challenged Patents

The Challenged Patents

'602 Patent



'602 Patent, FIG. 1

In recent years the use of pre-coated steels in hot-stamping processes for the shaping of parts has become important, especially in the automotive industry. Fabrication of such parts may include the following main steps:

- Pre-coating of a steel sheets by hot dipping;
- Trimming or cutting for obtaining blanks;

- Heating the blanks in order to obtain alloying of the steel substrate with the pre-coating, as well as the austenitizing of the steel; and

- Hot forming followed by rapid cooling of the part in order to obtain predominantly martensitic structures. See for Example U.S. Pat. No. 6,296,805, incorporated herein by reference.

Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having such coating may be heated in a temperature range where austenitizing of the metallic substrate takes place, allowing further hardening by quenching.

'602 Patent, 1:36-55

Example 2

i) Conditions according to the invention: In a second example of implementation, a cold rolled steel sheet, 1.2 mm thick, 120 m long and 650 mm wide, with same composition and same pre-coating as in example 1, has been fabricated. The sheets were afterwards cut into blanks which were heated at 920° C. for 6 mn, this time including the heating phase and the holding time. Heating rate V_c between 20 and 700° C. was 10° C./s. The blanks were finally hot stamped and quenched in order to obtain full martensitic structures. The parts obtained after hot-stamping are covered by a coating, 40 micrometers thick, illustrated at FIG. 1, which has a four layer structure. Starting from the steel substrate, the layers are the following:

- (a) Interdiffusion layer or intermetallic layer, 17 micrometers thick. This layer is itself composed of two sub-layers. Hardness HV50g ranges from 295 to 407, and the mean composition is: 90% Fe, 7% Al, 3% Si.

- (b) Intermediate layer, appearing darker, 8 micrometers thick. This layer has a hardness of 940 HV50g and a mean composition, by weight: 43% Fe, 57% Al, 1% Si.

- (c) Intermetallic layer appearing as a pale phase, 8 micrometers thick, displaying a hardness of 610 HV50g, a mean composition of 65% Fe, 31% Al, 4% Si

- (d) Darker superficial layer, 7 micrometers thick, 950 HV50g, with a mean composition of 45% Fe, 54% Al, 1% Si. Layers (c) and (d) are quasi-continuous, i.e. occupying at

'602 Patent, 12:32-57

The Challenged Patents

'602 Patent

What is claimed is:

1. A precoated steel product comprising:
a strip of base steel having a first side and a second side;
and
a coating on at least one of the first side of the strip of base steel and the second side of the strip of base steel, wherein the coating results from interdiffusion between the base steel, and an aluminum or aluminum alloy pre-coating, and wherein the coating includes, proceeding from the base steel outwards:
 - (a) an interdiffusion layer having a first mean iron composition,
 - (b) an intermediate layer having a second mean iron composition different from the first mean iron composition,
 - (c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron composition being higher than the second mean iron composition; and
 - (d) a superficial layer having a fourth mean iron composition different from the third mean iron composition,wherein the coating has a thickness greater than 30 micrometers.

'227 Patent

What is claimed is:

1. A hot stamped coated steel product, which comprises:
 - (a) a strip of base steel having a first side and a second side; and
 - (b) a coating on at least one of said first side of said strip of base steel and said second side of said strip of base steel, wherein:
 - (i) said coating results from interdiffusion between said base steel and an aluminum or aluminum alloy pre-coating, and
 - (ii) wherein said coating comprises, proceeding from the base steel outwards:
 - (a) an Interdiffusion layer,
 - (b) an Intermediate layer,
 - (c) an Intermetallic layer, and
 - (d) a Superficial layer,wherein layers (a), (b), (c), and (d) each have a different mean composition from one another,wherein said coating of the hot stamped coated steel product has a thickness greater than 30 micrometers.

ArcelorMittal does not dispute that the prior art teaches multilayer structures meeting the composition limitations

Overview of Grounds

Ground	Claims	Basis (§103)
1A	1-2, 5-6, 9-30	Takagi, Cornette
1B	3-4, 7-8	Takagi, Cornette, Laurent
1C	3-6	Takagi, Cornette, Nishibata
1D	1, 3-4, 11-17, 19-25, 27-30	Takagi, GMW14400
1E	3-4, 7	Takagi, GMW14400, Laurent
1F	3-5	Takagi, GMW14400, Nishibata
2A	1-2, 5-6, 9-30	Suehiro, Cornette
2B	3-4, 7-8	Suehiro, Cornette, Laurent
2C	3-6	Suehiro, Cornette, Nishibata
2D	1-4, 9-30	Suehiro, GMW14400
2E	3-4, 7-8	Suehiro, GMW14400, Laurent
2F	3-6	Suehiro, GMW14400, Nishibata

Key Prior Art: Takagi

Takagi Table 1

Corresponding layers of '602 patent

TABLE 1

No.	PRODUCTION		COATING LAYER STRUCTURE & COMPOSITION (%)						STEEL BASE HARDNESS (Hv)	COATING LAYER HARDNESS (Hv)			OXIDE WEIGHT (mg/dm ²)	FORMABILITY	CORROSION RESISTANCE	WELDABILITY
	RAISED TEMPERATURE (°C)	HOLD TIME (min.)	COMPONENT & HARDNESS	INNER	INTER 1	INTER 2	INTER 3	OUTER		SOFTEST	AVERAGE	SOFTER RANGE (%)				
1	920	3	Al	7.7	31.0	48.4	31.6	54.8	450	310	415	51	300	○	○	○
			Si	2.0	3.9	1.2	5.7	0.8								
			Fe	89.6	65.9	50.1	62.0	44.5								
			Hv	310	360	750	700	800								
2	900	2	Al	27.2	48.4	31.6	—	54.9	415	380	455	22	275	×	○	○
			Si	4.1	1.2	5.7	—	0.8								
			Fe	67.2	50.1	61.9	—	44.1								
			Hv	380	760	720	—	810								
3	930	10	Al	(a)	—	(b)	(c)	(d)	400	305	385	78	550	○	×	×
			Si	1.2	—	—	—	—								
			Fe	88.8	—	—	—	89.7								
			Hv	305	—	—	—	410								
4	950	5	Al	6.0	27.8	51.9	30.4	47.4	440	280	400	59	385	○	○	○
			Si	1.5	4.3	0.6	5.3	2.2								
			Fe	90.7	66.7	46.8	63.1	49.8								
			Hv	280	340	720	690	800								
5	900	4	Al	3.2	54.5	33.4	—	54.5	440	300	410	56	335	○	○	○
			Si	0.4	2.5	15.3	—	6.8								
			Fe	94.3	42.7	51.4	—	38.4								
			Hv	300	740	700	—	810								

(a) (b) (c) (d)

Takagi, Table 1; Petition, 28

Physical mechanism

[0019] The mechanism of formation of the layered structure is not fully evident. Currently, the presumption by the inventors of the present invention is as follows: (1) The retention of a specimen at an elevated temperature causes the diffusion of Fe, and produce a concentration gradient in Fe and Si in the coating layer. (2) In this case, the coating alloy phase is urged to transform into a stable compound phase determined by the composition at each depth, so that there are formed different compound layers in different regions of depth. (3) Therefore, by controlling the raised temperature, the diffusion quantity of Fe is varied and the degree of transformation into a stable compound is varied.

Takagi process parameters

[0033] Sheet thickness: 1.4 mm.

[0034] Si concentration in Aluminum coating: 5%.

[0035] Thickness of aluminum coating layer: 10~20 μm .

