EXHIBIT B-05

Invalidity of U.S. Patent Nos. 10,961,602 in View of Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References

Suehiro et. al, Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II"), published on July 2003, qualifies as prior art under at least 35 U.S.C. §§ 102 and/or 103 for the asserted claims of U.S. Patent No. 10,961,602 ("the '602 patent"), as discussed in detail in the claim chart below.

The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. As such, nothing in Respondents' claim charts should be construed as an admission regarding infringement, either literally or under the doctrine of equivalents, or as an admission regarding Respondents' understanding of the proper scope of the asserted claims. Respondents reserve the right to rely on additional citations or sources of evidence that also may be applicable, or that may become applicable in light of claim construction, changes in Complainant's infringement contentions, and/or information obtained during discovery as the investigation progresses.

To the extent Complainant allege that Suehiro II does not disclose any particular limitation of the asserted claims of the '602 patent, either expressly or inherently, it would have been obvious to a person of ordinary skill in the art as of the priority date of the '602 patent to modify Suehiro II and/or to combine the teachings of Suehiro II with other prior art references, including but not limited to other prior art references discussed in detail in this claim chart, the present prior art references cited in the Cover Pleading, and the relevant section(s) of claim charts for other prior art references for the '602 patent in a manner that would have rendered the asserted claims invalid as obvious.

Respondents reserve the right to amend or supplement this claim chart at a later date as more fully set forth in the Cover Pleading.

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Claim 1	
[1pre] A precoated steel product comprising:	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. To the extent the preamble of claim 1 is found to be limiting, Suehiro II and/or one or more prior art references disclose a precoated steel product. For example: "Properties of Aluminum-coated Steels for Hot-forming." Suehiro II at Title. "Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))" *Id.* at Abstract." "In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed

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	and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. "2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently." *Id.* at 16.

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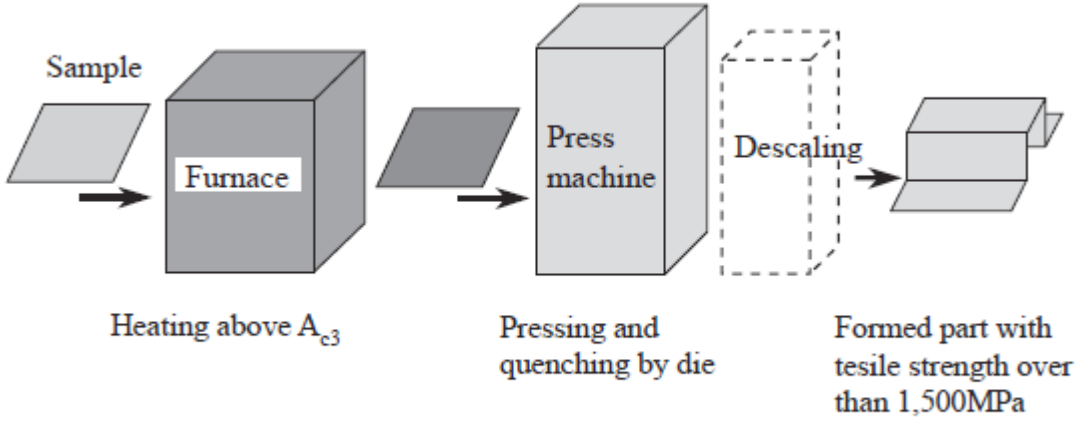


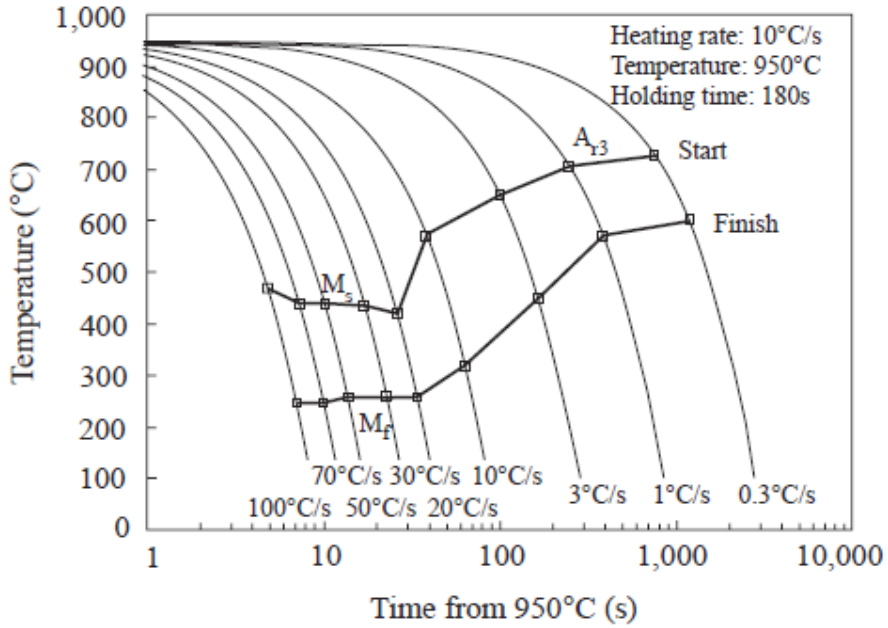
Fig. 1 Schematic illustration of hot forming process

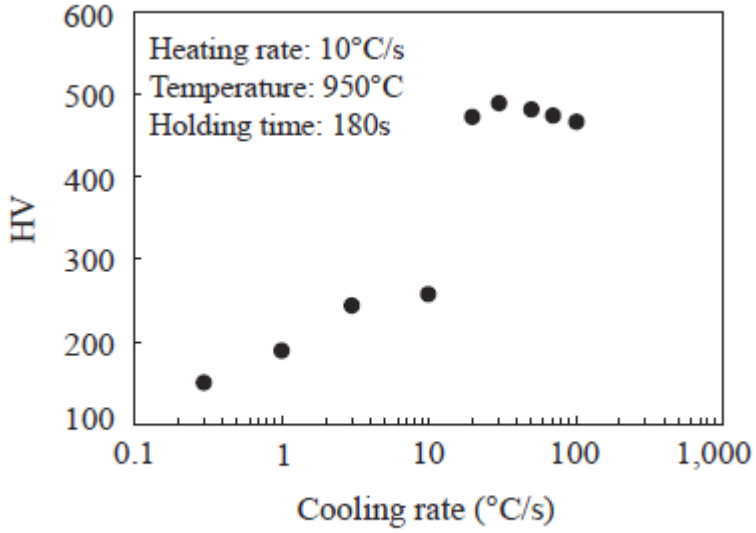
Id. at Fig. 1

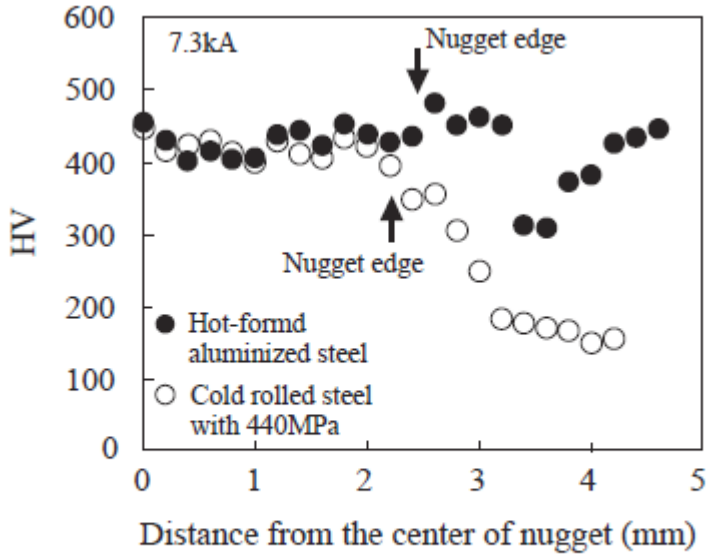
"3. Material
Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

"From Figs. 3 and 4 and the results of the tests at other heating

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	temperatures, it is understood that a sufficient hardness is obtained as far as the cooling rate during the hot forming is equal to or higher than 30°C/s. However, in actual practice, the cooling rate during the transfer from the heating furnace to the pressing machine and the time period before the commencement of the pressing work is close to that in the air. When a steel sheet with thickness of about 1.4 mm is cooled in the normal atmosphere, the cooling rate is 10 to 15°C/s. It is clear from Figs. 3 and 4 that the strength of the steel sheet is decreased when it is cooled to 600°C or lower at this cooling rate. To cool a steel sheet from 950 to 600°C it takes 23 to 35 s; therefore, a material steel sheet can be quenched if its cooling with the pressing dies is commenced within 23 s after it is extracted from a heating furnace. It should be noted that this time allowance changes depending on heating conditions, the atmosphere during the cooling and surrounding environment and for this reason, it has to be determined on the basis of actual work environment." *Id.* at 18.

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	 **Fig. 3 CCT curves** *Id.* at Fig 3.

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	 **Fig. 4 Influence of cooling rate on hardness** *Id.* at Fig 4.

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	 **Fig. 10 Hardness distribution near spot-welded portion** *Id.* at Fig. 10.

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Table 3 Evaluation of paint adhesion

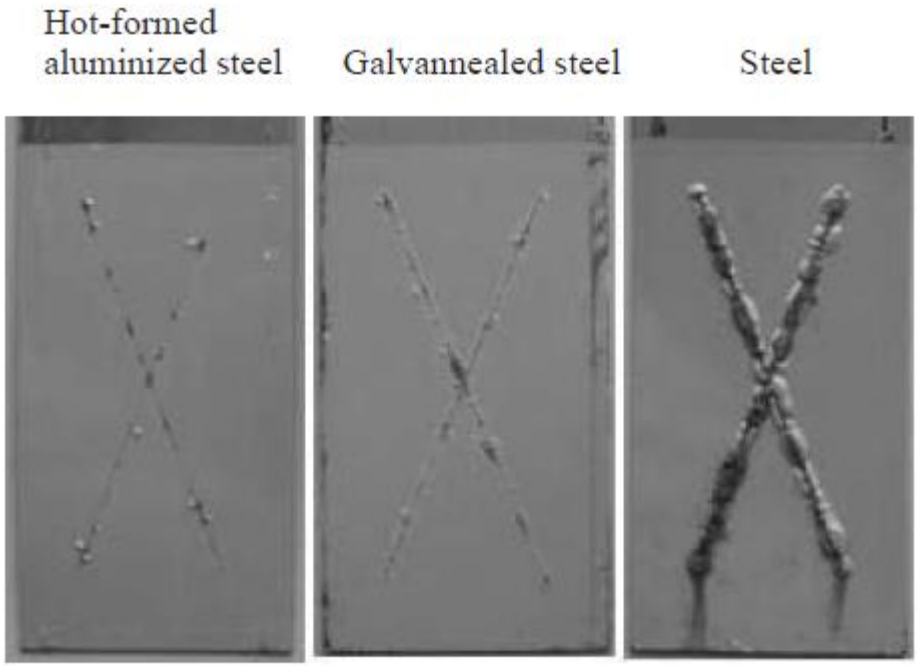
	Surface preparation	Primary adhesion*	Secondary adhesion**
Hot-formed aluminized steel	Phosphated	100/100	100/100
Hot-formed aluminized steel	Degreased	100/100	100/100
Galvannealed steel	Phosphated	100/100	100/100
Steel	Phosphated	100/100	100/100

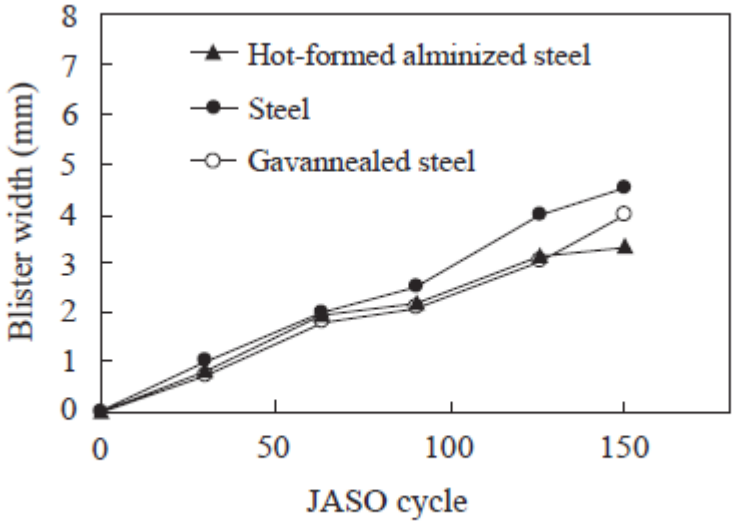
*Primary adhesion test: 100 grid cross-cutting by 2mm and taping after painting
**Secondary test: dipping at 40°C water for 10 days and cross-cutting and taping

Id. at Table 3.

"6.2 Paintability and corrosion resistance after painting
Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have

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	sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id.* at 20.

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	 **Fig. 17 Appearance of samples after 50 days of CCT according to JASO** *Id.* at Fig. 17.

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	 **Fig. 18 Change of paint blister width during CCT according to JASO** *Id.* at Fig. 18.