[0037] <Conditions of Heat treatment>

Heating rate:	8° C./sec
Heating temperature:	900~950° C.
Holding time:	2~10 min
Rate of Primary cooling:	7° C./sec
Temperature at a start of forming:	720° C.
Temperature at a start of rapid cooling:	720° C.
Rate of Secondary cooling (quenching):	30° C./sec
Temperature at an end of cooling:	100°

Takagi, [0033]-[0037]; Petitioner's Reply, 10

Takagi: Importance of multi-layer structure

Corresponding layers of '602 patent

(a) (b) (c) (d)

TABLE 1

No.	PRODUCTION		COATING LAYER STRUCTURE & COMPOSITION (%)					STEEL BASE HARDNESS (Hv)	COATING LAYER HARDNESS (Hv)		OXIDE WEIGHT (mg/dm ²)	FORMABILITY	CORROSION RESISTANCE	WELDABILITY		
	RAISED TEMPERATURE (°C)	HOLD TIME (min.)	COMPONENT & HARDNESS	INNER	INTER 1	INTER 2	INTER 3		SOFTTEST	AVERAGE					SOFTER RANGE (%)	
1	920	3	Al	7.7	31.0	48.4	31.6	54.8	450	310	415	51	300	○	○	○
			Si	2.0	3.9	1.2	5.7	0.8								
			Fe	89.6	65.9	50.1	62.0	44.5								
			Hv	310	360	750	700	800								
2	900	2	Al	27.2	48.4	31.6	—	54.9	415	380	455	22	275	×	○	○
			Si	4.1	1.2	5.7	—	0.8								
			Fe	67.2	50.1	61.9	—	44.1								
			Hv	380	760	720	—	810								
3	930	10	Al	(a)	—	(b)	(c)	(d)	400	305	385	78	550	○	×	×
			Si	1.2	—	—	—	6.0								
			Fe	88.4	—	—	—	85.7								
			Hv	305	—	—	—	410								
4	950	5	Al	6.0	27.8	51.9	30.4	47.4	440	280	400	59	385	○	○	○
			Si	1.5	4.3	0.6	5.3	2.2								
			Fe	90.7	66.7	46.8	63.1	49.8								
			Hv	280	340	720	690	800								
5	900	4	Al	3.2	54.5	33.4	—	54.5	440	300	410	56	335	○	○	○
			Si	0.4	2.5	15.3	—	6.8								
			Fe	94.3	42.7	51.4	—	38.4								
			Hv	300	740	700	—	810								

↑

↑

↑

↑

(a)

(b)

(c)

(d)

Takagi, Table 1; Petitioner's Reply, 18

[0020] The Al—Si—Fe alloy layer contiguous with the steel substrate layer is softened by the diffusion of Fe from the steel substrate layer, and made more adhesive with steel, and hence more formable. Specifically, a preferable range of the Fe content is 85~95%. When the Fe content is in this

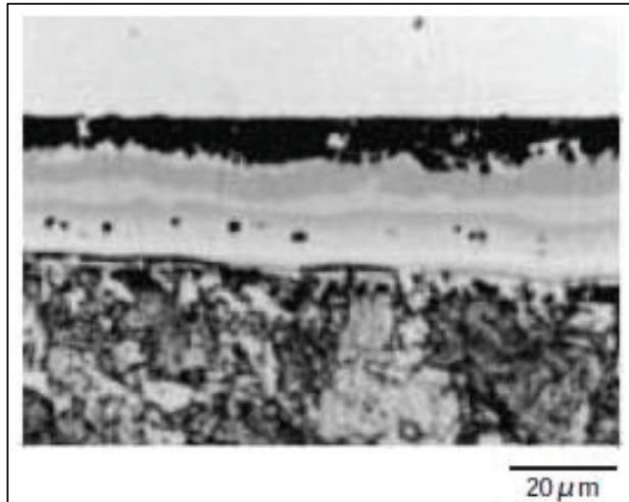
[0022] In the case of a multi-layer structure including three or more subordinate layers differing in composition or compound, there is one or more intermediate layers between an innermost layer contiguous with the steel substrate layer and an outermost layer forming the surface of the coating layer. Preferably, the intermediate layer or at least one of the intermediate layers contains 25~40% Al.

becomes feasible. It is possible to combine weldability and corrosion resistance by making the Fe concentration in the surface or outermost layer of the coating in the range of 35~50%. The coating layer having a surface Fe concentration in this range can be formed by forming an Al—Si—Fe layer having a multi-layer structure, or by forming an

[0024] Thermal stability is improved by alloying an Al—Si—Fe coating layer entirely into a multi-layer structure such as a five-layer structure having five layers of different alloy compositions. A multi-layer structure including a hard outermost layer is advantageous for maintaining good contact with a welding gun in spot welding even under great pressure for high tension material.

Takagi, [0020]-[0025]; Petition, 17; Petitioner's Reply, 18; EX-1003, 36, 79

Key Prior Art: Suehiro



Suehiro, FIG. 12

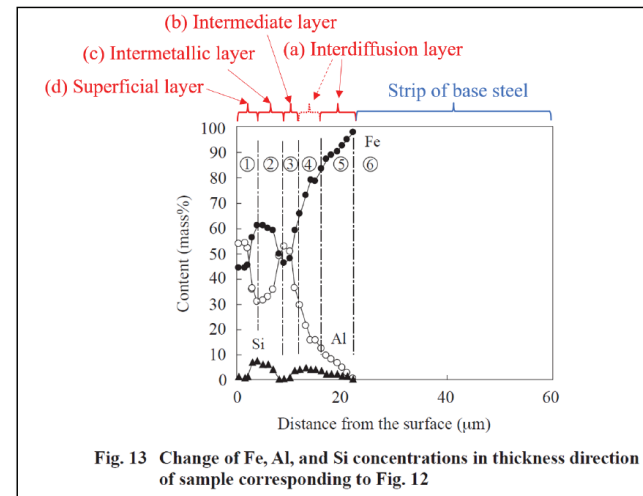


Fig. 13 Change of Fe, Al, and Si concentrations in thickness direction of sample corresponding to Fig. 12

Suehiro, FIG. 13; Petition, 81

[15] Figure 12 shows the alloying state after holding at 950°C for 0.5 min, and Figure 13 shows the results of SEM-EDS measurements of Fe, Al, and Si concentrations in the surface plating layer in the direction of the plate thickness. As alloying progresses, a layered alloy phase with the Al and Fe concentrations shown in the figure is formed. Under these heating conditions, the alloy phase consists of five layers, and the Al concentration changes from the topmost layer to approximately 50%, 30%, 50%, 30%, and 10%. From the fourth layer to the base layer, the element concentrations change continuously.

Suehiro, [15]; Petition, 57

Key Prior Art: GMW14400

	WORLDWIDE ENGINEERING STANDARDS	Material Specification Metals	GMW14400
Low Carbon, Heat-Treatable Boron Steel – Uncoated or Aluminized Pre-Coated			
1 Scope This specification covers the requirements for low carbon, heat-treatable boron steel used in the manufacture of structural parts requiring heat treatments to achieve high strength. Press-hardened steel can be pre-formed and subsequently hot-stamped and die quenched, but post-forming should not be the scope for this type of steel. Typical applications include door impact beams, bumper impact beams, and reinforcements for impact structures. 1.1 Material Description. The particular application shall determine the pre- or post- forming operations to produce the finished product. 1.1.1 Resistance Welded Mechanical Tubing. Tubes supplied to this specification are roll formed from steel strip to the desired shape and dimensions. blank or pre-stamped part, and rapid cooling (quenching) the stamped part in the die. The cooled part may be subsequently shot blasted to remove oxide from the surface. The microstructure of the finished parts shall consist of martensite and bainite. 1.1.3.2 Pre-Coated Products. Part sections formed with this operation and supplied under this standard shall be made by austenitizing a pre cut blank, hot stamping the heated blank and rapid cooling (quenching) the stamped part in the die or via water quenching. Parts shall not be pre-stamped prior to the hot stamping operation, but slight roll-forming operations may be allowable if the coating is not damaged. Shot blasting the cooled part is not permitted for pre-coated parts due to damage to the coating. The microstructure of the finished parts shall consist of martensite and bainite.			

GMW14400, 1; Petitioner's Reply, 16

Table 6: Al-Si Coating Requirements ^{Note 1}		
Condition	Coating Mass (g/m ²)	Coating Thickness (μm) ^{Note 2}
Prior to hot-stamping	60 to 100	20 to 33
Following hot-stamping	N/A	>35

Note 1: Additional demands can be specified by the local business units.
Note 2: Prior to hot-stamping, suitable evaluation instruments to measure coating thickness on the as-received sheet include eddy current, ferromagnetic, or microscopy. Magnetic inductive measurements are not recommended following the hot-stamping operation without proper calibration.