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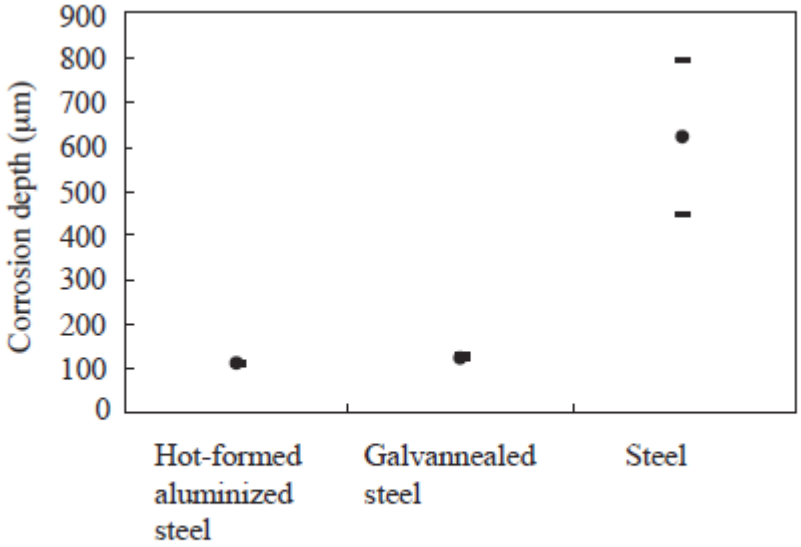


Fig. 19 Change of corrosion depth after 50 days of CCT according to JASO

Id. at Fig. 19.

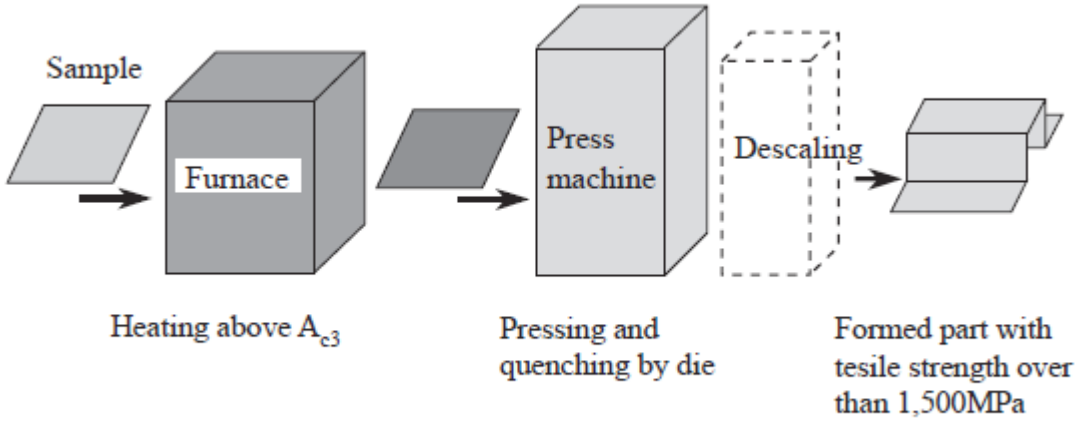
"6.3 Corrosion resistance of spot-welded portion
Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test

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	(SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id.* at 21. "7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id.* at 21.

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[1a] a strip of base steel having a first side and a second side; and	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose a strip of base steel having a first side and a second side. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." Suehiro II at Abstract. "1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures

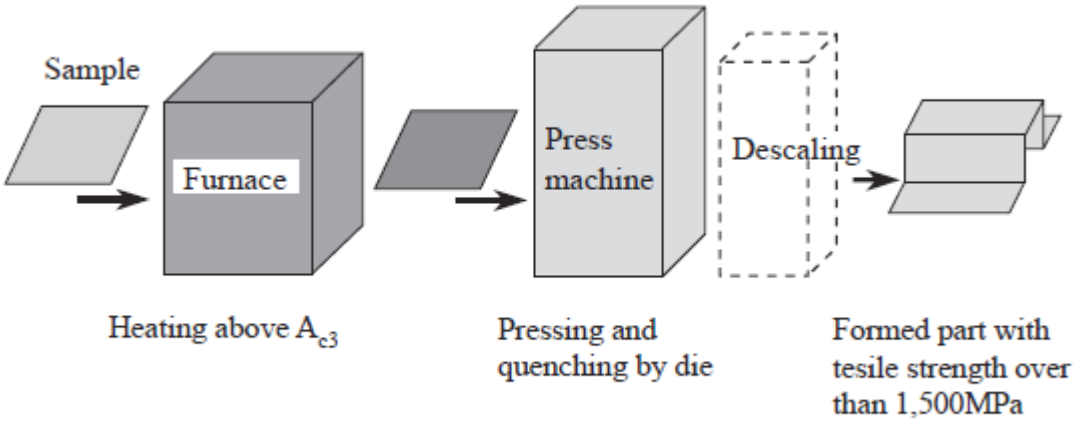
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	have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. "2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room

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	temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

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	 **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.
[1b] 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,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose 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. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good

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proceeding from the base steel outwards:	hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar

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	processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product

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	will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and

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the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

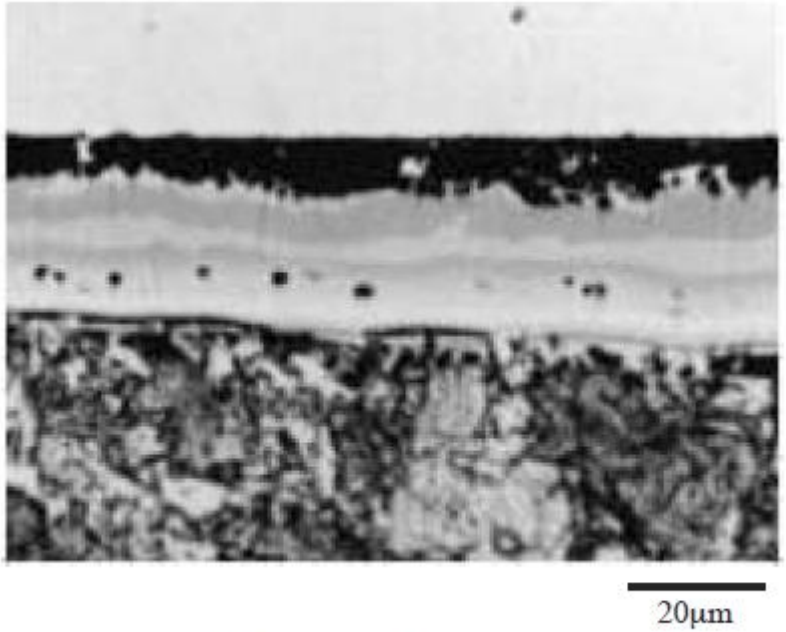
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

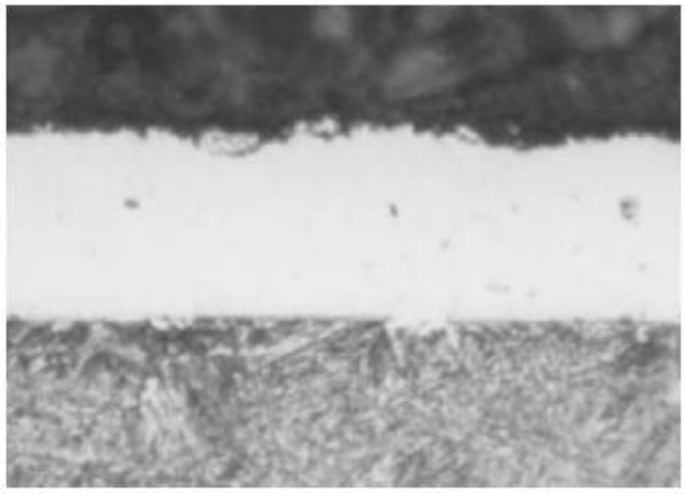
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of

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	120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel

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	sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

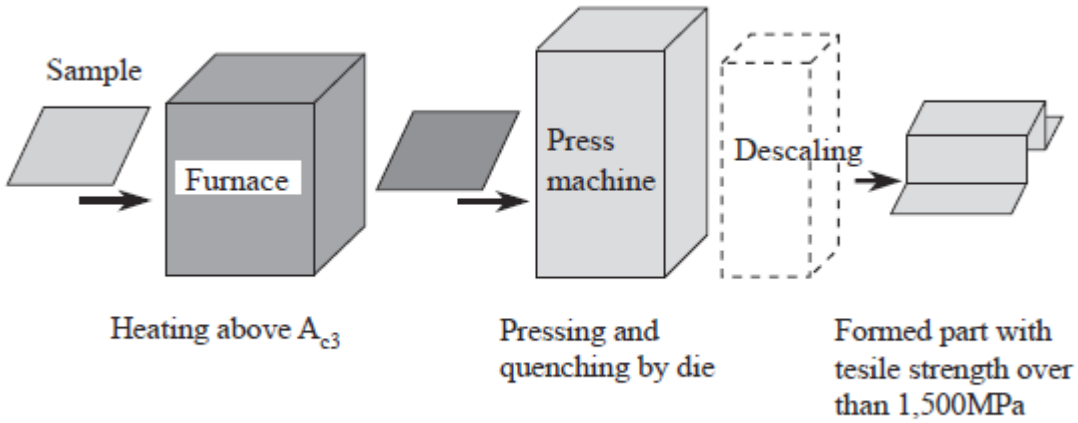
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[1c] (a) an interdiffusion layer having a first mean iron composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (a) an interdiffusion layer having a first mean iron composition. For example: "Abstract

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	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

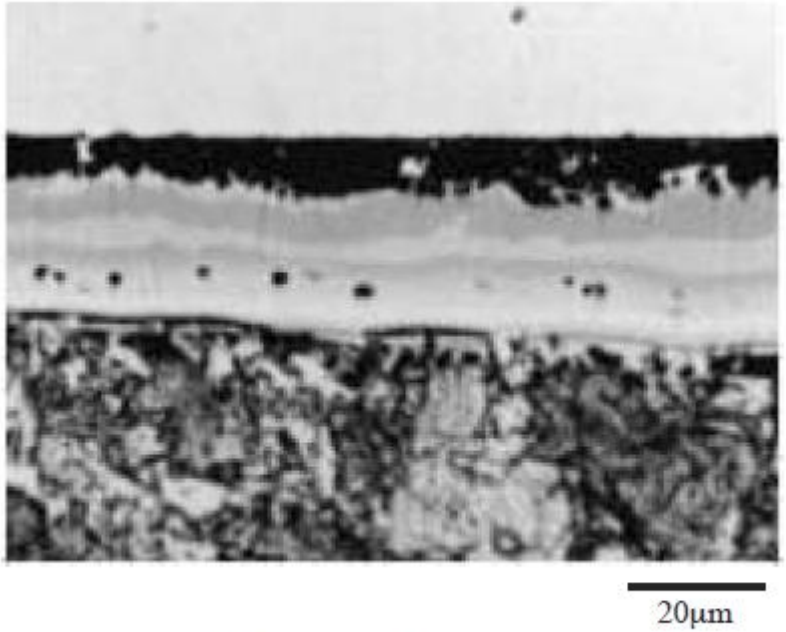
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

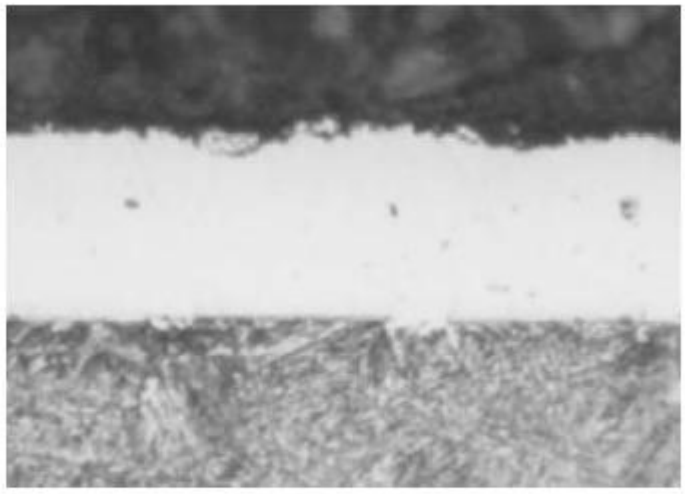
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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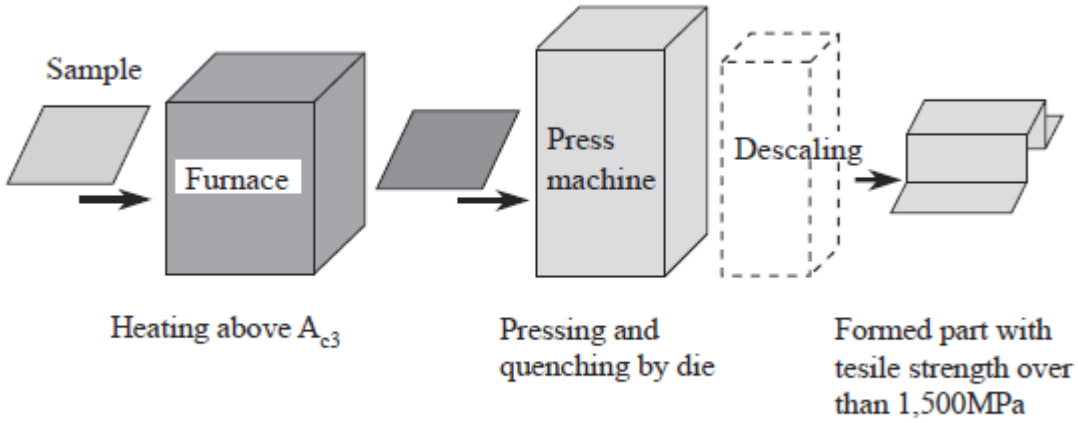
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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[1d] (b) an intermediate layer having a second mean iron composition different from the first mean iron composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (b) an intermediate layer having a second mean iron composition different from the first mean iron composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have