GMW14400, 7; Petition, 51-52

Key Prior Art: Cornette

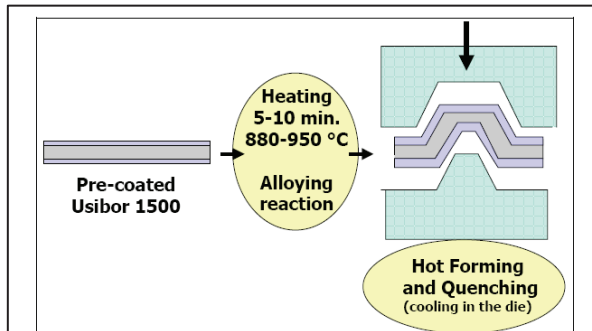


Fig. 21. Process used for the hot forming of USIBOR 1500 Pre-coated.

CHEMICAL COMPOSITION OF THE BASE MATERIAL

USIBOR 1500 is a carbon-manganese steel microalloyed with boron.

Table III. Chemical composition of pre-coated boron steel in thousandths of percent

	C	Mn	Si	S	Cr	Al	B	Ti
Min.	200	1100	150		150	20	2	20
Max.	250	1350	350	8	300	60	4	50

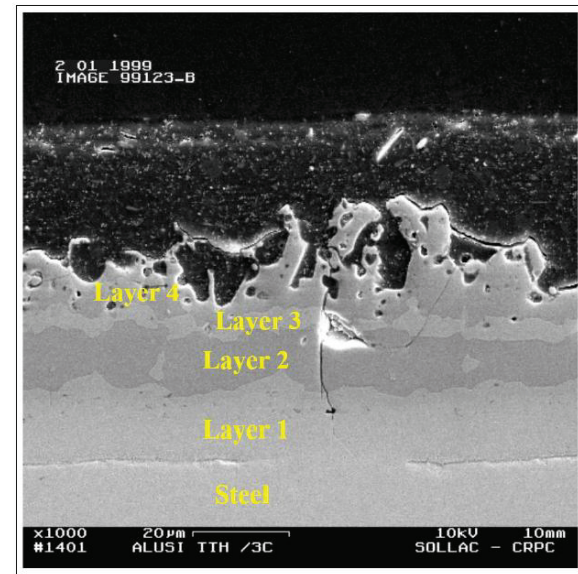
DESCRIPTION OF THE COATING

The coating, made of aluminum and silicon, is applied with a hot dipped process.

The average layer thickness showing the best compromise between corrosion protection and weldability is 25 μm .

Heating the pre-coated boron steel (generally 900°C, 5 minutes) creates an alloying reaction between substrate (iron) and the coating (aluminum - silicon) which leads to a hard multiphase alloy layer.

Fe-Al-Si layer is typically about 40 μm at the steel surface. The following photo shows a section view of the coating after heat treatment:



Cornette, FIG. 22; Petition, 11

Cornette, 9; Petition, 9-10

Issue 1

Construction of “intermetallic layer”

Construction of “*intermetallic layer*”

Term	Uncontested Construction – Prior IPR	ArcelorMittal’s Expert’s Construction – Prior IPR	ArcelorMittal’s Construction
<u>'602 Patent</u> : “ <i>an intermetallic layer</i> ” (claim 1)	a layer “composed of two or more metals or of a metal and a nonmetal in an alloy”	a layer that contains a compound of two different metals, potentially “in a matrix.”	“a layer containing two or more metallic (or metalloid) elements atomically joined with defined stoichiometry in an ordered crystal structure.”

EX-1031, 24; POR, 9; Petitioner’s Reply, 4; EX-1077, 107:22-108:1, 109:15-20

ArcelorMittal's position amounts to reading new limitations into the claims

What is missing from the Specification?

- Mention of crystallinity
- Mention of stoichiometry
- Mention of measurement methods cited by PO

'602 Specification

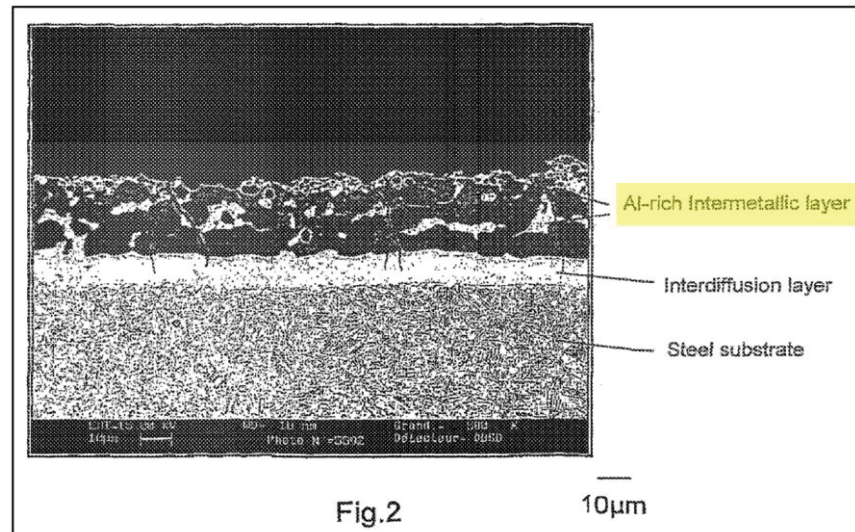
Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having such coating may be heated in a temperature range where austenitizing of the metallic substrate takes place, allowing further hardening by quenching.

where the pre-coating is thinner, becomes too important: The settings of the heating treatment in the furnace may be adapted to the thinner value of the pre-coating, but not to the thicker one. Thus, the alloying reaction forming the intermetallic alloy may take place to an insufficient degree since the mean diffusion distance of the elements in the pre-coating becomes significantly less than the local value of the pre-coating thickness. As a matter of results, alloying will

'602 Patent, 1:50-55, 5:54-61; Petitioner's Reply, 3

Dr. Raabe's construction of "intermetallic layer" disagrees with the Specification

'602 Patent, FIG. 2



'602 Patent, FIG. 2; Petitioner's Reply, 2

'602 Patent

FIG. 2 illustrates a coating of a steel substrate after heat treatment and stamping which does not correspond to the invention. This succession of layers (interdiffusion layer and intermetallic layer) yields inferior results in resistance spot welding.

'602 Patent, 3:57-61; Petitioner's Reply, 2

Deposition of Dr. Raabe

Q So your opinion is that figure 2 does not show a layer that meets your construction of intermetallic, correct?

A Correct.

Dr. Raabe Deposition, 129:21-24; Petitioner's Reply, 2

ArcelorMittal's prior expert confirmed a broad understanding of "intermetallic layer"

Testimony from ArcelorMittal's prior expert

Q And intermetallic means there is a mixture of different metals, right?

A It's a compound.

Q A compound of different metals?

A Right.

Q And the intermetallic layer, you said earlier intermetallic is a compound of two different metals. So this would be a layer that contains a compound of two different metals?

A There might be a matrix there too. It could be a series of compounds in a matrix.

EX-1077, 107:22-108:1, 109:15-20; Petitioner's Reply, 4

ArcelorMittal's construction inconsistent with prior Board decision

'683 FWD

four-layer structure. Accordingly, Petitioner establishes that Cornette discloses a coating comprising, proceeding from the base steel outwards: (a) an Interdiffusion layer, (b) an Intermediate layer, (c) an Intermetallic layer, and (d) a Superficial layer.

EX-1029, 39; Petitioner's Reply, 7

AM's construction is inconsistent with the Board's prior finding

- Cornette does not use the term “intermetallic”
- Cornette does not discuss crystallinity of coating
- Cornette does not discuss stoichiometry of coating

Dr. Raabe Deposition

THE WITNESS: What I tell in my report is when analyzing as an expert in the field with many, many decades of doing this hands on that what Cornette is showing is not an intermetallic layer. So I stay firmly with my statement in my report.

Now you show me a different statement which is clearly written out here which we both can read and, yes, this is inconsistent with what I say, but I am quite sure that my statement is correct.