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good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

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C	Mn	Cr	B
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Table 2 Tensile properties before and after quenching

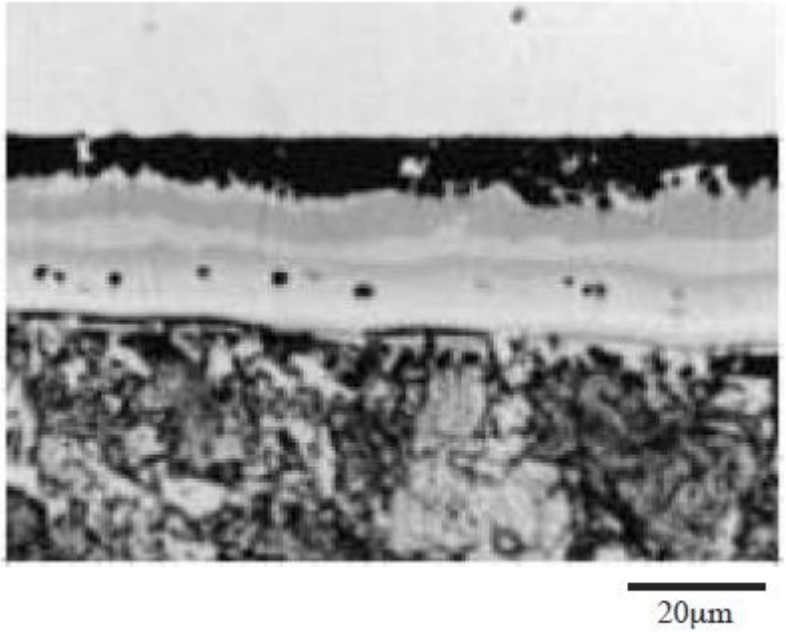
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

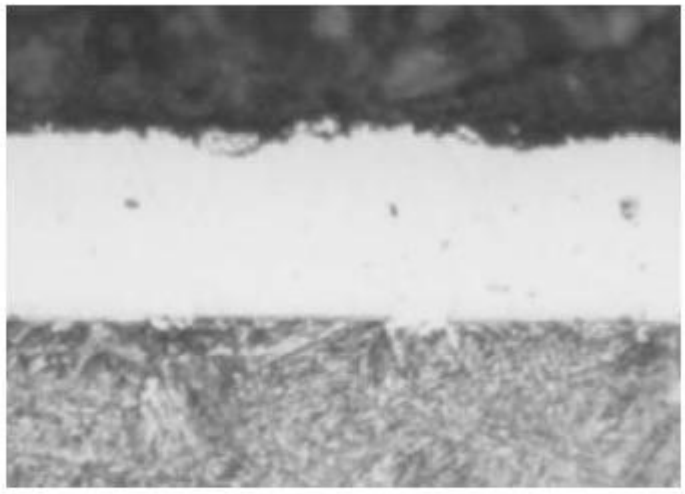
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere

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	is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

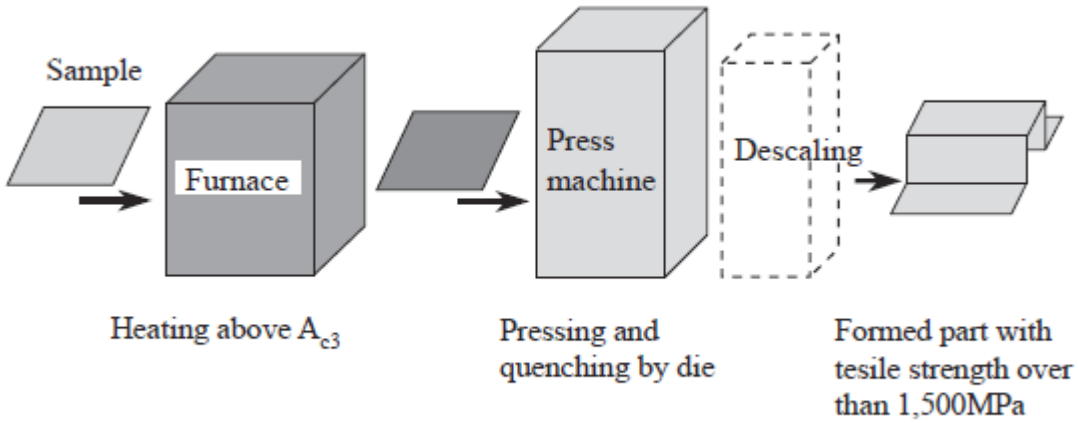
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21."
[1e] (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	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (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. For example: "Abstract

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

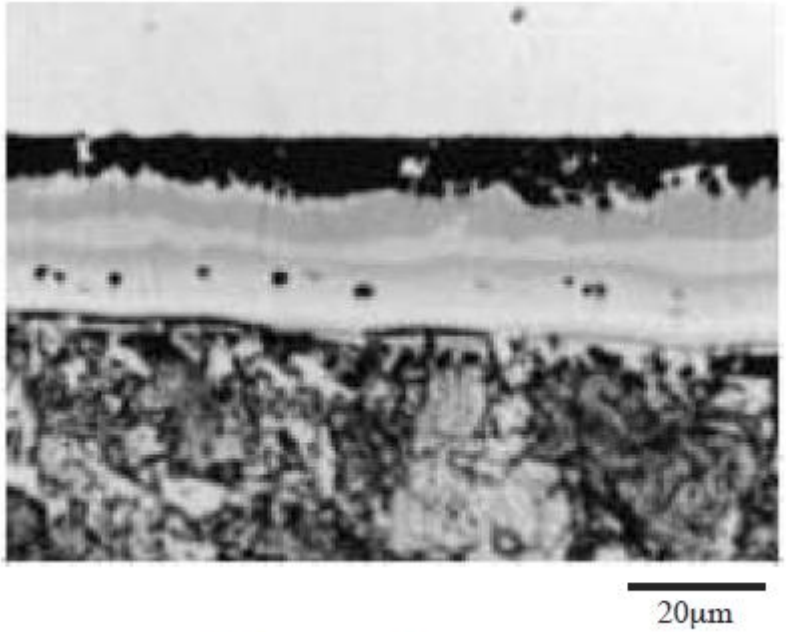
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

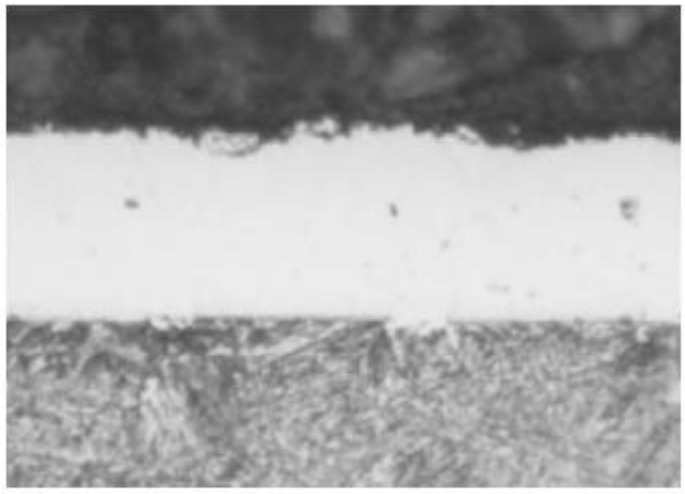
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

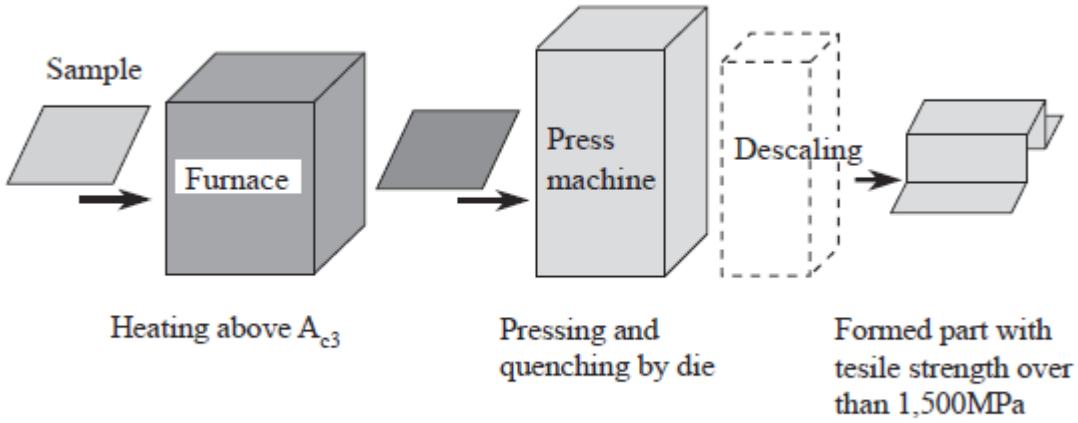
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[1f] (d) a superficial layer having a fourth mean iron composition different from the third mean iron composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (d) a superficial layer having a fourth mean iron composition different from the third mean iron composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

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	receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature.

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	Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have

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good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

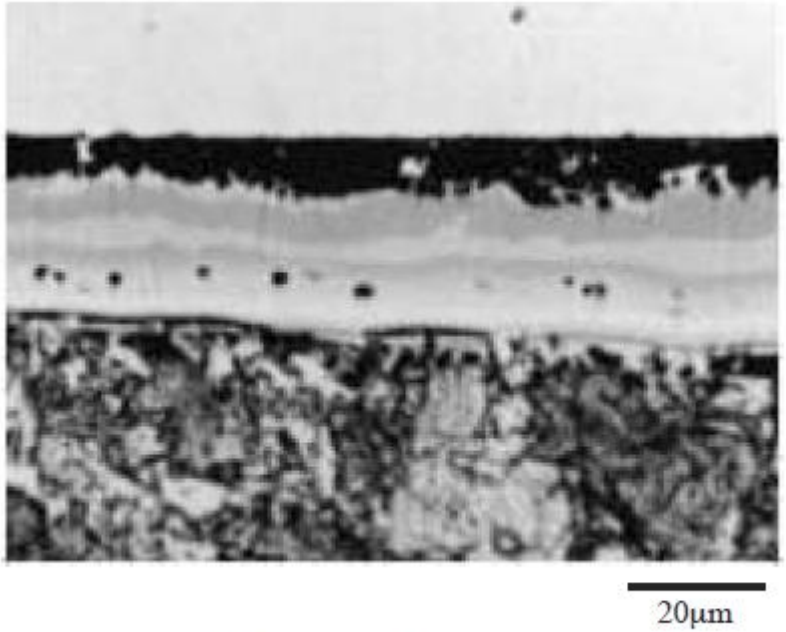
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

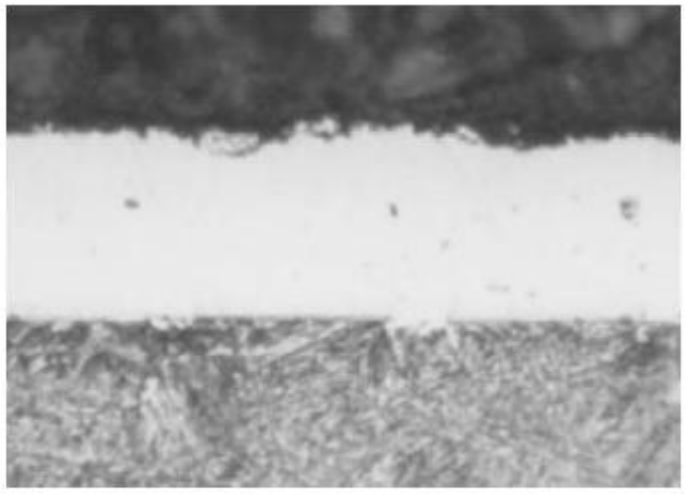
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Test pieces for spot welding tests were prepared by heating aluminized

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	steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere

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	is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

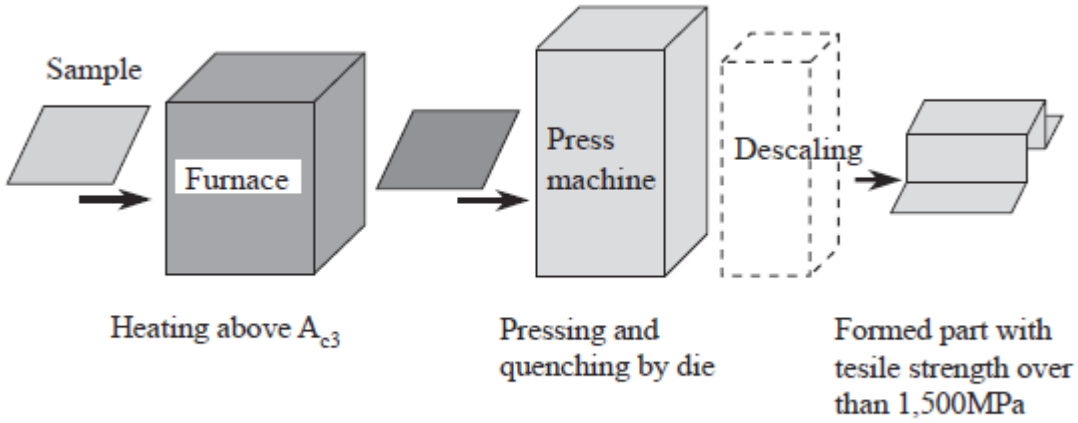
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[1g] wherein the coating has a thickness greater than 30 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose wherein the coating has a thickness greater than 30 micrometers. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

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	receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature.