EX-1076, 144; Petitioner's Reply, 7

Specification's broad usage is consistent with usage in the specific art of hot-stamping

“Intermetallic” is used in the field to refer generally to layers, coatings and compounds formed during the hot-stamping process

EX-1075, 22

FR2833504

When the sheet metal blank is reheated, the coating combines with the substrate to form an intermetallic alloy. The alloying, through interdiffusion, leads to an increased thickness of the layer which, for the treatment specified above, generally corresponds to a 50% increase.

EX-1025, 7:17-20; Petitioner's Reply, 5

Hein

2.2 Heat Treatment

The heat treatment of the blank in the furnace should be conducted so as to respect the kinetics of the austenitic transformation /4/ and of the intermetallic alloying reaction between the AlSi-coating and the iron substrate of the blank. A too rapid heating of the

EX-1019, 6; Petitioner's Reply, 5

Dr. Raabe's cited textbooks support other or contradictory definitions

Alternative definition provided

clear in the following sections. According to a simple definition (Schulze, 1967; Girgis, 1983), intermetallics are compounds of metals whose crystal structures are different from those of the constituent metals, and thus intermetallic phases and ordered alloys are included. During the last ten

EX-2038, 11; Petitioner's Reply, 6

Intermetallics falling outside ArcelorMittal's construction

A, B, C, S, I... 2, R... 3, and F... 4). Due to the lack of a 3D unit cell, this approach cannot be used for non-3D-periodic CIMs such as quasicrystals or amorphous intermetallic phases.

EX-2037, 452; Petitioner's Reply, 6

Dr. Raabe: "Amorphous means you don't have crystal structure"

Q What does it mean for material to be amorphous?

A Amorphous means you don't have crystal structure, but the atoms are more ordered like in a liquid. That means you do not have it like on a

EX-1078, 116:18-19; Petitioner's Reply, 6

Issue 2

The prior art discloses intermetallic layers

Takagi discloses intermetallic layers

Takagi

[0016] During the growth of the Al—Si—Fe alloy layer by the heat treatment, mutual diffusion between Al coating and steel substrate layer produces various Al—Si—Fe ternary intermetallic compounds such as α FeAlSi phase (alpha FeAlSi), β FeAlSi phase (beta FeAlSi) and γ FeAlSi phase (gamma FeAlSi). The Al—Si—Fe alloy layer formed by the heat treatment has a layered structure made up of these intermetallic compounds, and offers advantages of formability, corrosion resistance and weldability.

Takagi, [0016]; Petitioner's Reply, 8

TABLE 1								
No.	PRODUCTION		COATING LAYER STRUCTURE & COMPOSITION (%)					
	RAISED TEMPERATURE (°C)	HOLD TIME (min.)	COMPONENT & HARDNESS	INNER	INTER 1	INTER 2	INTER 3	OUTER
1	920	3	Al	7.7	31.0	48.4	31.6	54.8
			Si	2.0	3.9	1.2	5.7	0.8
			Fe	89.6	65.9	50.1	62.0	44.5
			Hv	310	360	750	700	800
2	900	2	Al	27.2	48.4	31.6	—	54.9
			Si	4.1	1.2	5.7	—	0.8
			Fe	67.2	50.1	61.9	—	44.1
			Hv	380	760	720	—	810
3	930	10	Al	9.4	—	—	—	11.6
			Si	1.3	—	—	—	1.8
			Fe	88.4	—	—	—	85.7
			Hv	305	—	—	—	410
4	950	5	Al	6.0	27.8	51.9	30.4	47.4
			Si	1.5	4.3	0.6	5.3	2.2
			Fe	90.7	66.7	46.8	63.1	49.8
			Hv	280	340	720	690	800
5	900	4	Al	3.2	54.5	33.4	—	54.5
			Si	0.4	2.5	15.3	—	6.8
			Fe	94.3	42.7	51.4	—	38.4
			Hv	300	740	700	—	810

Takagi, Table 1; Petition, 7-8

Dr. Raabe previously conceded Takagi's "intermetallic phase layering and structure"

Prior Dr. Raabe Declaration

166. It would have taken substantial expertise, experience, and extensive and undue experimentation to take the multi-layered microstructure shown in Takagi and replicate it in a thicker coating form—while still maintaining the intermetallic phase layering and structure in Takagi. This would take far more experimentation than routine “trial and error.” It would require extensive and undue experimentation.

EX-1075, 166; Petitioner's Reply, 3-4

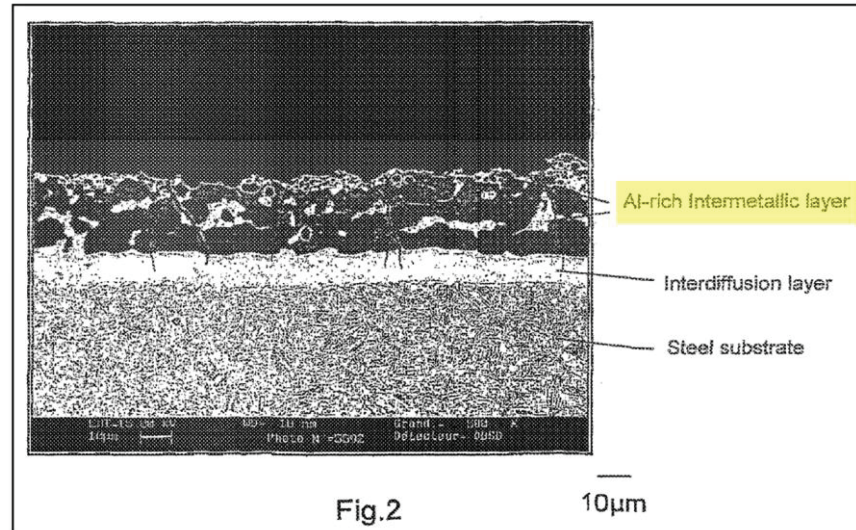
'602 Background

Thanks to an alloying of the pre-coating with the steel substrate, which has the effect of creating intermetallic alloys with high melting temperature, the blanks having

'602 1:50-52; Petitioner's Reply, 3

AM's narrow construction and arguments against Takagi are inconsistent with the Specification

'602 FIG. 2



Deposition of Dr. Raabe

Q So your opinion is that figure 2 does not show a layer that meets your construction of intermetallic, correct?

A Correct.

Dr. Raabe Deposition, 129:21-24; Petitioner's Reply, 2

Suehiro discloses intermetallic layers satisfying PO's construction

Suehiro

[15] Figure 12 shows the alloying state after holding at 950°C for 0.5 min, and Figure 13 shows the results of SEM-EDS measurements of Fe, Al, and Si concentrations in the surface plating layer in the direction of the plate thickness. As alloying progresses, a layered alloy phase with the Al and Fe concentrations shown in the figure is formed. Under these heating conditions, the alloy phase consists of five layers, and the Al concentration changes from the topmost layer to approximately 50%, 30%, 50%, 30%, and 10%. From the fourth layer to the base layer, the element concentrations change continuously.

[16] Figure 14 shows the state of the Fe-Al-Si system at 950°C, as calculated by Thermo-calc⁷⁾. The composition at each point in Figure 13 is superimposed on this figure. The Fe-Al-Si thermodynamic database for this calculation is from Z. Liu et al.⁸⁾. From Figure 14, the alloy layers from the surface layer are estimated to be Fe₂Al₅, BCC regular phase, FeAl₂, BCC regular phase, and BCC irregular phase. The alloy layers in the surface layer disappear from the topmost layer as Al diffuses into the

Suehiro, [15]-[16]; Petition, 60, 64

FR2833504

When the sheet metal blank is reheated, the coating combines with the substrate to form an intermetallic alloy. The alloying, through interdiffusion, leads to an increased thickness of the layer which, for the treatment specified above, generally corresponds to a 50% increase.