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	Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have

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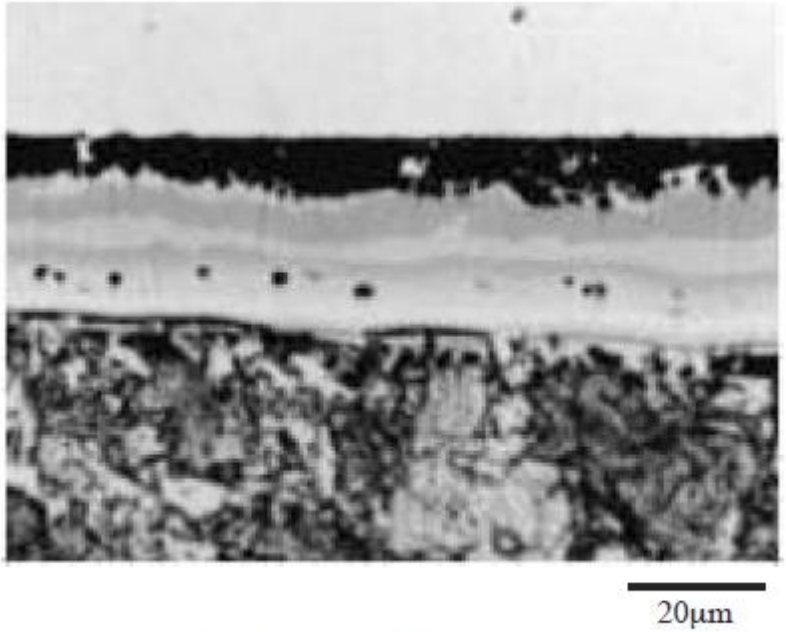
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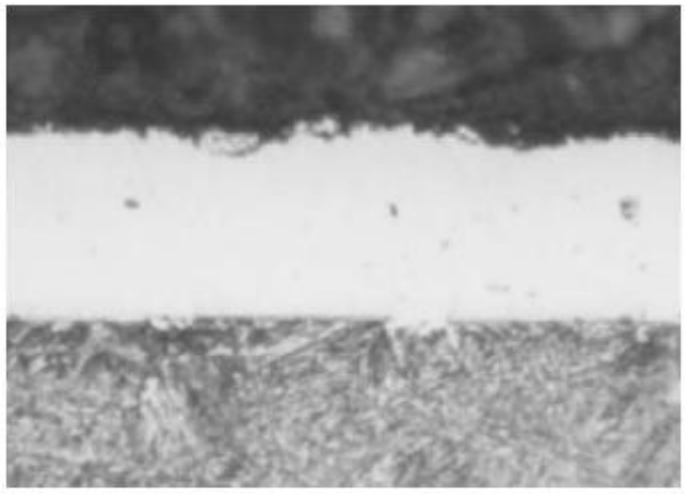
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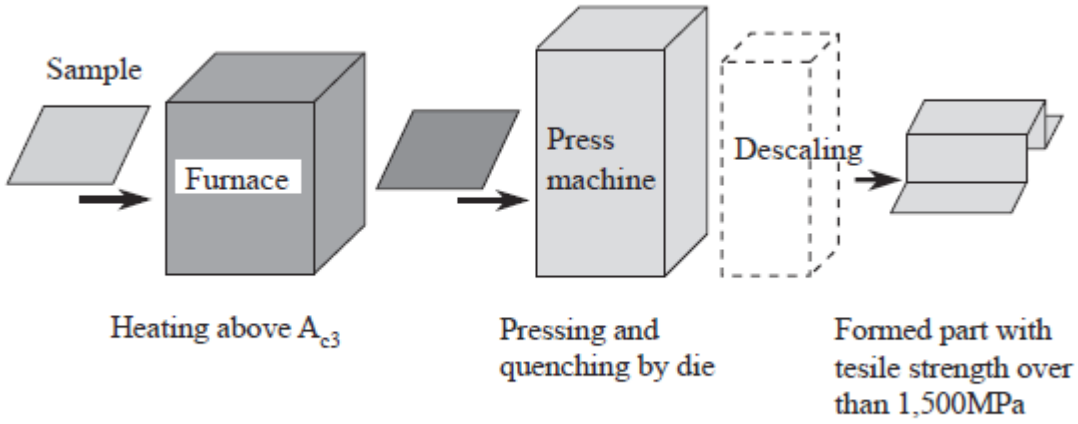
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Claim 2	
[2] The precoated steel product as recited in claim 1 wherein the layers (c) and (d) are quasi continuous by occupying at least 90% of a level corresponding to each of the layers (c) and (d) and wherein less than 10% of	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the layers (c) and (d) are quasi continuous by occupying at least 90% of a level corresponding to each of the layers (c) and (d) and wherein less than 10% of layer (c) is present at an extreme surface of the product. For example:

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layer (c) is present at an extreme surface of the product.	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this

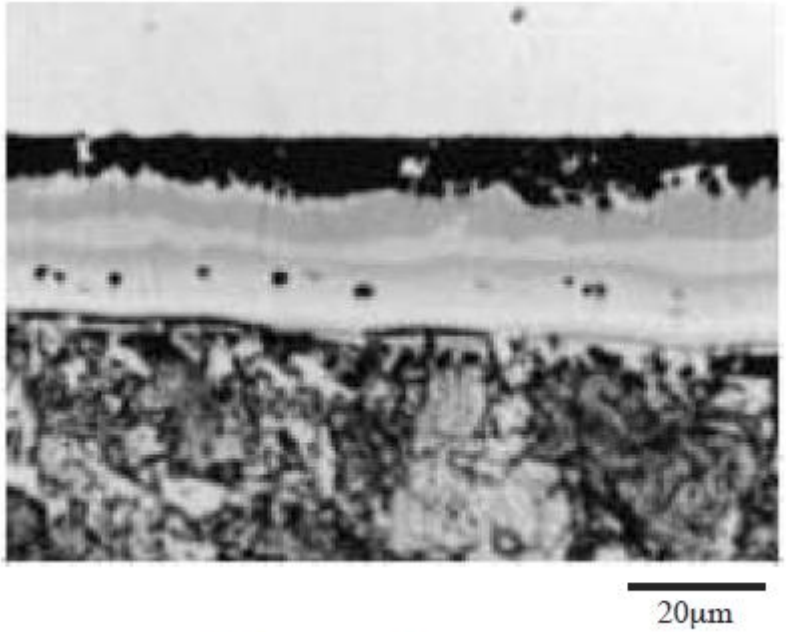
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers.

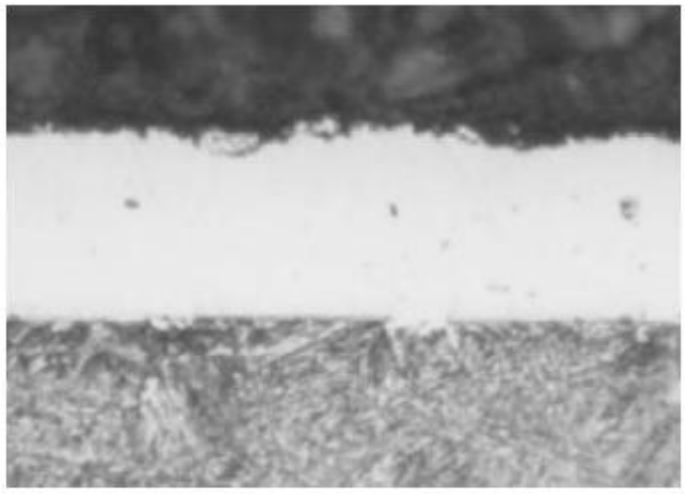
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	Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.

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	"3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C: 0.22 | Mn: 1.2 | Cr: 0.15 | B: 0.002 **Table 2 Tensile properties before and after quenching** As coated: Yield strength (MPa) 394 | Tensile strenght (MPa) 615 | Elongation (%) 26 As formed: Yield strength (MPa) 1,280 | Tensile strenght (MPa) 1,530 | Elongation (%) 8 *Id.* at Table 1 and Table 2.

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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying

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	quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

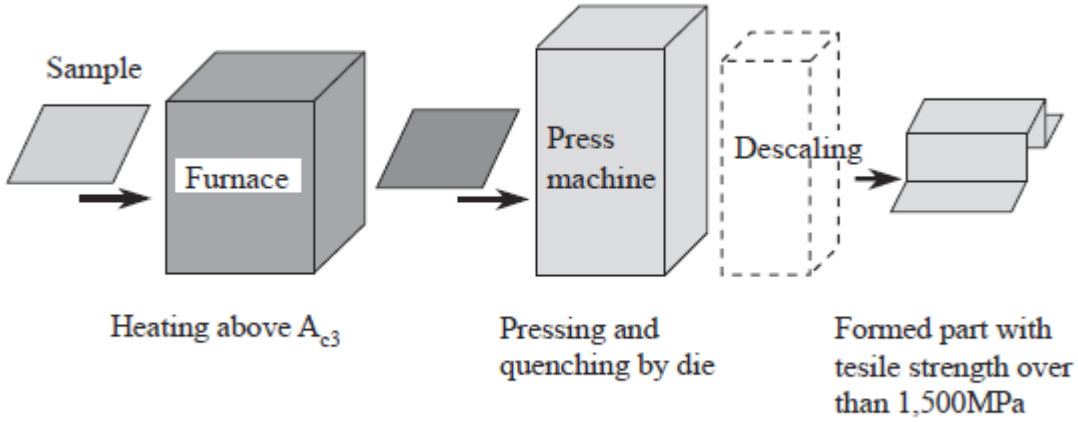
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 3	
[3] The precoated steel product as recited in claim 1 wherein the base steel includes the following components by weight based on total weight: 0.15%<carbon<0.5%; 0.5%<manganese<3%;	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the base steel includes the following components by weight based on total weight: 0.15%<carbon<0.5%; 0.5%<manganese<3%;

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0.1%<silicon<0.5%; 0.01%<chromium<1%; titanium<0.2%; aluminum<0.1%; phosphorus<0.1%; sulfur<0.05%; 0.0005%<boron<0.08%; and further comprises iron and impurities inherent in processing.	0.1%<silicon<0.5%; 0.01%<chromium<1%; titanium<0.2%; aluminum<0.1%; phosphorus<0.1%; sulfur<0.05%; 0.0005%<boron<0.08%; and further comprises iron and impurities inherent in processing. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases,

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	its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet

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	is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

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	 **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

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Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

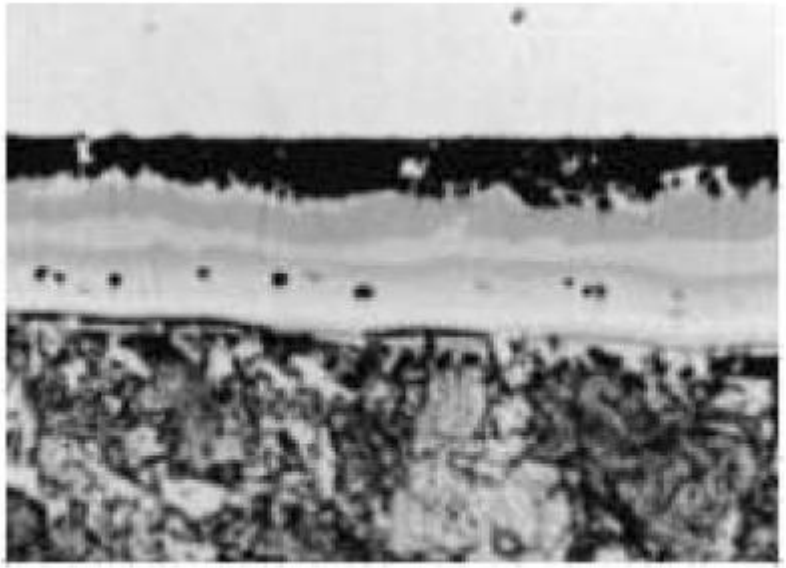
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

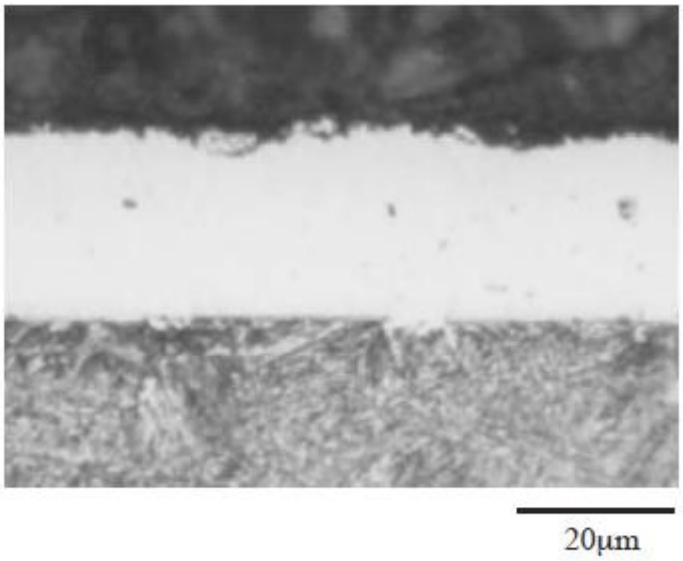
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current