EX-1025, 7:17-20; Petitioner's Reply, 9

Hein

2.2 Heat Treatment

The heat treatment of the blank in the furnace should be conducted so as to respect the kinetics of the austenitic transformation /4/ and of the intermetallic alloying reaction between the AlSi-coating and the iron substrate of the blank. A too rapid heating of the

EX-1019, 6; Petitioner's Reply, 9

Suehiro '073

However, in the prior arts, when a steel sheet is heated to a high temperature of not lower than 800°C, Fe diffuses up to the surface for a short period of time and an aluminum plated layer changes to an intermetallic compound, hereinafter called "alloyed aluminum-system plated layer". Since the alloyed aluminum-system plated

as the addition amount is not less than 0.1%. It is known that one to five phases can coexist in an alloyed aluminum-system plated layer depending on the deposit amount of plating, the steel composition, the heating conditions and the like. Since the influence of phases

FeAl₃, Fe₂Al₅, Fe₃Al, Fe₂Al₃Si, etc. are generated as an element of the alloyed aluminum-system plated layer. Those phases tend to form a multi-layered structure in a laminar manner, but the structures of the phases are not specifically regulated. When the composition is mainly

EX-1035, 5:19-21, 14:30-32, 28:15- 19; Petitioner's Reply, 5, 9

Issue 3

Motivations for Combinations of Takagi/Suehiro + GMW14400/Cornette

Thickness increase

Takagi

[0035] Thickness of aluminum coating layer:
10~20 μm .

Takagi, [0035]; Petition, 52

POSITA motivated to achieve coating thickness $> 30 \mu\text{m}$ to:

Satisfy GMW14400's requirements

Dr. Miles' Testimony

121. Further, GMW14400 demonstrates strong market motivation and demand to achieve such a thickness, as steel researchers and manufacturers would have been highly motivated to conform to General Motors' requirements. It would have been typical for a researcher in industry or academia to review standards such as GMW14400 to learn about industrial objectives and steel processing, for example, in order to guide internal design and research. Based on GMW14400's requirements, a POSITA would have sought to form a hot-stamped coating with a thickness greater than $35 \mu\text{m}$.

EX-1003, 121; Petition, 52-53

GMW14400

Table 6: Al-Si Coating Requirements ^{Note 1}		
Condition	Coating Mass (g/m^2)	Coating Thickness (μm) ^{Note 2}
Prior to hot-stamping	60 to 100	20 to 33
Following hot-stamping	N/A	>35

GMW14400, 7; Petition, 51-52

Achieve Cornette's results

Dr. Miles' Testimony

recognized by the art as beneficial. For example, it would have been obvious for a POSITA to seek to obtain a coating thickness of "about $40 \mu\text{m}$ " by using a pre-coating thickness of " $25 \mu\text{m}$ " as taught by Cornette, in order to achieve "the best compromise between corrosion protection and weldability." EX-1014, 9. Further

EX-1003, 31; Petition, 13

Cornette

The coating, made of aluminum and silicon, is applied with a hot dipped process.

The average layer thickness showing the best compromise between corrosion protection and weldability is $25 \mu\text{m}$.

Heating the pre-coated boron steel (generally 900°C , 5 minutes) creates an alloying reaction between substrate (iron) and the coating (aluminum - silicon) which leads to a hard multiphase alloy layer.

Fe-Al-Si layer is typically about $40 \mu\text{m}$ at the steel surface. The following photo shows a section view of the coating after heat treatment:

Cornette, 9; Petition, 13

Takagi/Suehiro layer structure

POSITA motivated to retain Takagi/Suehiro layer structure

Importance of “five-layer structure”

[0024] Thermal stability is improved by alloying an Al—Si—Fe coating layer entirely into a multi-layer structure such as a five-layer structure having five layers of different alloy compositions. A multi-layer structure including a hard outermost layer is advantageous for maintaining good contact with a welding gun in spot welding even under great pressure for high tension material.

Takagi, [0024]; Petitioner's Reply, 18

Importance of innermost layer

increasing the possibility of cracks in the coating. Therefore, in this embodiment, there is formed a less hard or soft layer having a hardness smaller than the hardness of the steel substrate at or near the boundary between the steel and coating. This soft layer prevents crack, even if produced by any chance, from extending deeper from the surface toward the steel substrate. In this embodiment, the thickness of this

Takagi, [0017]; Petitioner's Reply, 18

Importance of “intermediate layer”

[0022] In the case of a multi-layer structure including three or more subordinate layers differing in composition or compound, there is one or more intermediate layers between an innermost layer contiguous with the steel substrate layer and an outermost layer forming the surface of the coating layer. Preferably, the intermediate layer or at least one of the intermediate layers contains 25~40% Al.

Takagi, [0022]; Petition, 17; EX-1003, 36

Importance of “outermost layer” and “multilayer structure”

becomes feasible. It is possible to combine weldability and corrosion resistance by making the Fe concentration in the surface or outermost layer of the coating in the range of 35~50%. The coating layer having a surface Fe concentration in this range can be formed by forming an Al—Si—Fe layer having a multi-layer structure, or by forming an Al—Si—Fe layer having a concentration gradient of Fe content. The improvement in weldability is insufficient when

Takagi, [0025]; Petitioner's Reply, 18

Takagi/Suehiro layer structure

POSITA motivated to retain Takagi/Suehiro layer structure

Certain multi-layer structures are advantageous

Corresponding layers of '602 patent

TABLE 1

No.	PRODUCTION		COATING LAYER STRUCTURE & COMPOSITION (%)						STEEL BASE HARDNESS (Hv)	COATING LAYER HARDNESS (Hv)			OXIDE WEIGHT (mg/dm ²)	FORMABILITY	CORROSION RESISTANCE	WELDABILITY
	RAISED TEMPERATURE (°C)	HOLD TIME (min.)	COMPONENT & HARDNESS	INNER	INTER 1	INTER 2	INTER 3	OUTER		SOFTTEST	AVERAGE	SOFTER RANGE (%)				
1	920	3	Al	7.7	31.0	48.4	31.6	54.8	450	310	415	51	300	○	○	○
			Si	2.0	3.9	1.2	5.7	0.8								
			Fe	89.6	65.9	50.1	62.0	44.5								
			Hv	310	360	750	700	800								
2	900	2	Al	27.2	48.4	31.6		54.9	415	380	455	22	275	×	○	○
			Si	4.1	1.2	5.7		0.8								
			Fe	67.2	50.1	61.9		44.1								
			Hv	380	760	720		810								
3	930	10	Al	(a)		(b)	(c)	(d)	400	305	385	78	550	○	×	×
			Si	1.5		0.6	5.3	2.2								
			Fe	88.4				85.7								
			Hv	305				410								
4	950	5	Al	6.0	27.8	51.9	30.4	47.4	440	280	400	59	385	○	○	○
			Si	1.5	4.3	0.6	5.3	2.2								
			Fe	90.7	66.7	46.8	63.1	49.8								
			Hv	280	340	720	690	800								
5	900	4	Al	3.2	54.5	33.4		54.5	440	300	410	56	335	○	○	○
			Si	0.4	2.5	15.3		6.8								
			Fe	94.3	42.7	51.4		38.4								
			Hv	300	740	700		810								

(a) (b) (c) (d)

Takagi, Table 1; Petitioner's Reply, 18

Takagi/Suehiro layer structure

POSITA motivated to retain Takagi/Suehiro layer structure

Importance of layer composition (Dr. Miles' testimony)

1016, [0019]. This emphasis on layer composition as a parameter to be tuned would have been corroborated by (i) Maki's disclosure that Al% at least partially determines corrosion resistance, (ii) WO02/103073's disclosure that Si% and Al% modulate layer hardness, workability, weldability, and/or corrosion resistance, and (iii) the Laurent Presentation's detailed measurements of layer composition within a hot-stamped coating. EX-1034, [0012]; EX-1035, 25:21-28, 29:3-7, 31:6-12; EX-1056, 7. By varying the parameters noted by Takagi and Cornette (e.g., heating

EX-1003, 79; Petition, 41

Cornette's "40 µm" refers to a coating thickness

Cornette

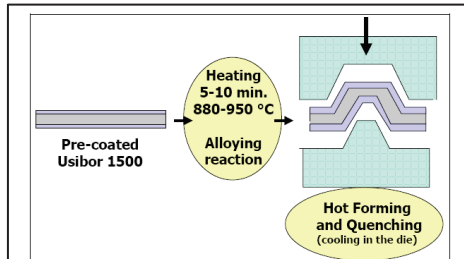


Fig. 21. Process used for the hot forming of USIBOR 1500 Pre-coated.

CHEMICAL COMPOSITION OF THE BASE MATERIAL

USIBOR 1500 is a carbon-manganese steel microalloyed with boron.