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	range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers,

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	and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors

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	superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

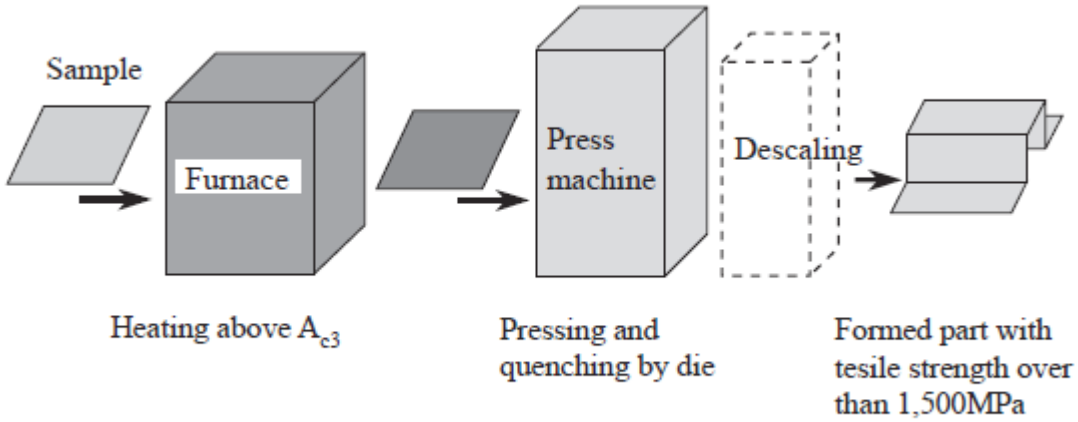
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

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	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

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	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 4	
[4] The precoated steel product as recited in claim 1 wherein the base steel comprises the following components by weight based on total weight: 0.20%<carbon<0.5%; 0.8%<manganese<1.5%; 0.1%<silicon<0.35%; 0.01%<chromium<1%; titanium<0.1%; aluminum<0.1%; phosphorus<0.05%; sulfur<0.03%; 0.0005%<boron<0.01%;	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the base steel comprises the following components by weight based on total weight: 0.20%<carbon<0.5%; 0.8%<manganese<1.5%; 0.1%<silicon<0.35%; 0.01%<chromium<1%; titanium<0.1%; aluminum<0.1%; phosphorus<0.05%; sulfur<0.03%; 0.0005%<boron<0.01%;

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
and further comprises iron and impurities inherent in processing.	and further comprises iron and impurities inherent in processing. For example: Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile

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	structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References

"3. Material
Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

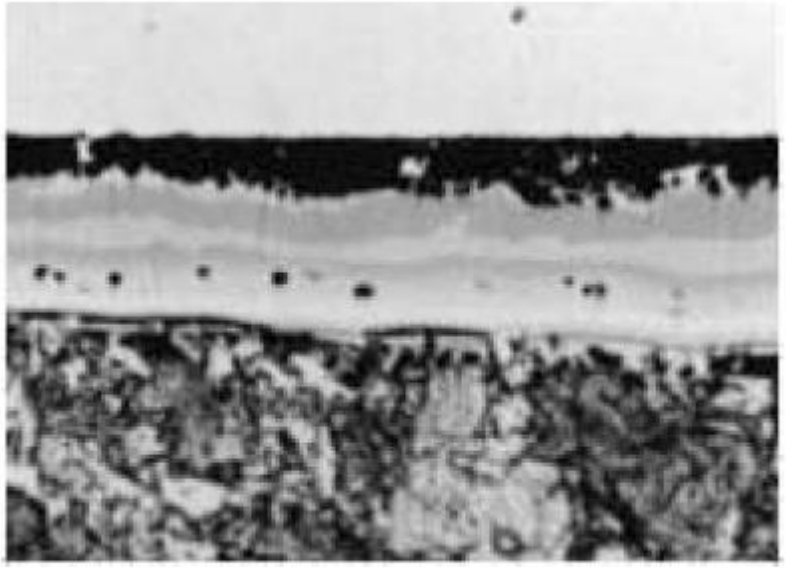
C	Mn	Cr	B
0.22	1.2	0.15	0.002

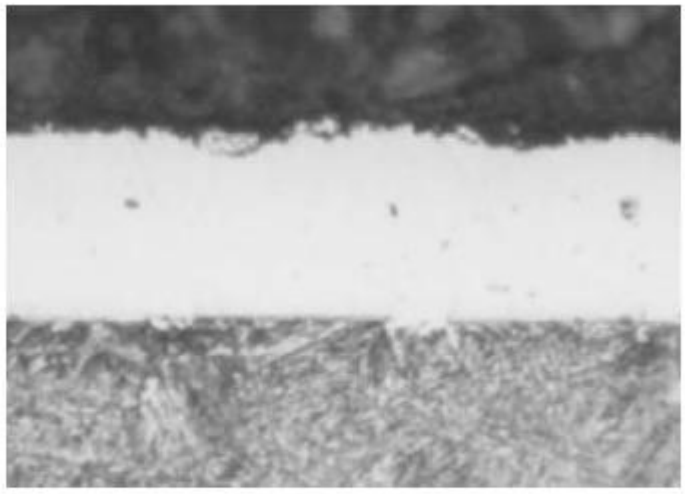
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

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	Id. at Table 1 and Table 2. "5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting

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	point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

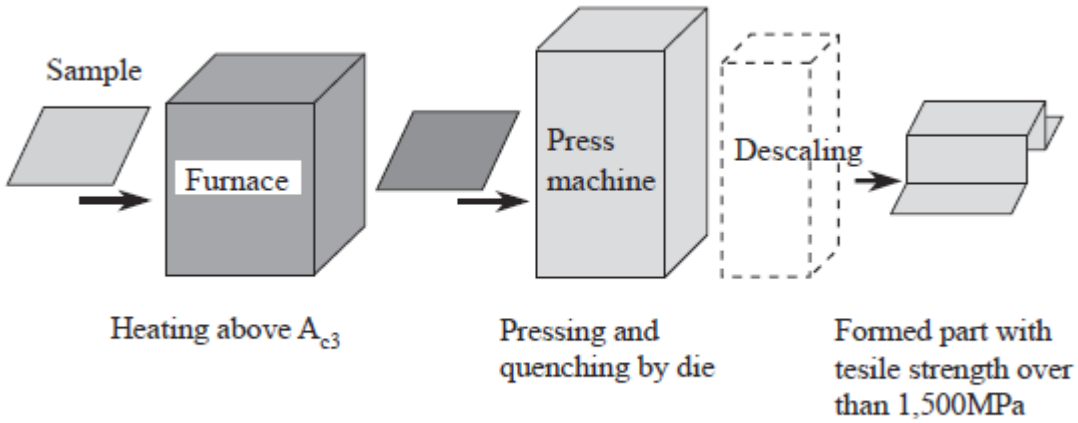
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 5	
[5] The precoated steel product as recited in claim 1 wherein the base steel comprises 20 ppm or less of sulfur.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the base steel comprises 20 ppm or less of sulfur. For example: "Abstract

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	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

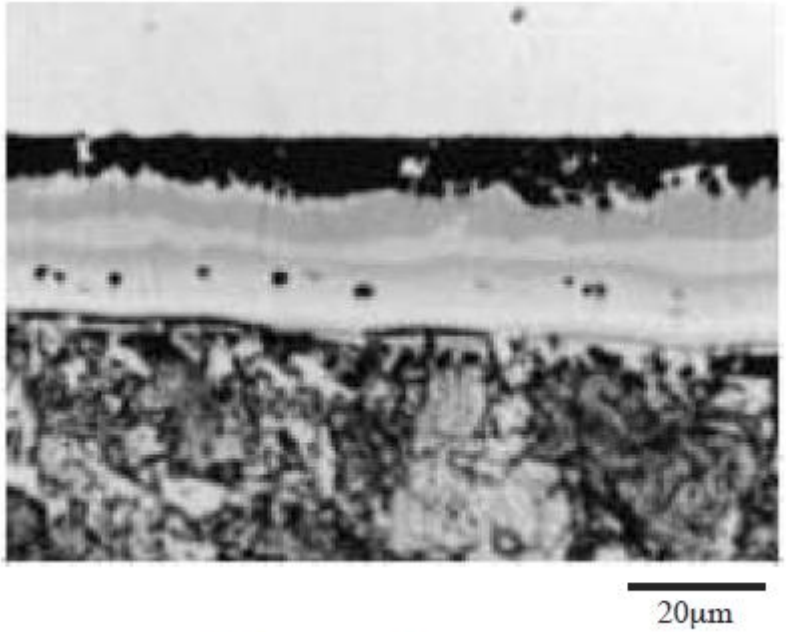
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
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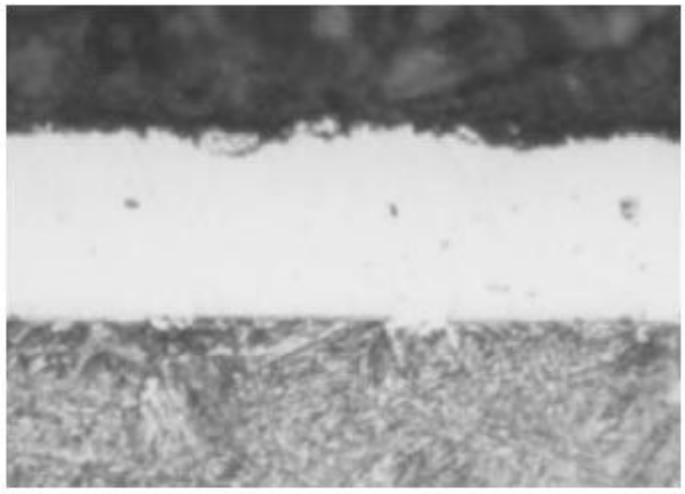
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

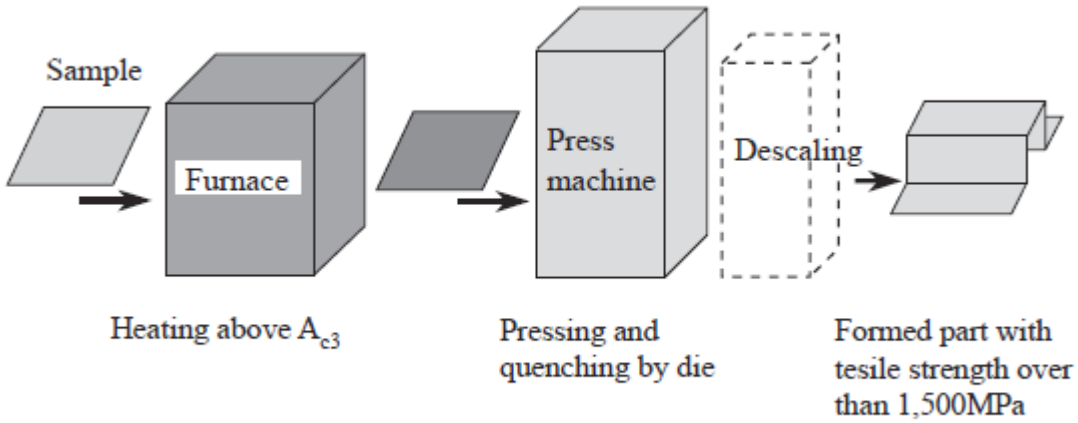
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 6	
[6] The precoated steel product as recited in claim 2 wherein the base steel comprises 20 ppm or less of sulfur.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 2 wherein the base steel comprises 20 ppm or less of sulfur. For example: "Abstract

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

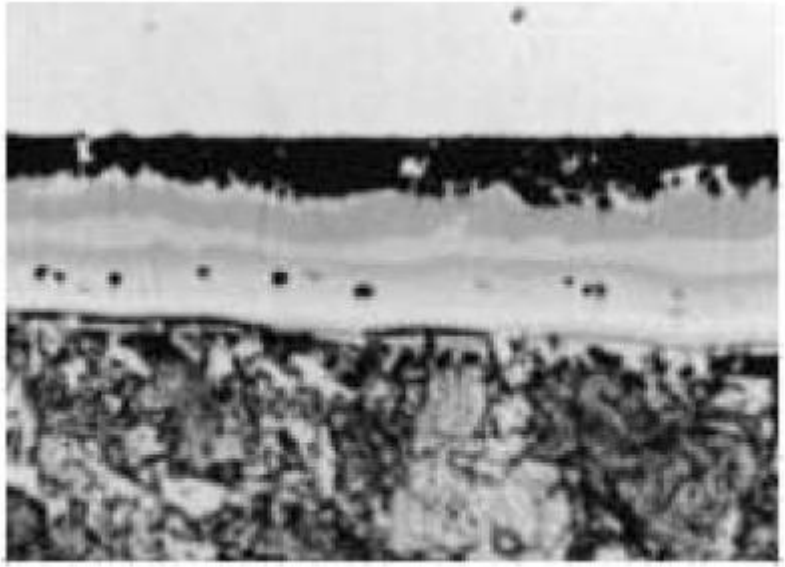
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

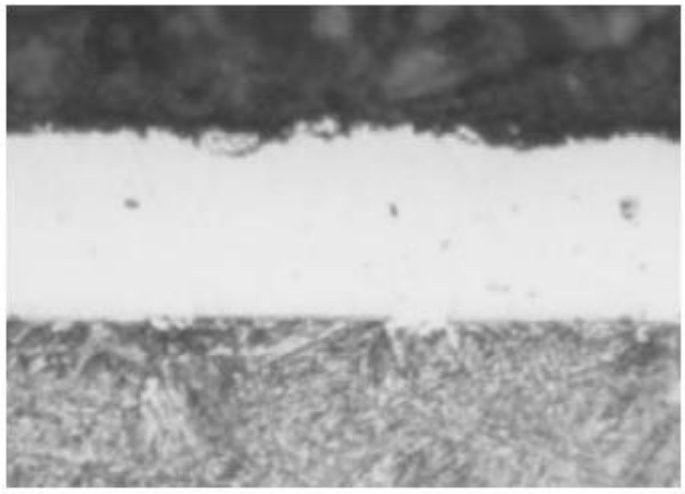
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

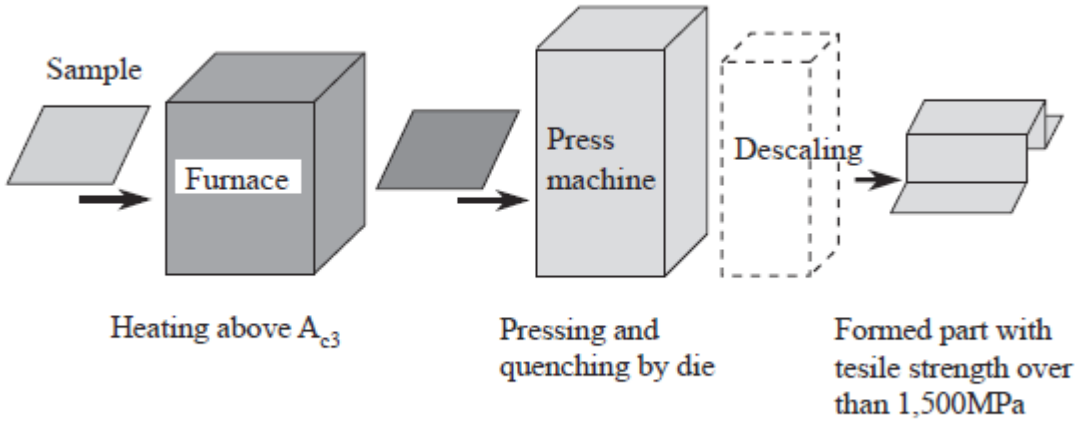
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 7	
[7] The precoated steel product as recited in claim 1 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42. For example:

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	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

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	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

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Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

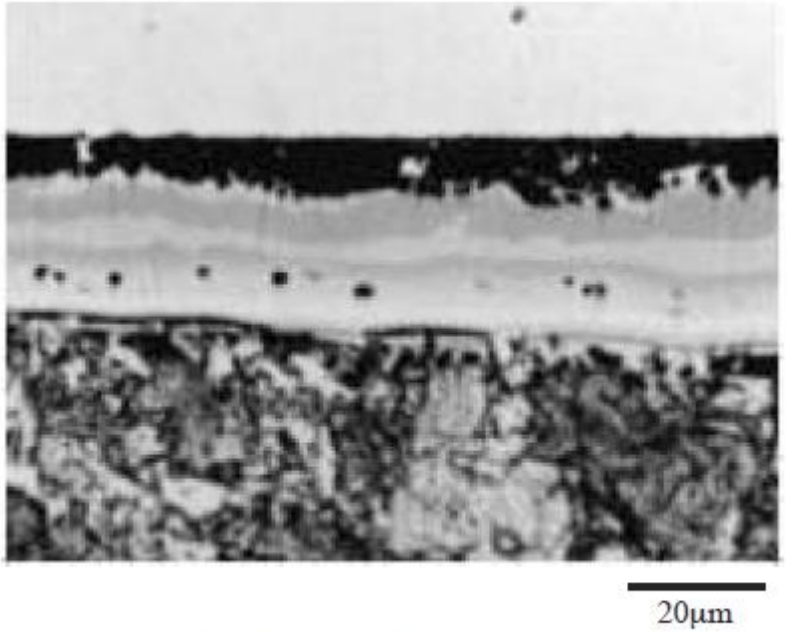
Table 2 Tensile properties before and after quenching

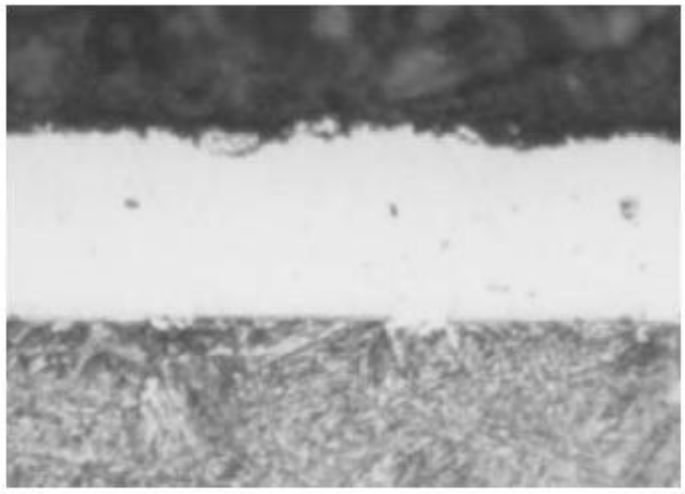
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

Id. at Table 1 and Table 2.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

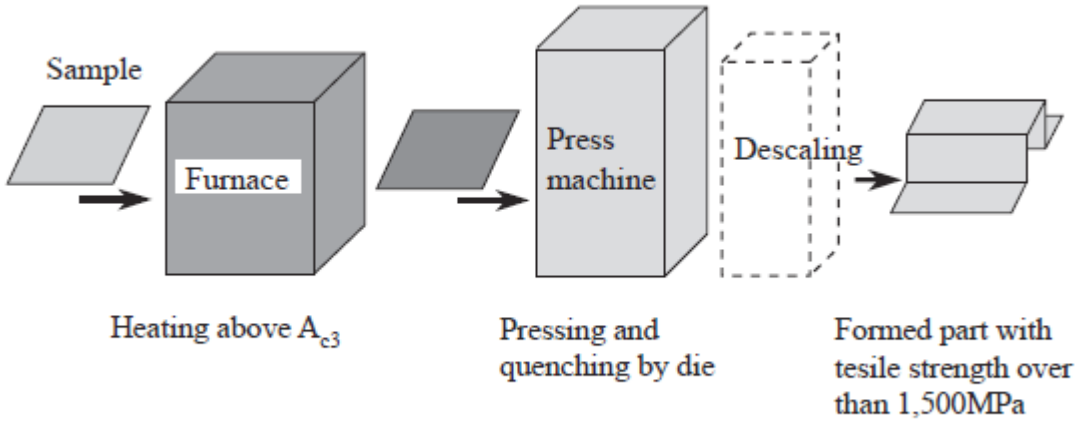
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 8	
[8] The precoated steel product as recited in claim 2 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 2 wherein a ratio of titanium to nitrogen in the base steel in weight % is in excess of 3.42. For example:

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

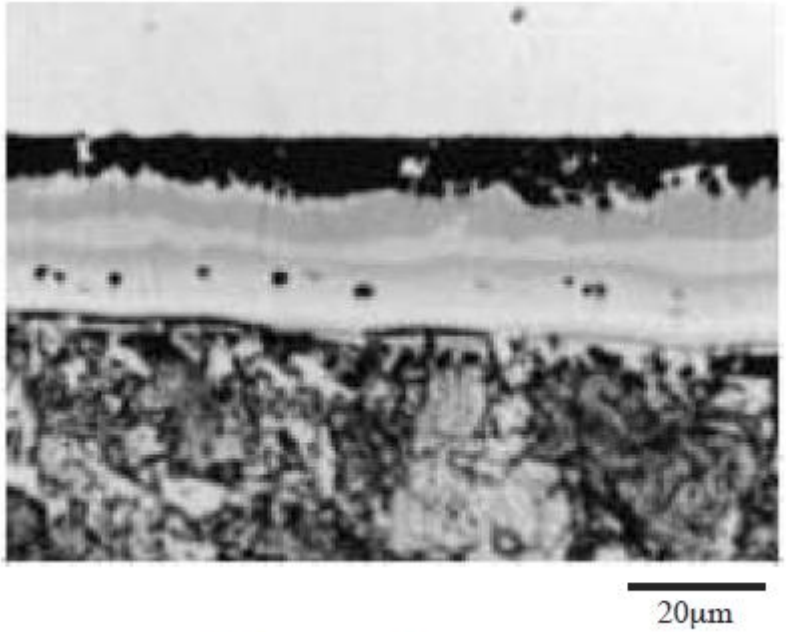
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

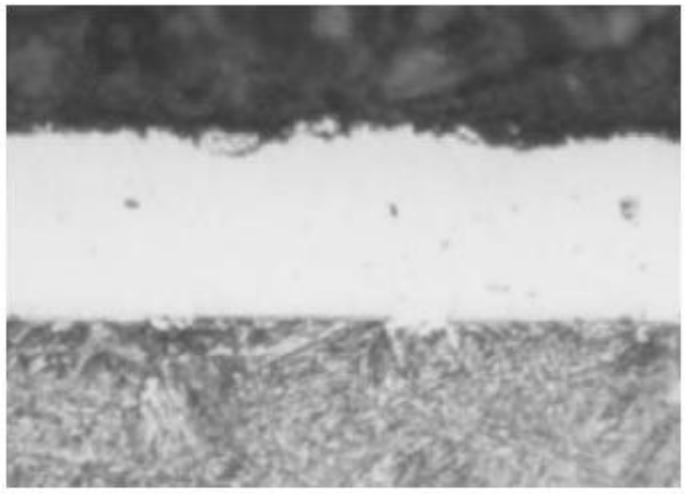
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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C: 0.22 | Mn: 1.2 | Cr: 0.15 | B: 0.002 **Table 2 Tensile properties before and after quenching** As coated: Yield strength (MPa) 394 | Tensile strenght (MPa) 615 | Elongation (%) 26 As formed: Yield strength (MPa) 1,280 | Tensile strenght (MPa) 1,530 | Elongation (%) 8 *Id.* at Table 1 and Table 2.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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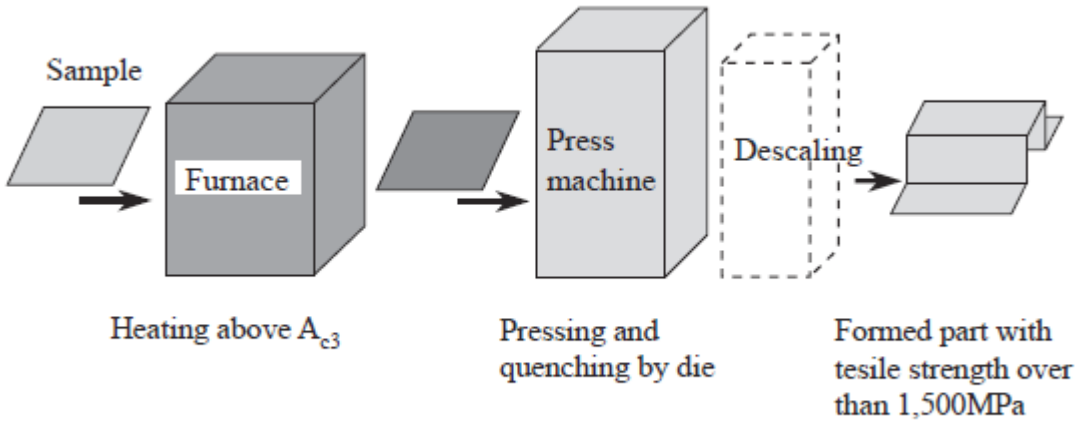
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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Claim 9	
[9] The precoated steel product as recited in claim 1 wherein the layer (a) has a thickness less than 15 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the layer (a) has a thickness less than 15 micrometers. For example: "Abstract

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

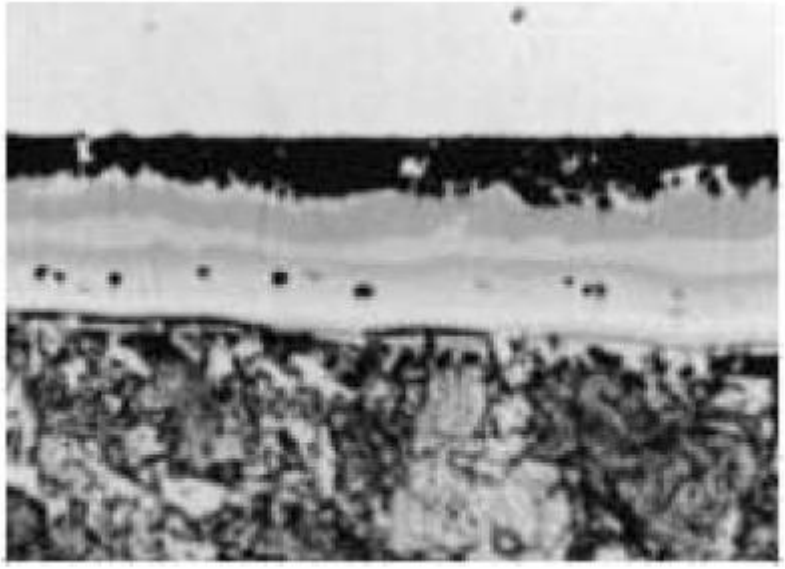
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