Table III. Chemical composition of pre-coated boron steel in thousandths of percent

	C	Mn	Si	S	Cr	Al	B	Ti
Min.	200	1100	150		150	20	2	20
Max.	250	1350	350	8	300	60	4	50

DESCRIPTION OF THE COATING

The coating, made of aluminum and silicon, is applied with a hot dipped process.

The average layer thickness showing the best compromise between corrosion protection and weldability is 25 µm.

Heating the pre-coated boron steel (generally 900°C, 5 minutes) creates an alloying reaction between substrate (iron) and the coating (aluminum - silicon) which leads to a hard multiphase alloy layer.

Fe-Al-Si layer is typically about 40 µm at the steel surface. The following photo shows a section view of the coating after heat treatment:

Cornette, 9

Dr. Miles' testimony

46. Patent Owner's interpretation is less parsimonious, for two distinct reasons. First, Patent Owner's interpretation requires Cornette to zig-zag back and forth in time in the hot-stamping process: starting with a hot-dipped pre-coating, going forwards in time (skipping past the heating process) to discuss a post-heating thickness, then going backwards in time to discuss the heating process, and then going forwards in time again to discuss a second post-heating thickness. This would be an unusual way to present information. The more typical approach, consistent with the interpretation provided in my prior Declaration, would be to first discuss characteristics prior to heating, then discuss the heating, and then discuss post-heating characteristics.

EX-1075, 46; Petitioner's Reply, 17-18

Issue 4

Reasonable Expectation of Success and
Prior Art Enablement

Matching process parameters

Compared parameters

Parameter	'602 Patent	'602 Patent Example 2	Takagi	Cornette	Suehiro
Pre-coating thickness (μm)	20 – 33	20 – 33	10 – 20	25	---
Heating rate (°C/s)	4 - 12	10	8; 1-10	---	~8 ¹ , 10
Temperature (°C)	880 - 940	920	900, 920, 950	880-950; 900	900, 950
Hold time (min)	< 3 – 13	< 6	3, 4, 5; 2-8; 2-10	< ² 5 – 10; 5	0.5; 3
Cooling rate (°C/s)	> 30, or > 50	---	20 – 100; 30	---	> 20, > 30
Steel sheet thickness (mm)	0.7 - 3	1.2	1.4	---	1.4, 1.6
Si% in pre-coating (%)	5 - 11	9.3	5	---	10

Petitioner's Reply, 11; EX-1075, 26; EX-1001, 5:9-14, 6:63-7:1, 7:12-14, 7:41-43, 7:46-50, 11:12-14, 11:54-62, 12:32-39; EX-1016, [0026]-[0028], [0033]-[0035], [0037], FIG. 4; EX-1014, 9; EX-1055, [02], [07], [09], [14]-[15], [18], FIG. 3.

Dr. Miles' testimony

and (ii) the other process parameters discussed by the '602 Patent. But, as discussed in §III above and in my prior Declaration, the art teaches essentially the same process parameter values disclosed by the '602 Patent. Further, the art teaches at least as specific a starting point for pre-coating thickness as the '602 Patent: GMW14400's pre-coating thickness range of "20 to 33" μm *exactly matches* the '602 Patent's range, and Cornette discloses a 25 μm pre-coating thickness. EX-1016, 7; EX-1014, 9. It follows that a POSITA, motivated by GMW14400 and Cornette as discussed above, would have had a reasonable expectation of success in selecting a suitable pre-coating thickness to obtain a coating thickness that satisfies the Challenged Claims.

EX-1075, 54; Petitioner's Reply, 19-20

ArcelorMittal does not dispute that the parameters match

The art discloses the same layer structure at the same level of detail as ArcelorMittal's patents

Takagi, Table 1

Corresponding layers of '602 patent

TABLE 1

No.	PRODUCTION		COATING LAYER STRUCTURE & COMPOSITION (%)						STEEL BASE HARDNESS (HV)	COATING LAYER HARDNESS (HV)			OXIDE WEIGHT (mg/dm ²)	FORMABILITY	CORROSION RESISTANCE	WELDABILITY
			COMPONENT & HARDNESS	INNER	INTER 1	INTER 2	INTER 3	OUTER		SOFTTEST	AVERAGE	SOFTER RANGE (%)				
1	920	3	Al	7.7	31.0	48.4	31.6	54.8	450	310	415	51	300	○	○	○
			Si	2.0	3.9	1.2	5.7	0.8								
			Fe	89.6	65.9	50.1	62.0	44.5								
			Hv	310	360	750	700	800								
			Al	27.2	48.4	31.6	54.9	—								
2	900	2	Si	4.1	1.2	5.7	—	0.8	415	380	455	22	275	×	○	○
			Fe	67.2	50.1	61.9	—	44.1								
			Hv	280	760	720	—	810								
			Al	(a)	—	(b)	(c)	(d)								
			Si	127	—	—	—	—								
3	930	10	Fe	88.9	—	—	—	85.7	400	305	385	78	550	○	×	×
			Hv	305	—	—	—	410								
			Al	6.0	27.8	51.9	30.4	47.4								
			Si	1.5	4.3	0.6	5.3	2.2								
			Fe	90.7	66.7	46.8	53.1	49.8								
4	950	5	Hv	280	340	720	690	800	440	280	400	59	385	○	○	○
			Al	3.2	54.5	33.4	—	54.5								
			Si	0.4	2.5	15.3	—	6.8								
			Fe	94.3	42.7	51.4	—	38.4								
			Hv	300	740	700	—	810								
5	900	4	Al	—	—	—	—	—	440	300	410	56	335	○	○	○
			Si	—	—	—	—	—								
			Fe	—	—	—	—	—								
			Hv	—	—	—	—	—								
			Al	—	—	—	—	—								

(a) (b) (c) (d)

Takagi

[0016] During the growth of the Al—Si—Fe alloy layer by the heat treatment, mutual diffusion between Al coating and steel substrate layer produces various Al—Si—Fe ternary intermetallic compounds such as α FeAlSi phase (alpha FeAlSi), β FeAlSi phase (beta FeAlSi) and γ FeAlSi phase (gamma FeAlSi). The Al—Si—Fe alloy layer formed by the heat treatment has a layered structure made up of these intermetallic compounds, and offers advantages of formability, corrosion resistance and weldability.

Takagi, [0016]; Petitioner's Reply, 8

Takagi's pre-coating corresponds to > 30 µm coating thickness

Takagi

[0035] Thickness of aluminum coating layer:
10~20 µm.

Takagi, [0035]; Petition, 52

GMW14400

Table 6: Al-Si Coating Requirements ^{Note 1}		
Condition	Coating Mass (g/m ²)	Coating Thickness (µm) ^{Note 2}
Prior to hot-stamping	60 to 100	20 to 33
Following hot-stamping	N/A	>35

Note 1: Additional demands can be specified by the local business units.
Note 2: Prior to hot-stamping, suitable evaluation instruments to measure coating thickness on the as-received sheet include eddy current, ferromagnetic, or microscopy. Magnetic inductive measurements are not recommended following the hot-stamping operation without proper calibration.

GMW14400, 7; Petition, 51-52

FR Laurent

When the sheet metal blank is reheated, the coating combines with the substrate to form an intermetallic alloy. The alloying, through interdiffusion, leads to an increased thickness of the layer which, for the treatment specified above, generally corresponds to a 50% increase.