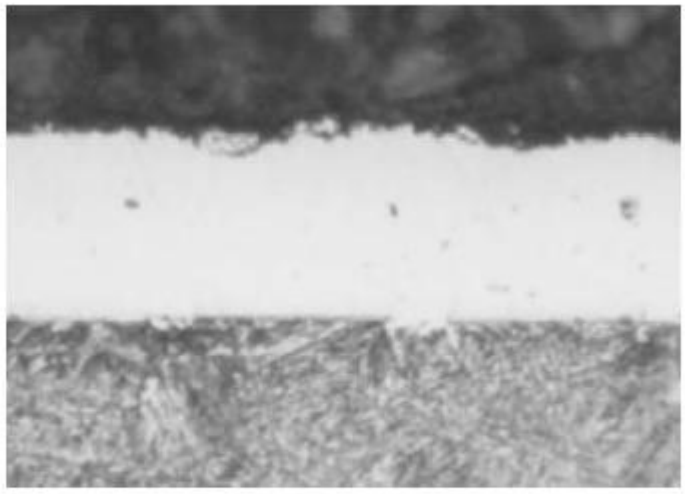
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

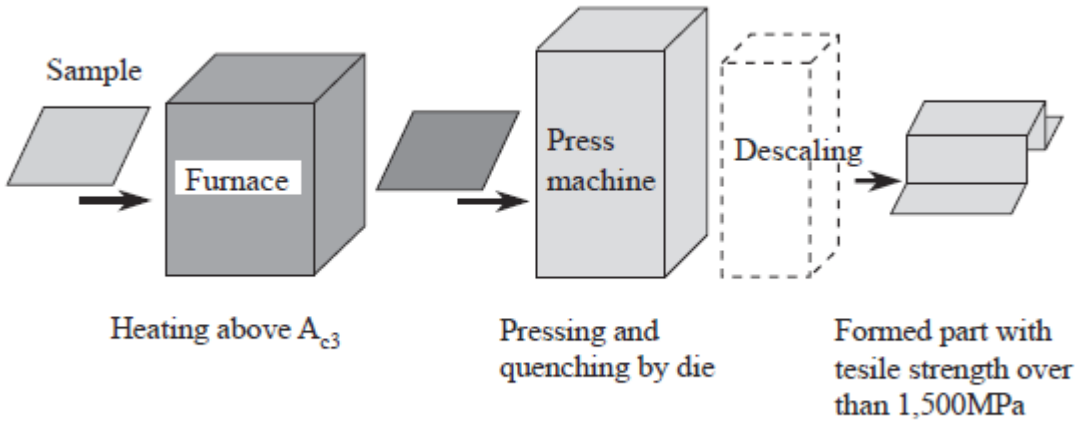
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 10	
[10] The precoated steel product as recited in claim 1 wherein the layer (a) has a thickness less than 10 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the layer (a) has a thickness less than 10 micrometers. For example: "Abstract

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	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

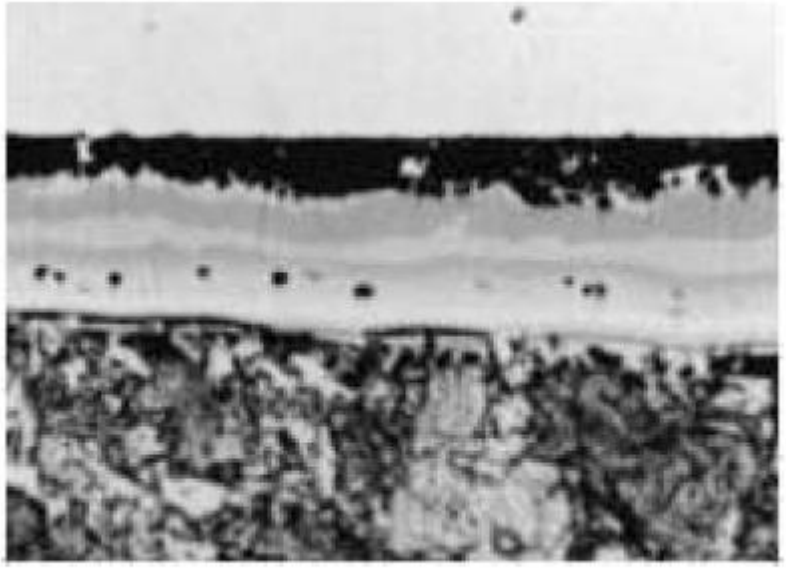
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

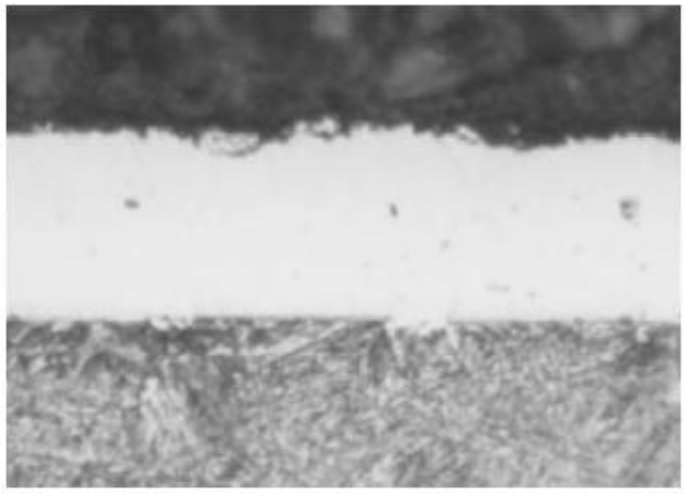
Id. at Table 1 and Table 2.

"5. Spot Weldability

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	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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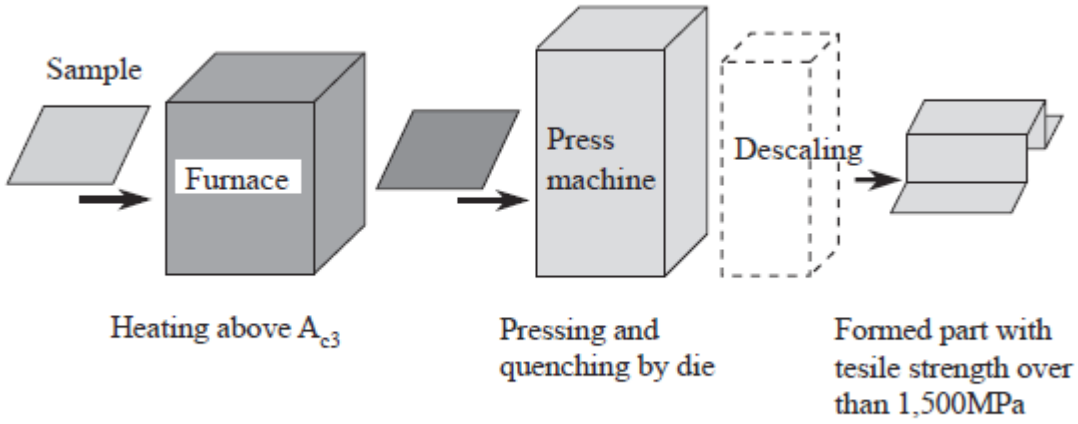
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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Claim 12	
[12] The precoated steel product as recited in claim 1 wherein the intermediate layer comprises the following components by weight based on total	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si. For example:

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weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this

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	method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers.

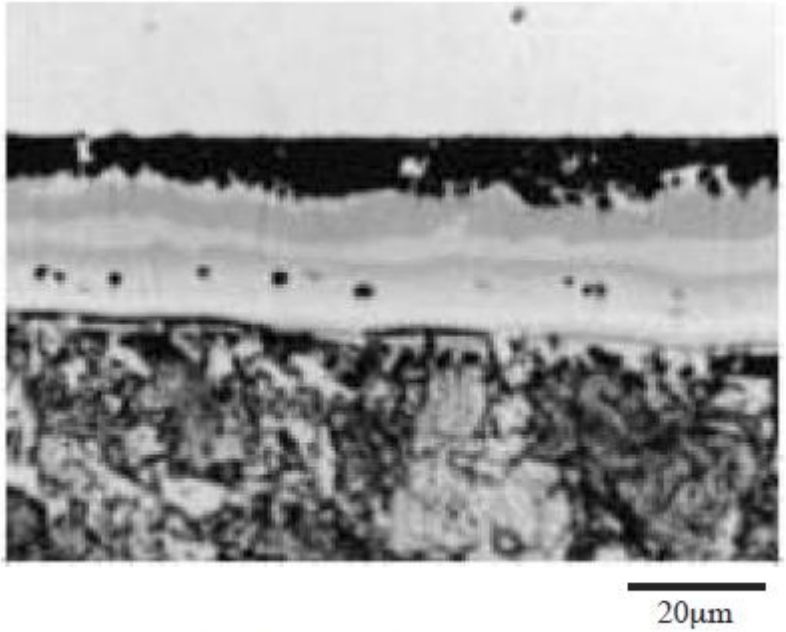
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	Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.

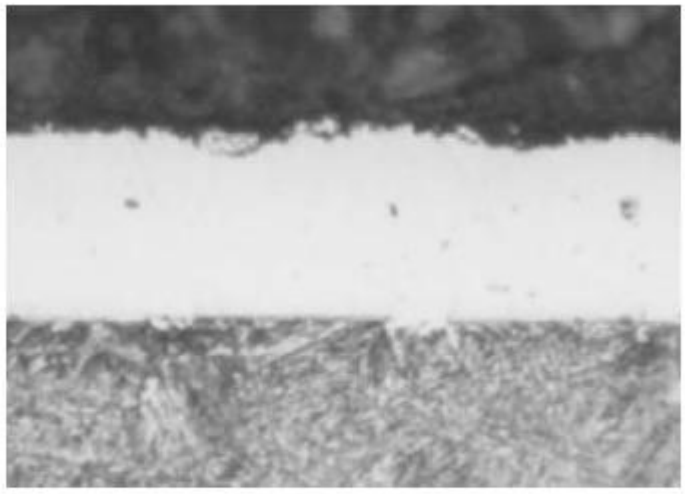
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<tr><th>'602 Patent</th><th>Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References</th></tr>
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Table 1 Chemical composition of steel sheets used
<table><tr><th>C</th><th>Mn</th><th>Cr</th><th>B</th></tr><tr><td>0.22</td><td>1.2</td><td>0.15</td><td>0.002</td></tr></table>
Table 2 Tensile properties before and after quenching
<table><tr><th></th><th>Yield strength (MPa)</th><th>Tensile strenght (MPa)</th><th>Elongation (%)</th></tr><tr><td>As coated</td><td>394</td><td>615</td><td>26</td></tr><tr><td>As formed</td><td>1,280</td><td>1,530</td><td>8</td></tr></table>
Id. at Table 1 and Table 2.</td></tr>
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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying

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	quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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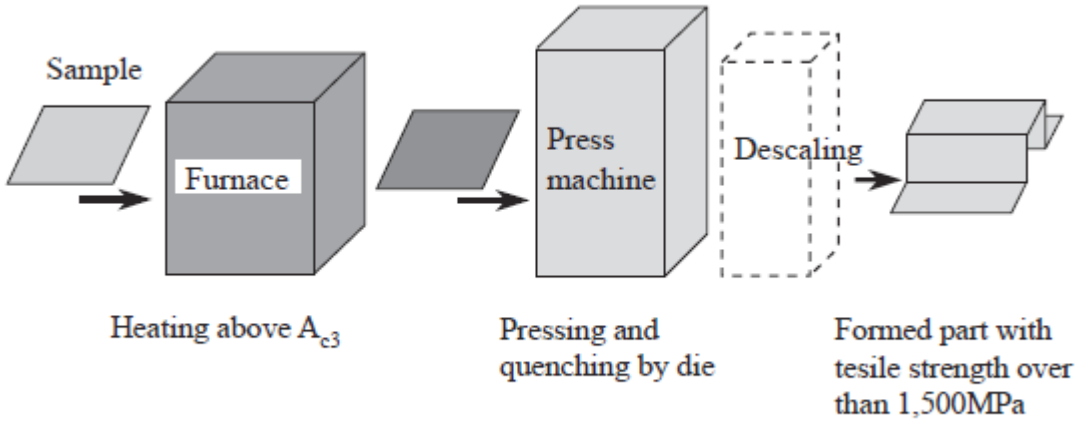
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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Claim 18	
[18] The precoated steel product as recited in claim 1 wherein the interdiffusion layer has a thickness of from 1 micron to 15 microns.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the interdiffusion layer has a thickness of from 1 micron to 15 microns. For example:

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	Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

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	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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C	Mn	Cr	B
0.22	1.2	0.15	0.002