EX-1025, 7; Petition, 11-12

Dr. Miles' testimony

more. Cornette discloses a post hot-stamping coating thickness of "about 40 µm" corresponding to a pre-coating thickness of 25 µm, an increase of 60%. EX-1014.
9. When this factor is applied to Takagi's 20 µm pre-coating thickness, the expected coating thickness would be 32 µm. This relationship is corroborated by

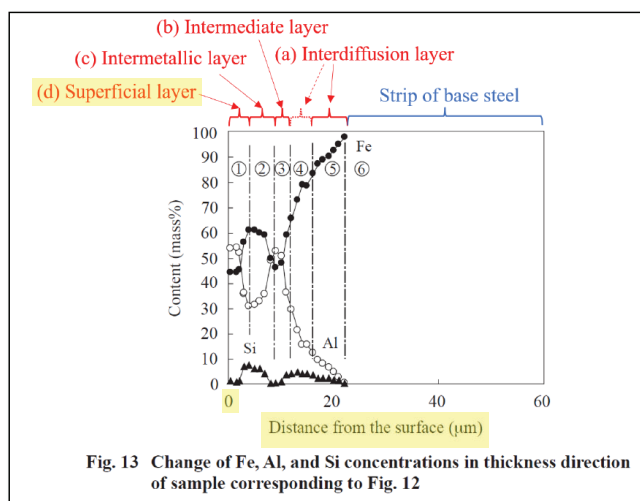
EX-1003, 28; Petition, 12

Issue 5

Suehiro's disclosure of a superficial layer

Suehiro FIG. 13 shows a superficial layer

Suehiro, FIG. 13



Suehiro, FIG. 13; Petition, 81

Suehiro

direction of the plate thickness. As alloying progresses, a layered alloy phase with the Al and Fe concentrations shown in the figure is formed. Under these heating conditions, the alloy phase consists of five layers, and the Al concentration changes from the topmost layer to approximately 50%, 30%,

Suehiro, [15]; Petitioner's Reply, 22

Dr. Miles' testimony

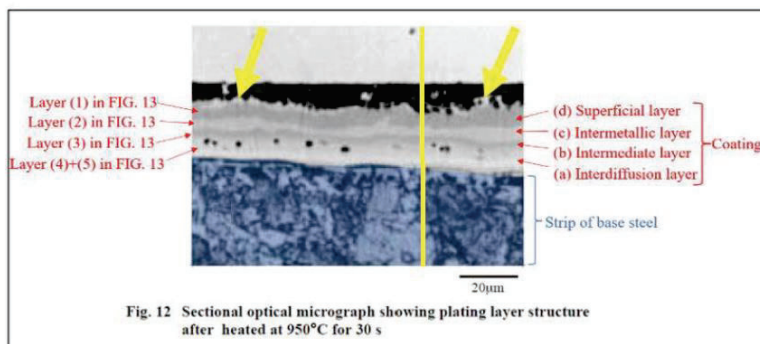
phase consists of five layers." EX-1055, [15]. All five layers are accounted for in FIG. 13 (layers (1)-(5)), and layer (1) is both the outermost one and explicitly present at "the surface." PO's argument—essentially, that the annotation in FIG. 12 points to the wrong layer—cannot detract from this independent, cited disclosure of a "superficial layer."

EX-1075, 61; Petitioner's Reply, 22

ArcelorMittal's further arguments are unavailing

ArcelorMittal's Sur-Reply

was taken. *E.g.*, EX2021 199:23-200:21. It well could have been taken from where the extra layer was interrupted/thin, *e.g.*, PO's yellow line below (Petitioner's annotations in red):



Annotated Suehiro FIG. 12

Sur-Reply, 23

Dr. Miles' testimony

60. Suehiro's FIG. 13 unmistakably shows that layer (1) is a superficial layer, because layer (1) is the layer present at the surface. That is, as a POSITA would have understood, the position where "Distance from the surface" is "0" is the surface itself. In FIG. 13, the layer that has a "Distance from the surface" of "0" is layer (1), which is correctly applied as "(d) Superficial layer." This point is

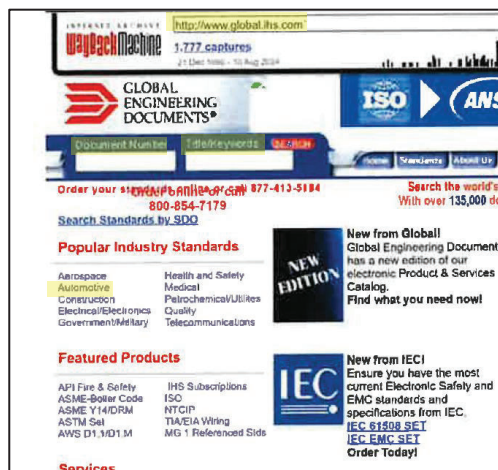
EX-1075, 60; Petitioner's Reply, 21-22

Issue 6

Prior art status of GMW14400, Suehiro,
Cornette

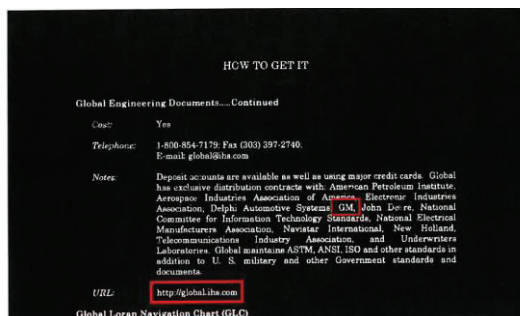
GMW14400 was publicly accessible

Searching/indexing features for standards database



EX-1082, 47-48, appendix IHS01; Petitioner's Reply, 23-24

Reference book pointing to standards database



EX-1082, 43-44, Appendix GMW14402; Petitioner's Reply, 23

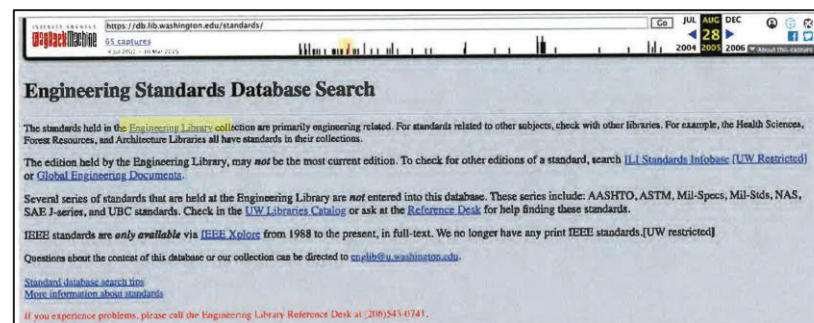
GMW14400 listed in standards database

I have reviewed the attached document "GMW14400" ("Low Carbon, Heat-Treatable Boron Steel – Uncoated or Aluminized Pre-Coated"), which lists a publication date of November 2005. I have also consulted our internal database, which includes standards listings stretching back to the Standards Store launched by IHS.

Based on my review, I can confirm that the "GMW14400" document has been listed in our database and available to the public for purchase online since December 1, 2005. The "GMW14400" document is a true, complete, and accurate copy of the document that would have been available for purchase as of December 1, 2005.

EX-1027, 23; Petition, 2-3

U. of Washington Engineering Library webpage



EX-1082, 46, Appendix GMW14403; Petitioner's Reply, 23

Cornette was publicly accessible

Head of Engineering Library testifies Cornette “publicly available”

The Library’s historical collection includes various publications. As part of that collection, the Library maintains custody of an original copy of “High Strength Steels for Automotive Safety Parts,” SAE Technical Paper 2001-01-0078, 2001, by Cornette, D., Hourman, T., Hudin, O., Laurent, J., and Reynaert, A. (attached as Exhibit A) (the “Paper”). Based upon my review of the Library’s records, my knowledge of the Library’s standard procedures, and the date stamp on the Cover Sheet of Exhibit A, the Paper was publicly available at the Library within a few weeks of March 13, 2001.

EX-1015, 1; Petition, 2

“Shelving” is indicative of cataloguing and public accessibility

That is, my experience with library cataloging is that the indexing and cataloging process represented in Appendices CORNETTE01 – CORNETTE04 and reflected in Mr. DeSart’s statement is standard library practice when making periodicals available to the public. This standard library practice would have allowed library users to discover Cornette (and its series, the SAE Technical Paper Series) via the library’s catalog.

EX-1082, 51; Petitioner’s Reply, 25

Cornette was published in a long-running periodical

**SAE TECHNICAL
PAPER SERIES**

2001-01-0078

High Strength Steels for Automotive Safety Parts

D. Cornette, T. Hourman, O. Hudin, J. P Laurent and A. Reynaert
Usinor Research

EX-1014, 1; Petitioner’s Reply, 25

Suehiro was publicly accessible

Suehiro was available through the Nippon Steel homepage

A series of archived webpages illustrating how an interested person could, with only three clicks, navigate from (1) the Nippon Steel homepage, to (2) Nippon Steel's R&D page, to (3) a table of contents providing a link to access Suehiro itself, labeled with Suehiro's title. EX-1082, 9-17.

Petitioner's Reply, 24; EX-1082, 9-17

Suehiro was publicly available at the National Diet Library in Japan

Certificate for Library Document Held by the National Diet Library	
I hereby certify that the following information is accurate.	
Library Material Title and Call Number	Nippon Steel Technical Report Z17-328
Publication Year/Volume/Issue	July 31, 2003 No. 378
Date Received	August 13, 2003
Published Article	Properties of Aluminum Coated Steels for Hot-Forming Properties of Aluminum Coated Steels for Hot-Forming
Pages	Cover, Table of Contents, Pages 15-20, Copyright Page
February 10, 2026	
Toshiyasu OBA Director, User Services Department, National Diet Library	
[Seal of the Director of the User Services Department at the National Diet Library]	

EX-1082, 22-25, Appendix SUEHIRO17; Petitioner's Reply, 24

Suehiro bears markers of public accessibility

[Nippon Steel Technical Report No. 378] (2003) pp. 15-20	UDC 669.718.5:669.14.018.295-415
Properties of Aluminum Coated Steels for Hot-Forming	
Masayoshi SUEHIRO ^{*(1)}	Jun MAKI ^{*(2)}
Masahiro OHGAMI ^{*(2)}	Kazuhisa KUSUMI ^{*(2)}
	Toshihiro MIYAKOSHI ^{*(3)}

EX-1055, 1; EX-1082, 26-30; Petitioner's Reply, 24

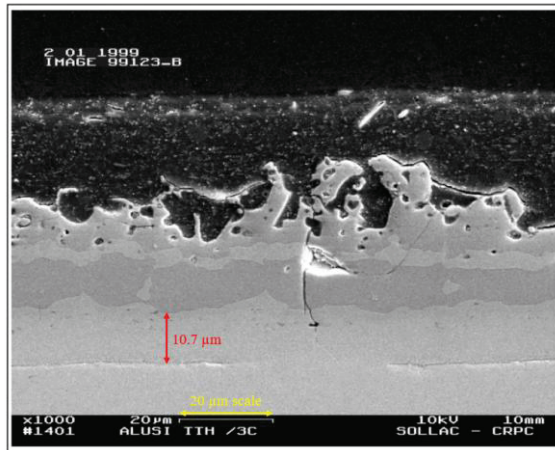
Issue 7

Dependent claims

'602 Claim 10: “layer (a) has a thickness less than 10 micrometers”

Cornette's 10.7 μm thickness renders obvious a $< 10 \mu\text{m}$ thickness

Cornette discloses a 10.7 μm thickness



Cornette, FIG. 22; EX-1003, 69; Petition, 37

A 0.7 μm difference is within measurement tolerance (GMW14400)

perpendicular to the panel surface. Suitable instruments for evaluation of coating thickness on the as-received pre-coated sheet (eg. eddy current, ferromagnetic, or metallurgical microscope) shall have a capability of $\pm 1.0 \mu\text{m}$ accuracy. Mag-

GMW14400, 3; EX-1003, 71; Petition, 38

No criticality or unexpected results disclosed in '602 Patent (testimony of Dr. Miles)

(a) of less than 1 μm , and the '602 Patent does not describe any criticality or unexpected results for “less than 10 micrometers” compared to 10.7 μm in the Takagi-Cornette coating. Nor would a POSITA have expected there to be such a

EX-1003, 70; Petition, 37

Dr. Raabe: this is a “second or third order” “minor thickness variation” that would not result in “game changers”

And when indeed like you say when then there's a minor thickness variation in that second or third order point, yes, it is not to be excluded that this might translate into minor chemical variations also, but they would not be maybe game changers

EX-1078, 217:23-218:4; Petitioner's Reply, 39

The compositions of '602 claim 12 and '227 claims 19, 21 are obvious

	Element	Claimed range	Takagi No. 1	Takagi No. 4	Takagi No. 5	Suehiro
'602 claim 12; '227 claim 19 (Intermediate)	Fe	39-47%	50.1	46.8	42.7	51.1
	Al	53-61%	48.4	51.9	54.5	46.5
	Si	0-2%	1.2	0.6	2.5	1.3
'227 claim 21 (Superficial)	Fe	39-47%	44.5	49.8	38.4	50.2
	Al	53-61%	54.8	47.4	54.5	45.4
	Si	0-2%	0.8	2.2	6.8	3.3

'602 Patent, claim 12; '227 Patent, claims 19, 21; Petition, 40, 48, 74-76, 79; Takagi, Table 1; Suehiro, FIG. 13; EX-1003, 77, 83, 168-169, 172-173

Dr. Miles' testimony

Here, the '602 Patent describes no criticality or unexpected results for the claimed ranges compared to Takagi's very similar values. Based on my metallurgical experience, a POSITA would not expect there to be any qualitative difference in layer properties between, for example, a 53% Al layer and a 51.9% Al layer, or between a 2% Si layer and a 2.5% Si layer.

would be relevant for determining properties of that layer. In addition, Takagi describes both Fe% and Al% as result-effective, noting specifically Fe%'s relationship to hardness and Al%'s relationship to corrosion resistance. EX-1016, [0020]-[0021]. Takagi also describes the physical mechanism behind layer

EX-1003, 78; Takagi, [0020]-[0021]

Takagi

regions of depth. (3) Therefore, by controlling the raised temperature of the heating and the holding time at the raised temperature, the diffusion quantity of Fe is varied and the

EX-1034

surface. The reason for this is the same as that described above, namely, that by increasing the Al concentration on the surface, the cathodic reaction of corrosion is suppressed and extremely good post-coating corrosion resistance is obtained. There are no particular restrictions on the upper limit, but since the Al concentration in the phase formed after alloying is usually no more than 75%, this is effectively the upper limit. The composition of the plating layer on the Al-plated steel sheet before heating is Al-Si, as described above, and the resulting Si can be included in the Fe-Al coating layer. The amount of Si is preferably no more than 5%. In general, a higher amount of Si results in a lower amount of Al in the Fe-Al coating layer after alloying.

Dr. Miles' testimony

80. Also, the above differences in Al%, Fe%, and Si% (e.g., the difference between 51.9% and 53%) would have been well within manufacturing tolerances and measurement accuracy for a micron-scale layer in a thin, multi-layer coating. Layers would never be perfectly uniform, and the composition of the layer

Takagi, [0019]; EX-1034, [0012]; EX-1003, 78, 80; Petition, 41, 42

The compositions of '602 Patent claim 19 are obvious

Layer	Claimed mean iron composition	Takagi No. 1	Takagi No. 4	Takagi No. 5	Suehiro
Interdiffusion	90%	89.6	90.7	94.3	91.9
Intermediate	43%	50.1	46.8	42.7	51.1
Intermetallic	63%	62.0	63.1	51.4	57.4
Superficial	45%	44.5	49.8	38.4	50.2

'602 Patent, claim 19; Petition, 43, 81; Takagi, Table 1; Suehiro, FIG. 13; EX-1003, 86-87, 178

Takagi

and hence more formable. Specifically, a preferable range of the Fe content is 85~95%. When the Fe content is in this range, the hardness of the soft layer contacting with the steel substrate is equal to or lower than 80% (300~400 Hv) of an average hardness of the coating layer. When the Fe content is less than 85%, the above-mentioned advantageous effect by the diffusion of Fe tends to be insufficient. When the Fe content is more than 95%, the diffusion of Fe tends to become excessive and to make the Al content too low to obtain the corrosion resistance in the outermost layer in the multi-layer structure. In this specification, the percent % is

becomes feasible. It is possible to combine weldability and corrosion resistance by making the Fe concentration in the surface or outermost layer of the coating in the range of 35~50%. The coating layer having a surface Fe concentration in this range can be formed by forming an Al—Si—Fe layer having a multi-layer structure, or by forming an Al—Si—Fe layer having a concentration gradient of Fe content. The improvement in weldability is insufficient when the Fe concentration in the outermost layer is less than 35%. The Al content is decreased relatively and the corrosion resistance degrades when the Fe concentration in the outermost layer is more than 50%.

Takagi, [0020], [0025]; Petition, 17; EX-1003, 36