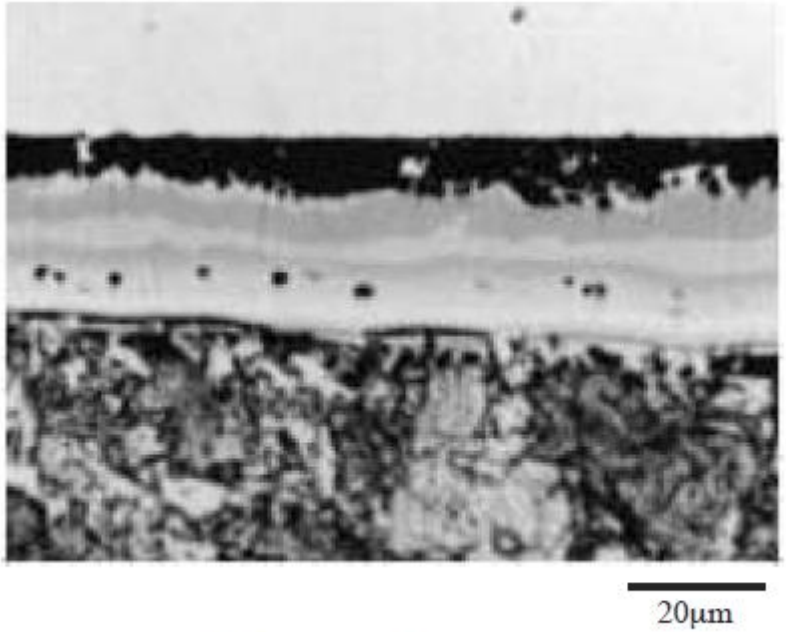
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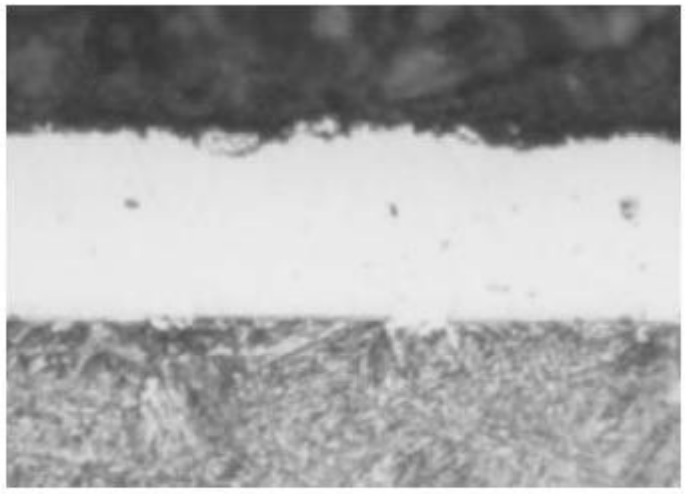
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

Id. at Table 1 and Table 2.

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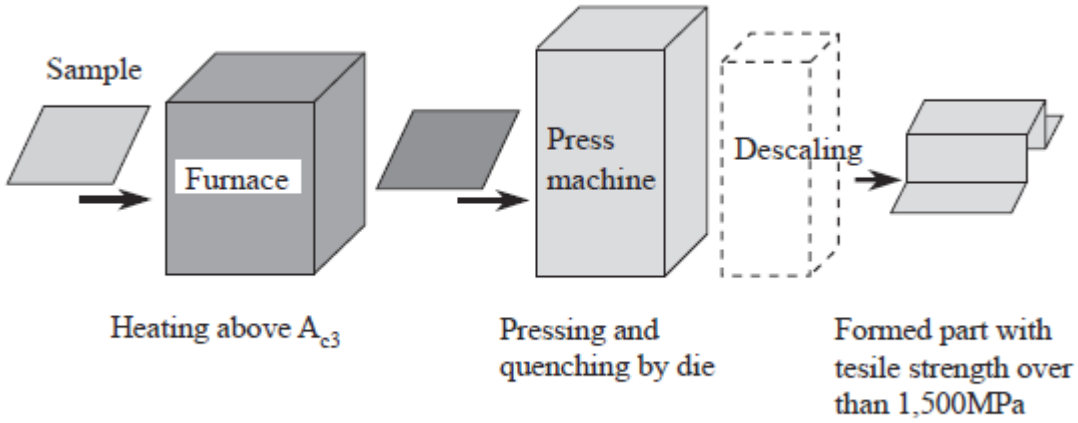
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[20] The precoated steel product as recited in claim 1 wherein the fourth mean iron composition is lower than the third mean iron composition.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 1 wherein the fourth mean iron composition is lower than the third mean iron composition. For example:

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	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

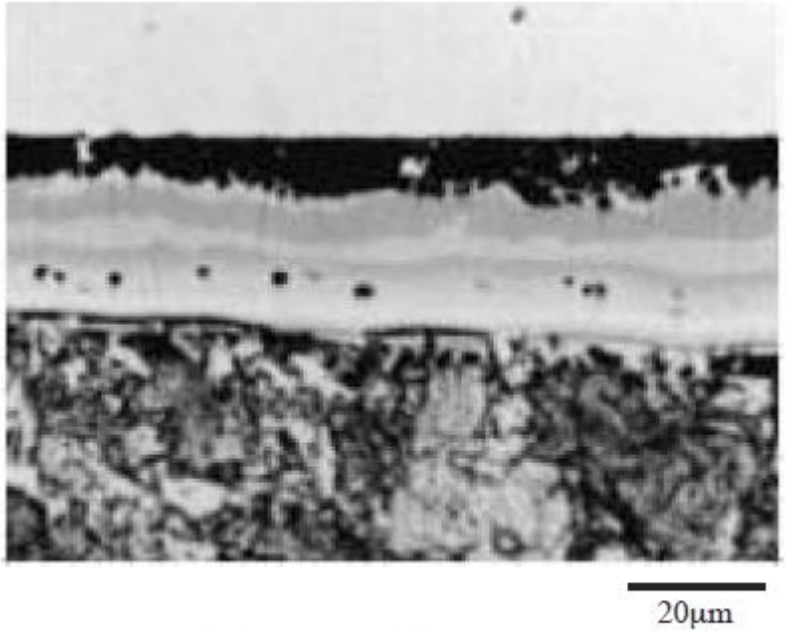
Table 2 Tensile properties before and after quenching

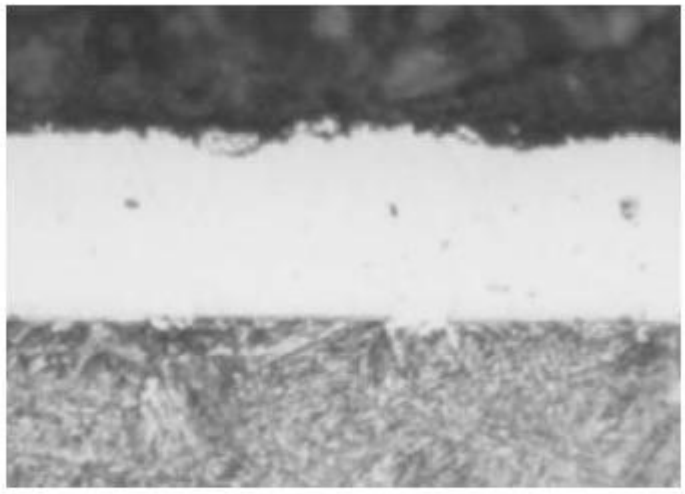
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

Id. at Table 1 and Table 2.

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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

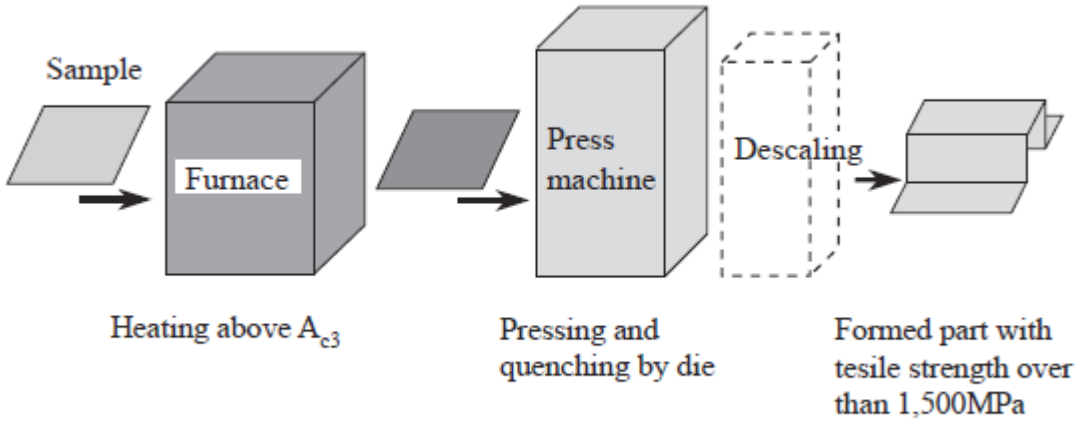
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 21	
[21pre] A precoated steel product comprising:	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. To the extent the preamble of claim 1 is found to be limiting, Suehiro II and/or one or more prior art references disclose a precoated steel product comprising. For example:

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	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

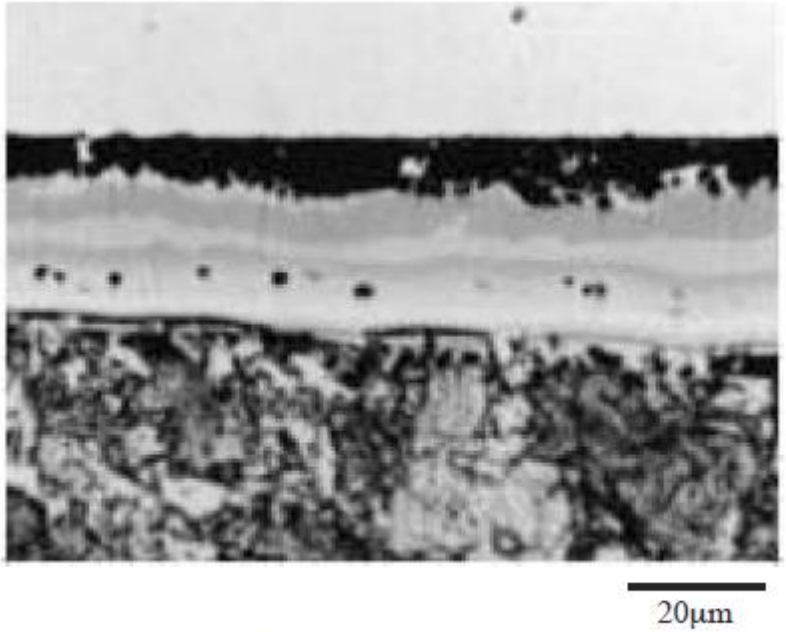
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

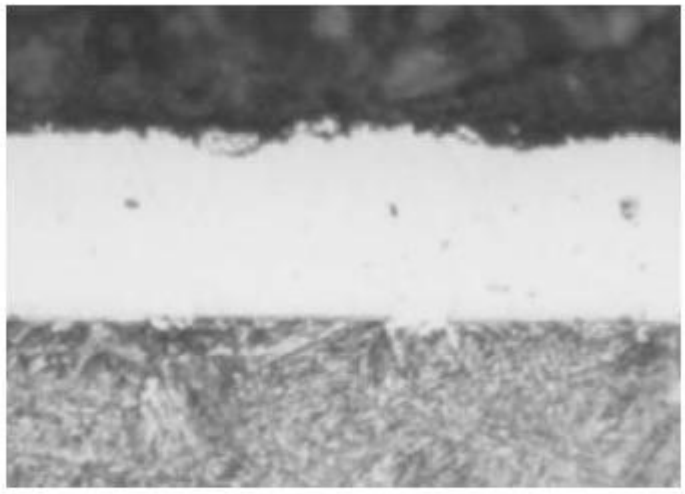
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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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	Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C Mn Cr B 0.22 1.2 0.15 0.002 **Table 2 Tensile properties before and after quenching** Yield strength (MPa) / Tensile strenght (MPa) / Elongation (%) As coated: 394 / 615 / 26 As formed: 1,280 / 1,530 / 8 *Id.* at Table 1 and Table 2.

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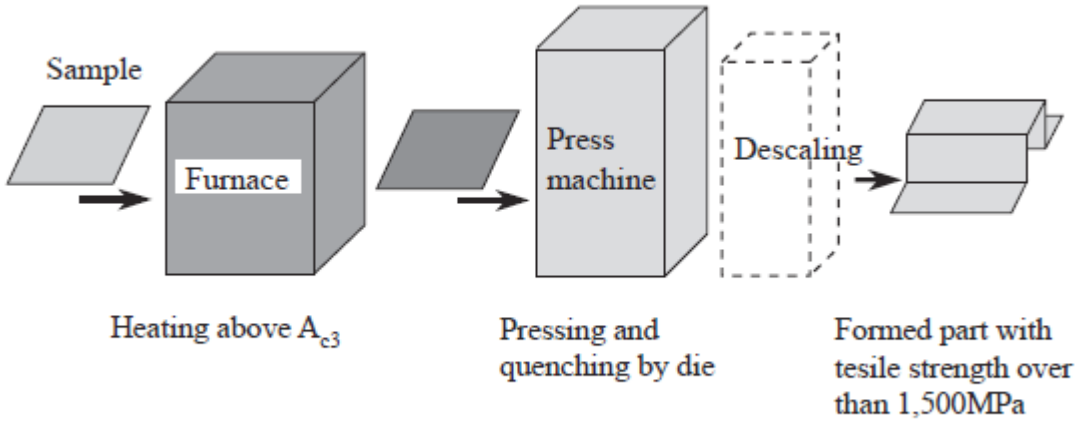
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[21a] a strip of base steel having a first side and a second side; and	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose a strip of base steel having a first side and a second side. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

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	receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." Suehiro II at Abstract. "1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature.

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	Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. "2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.
[21b] a coating on at least one of the first side of the strip of base steel and the	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with.

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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:	Suehiro II and/or one or more prior art references disclose 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. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however,

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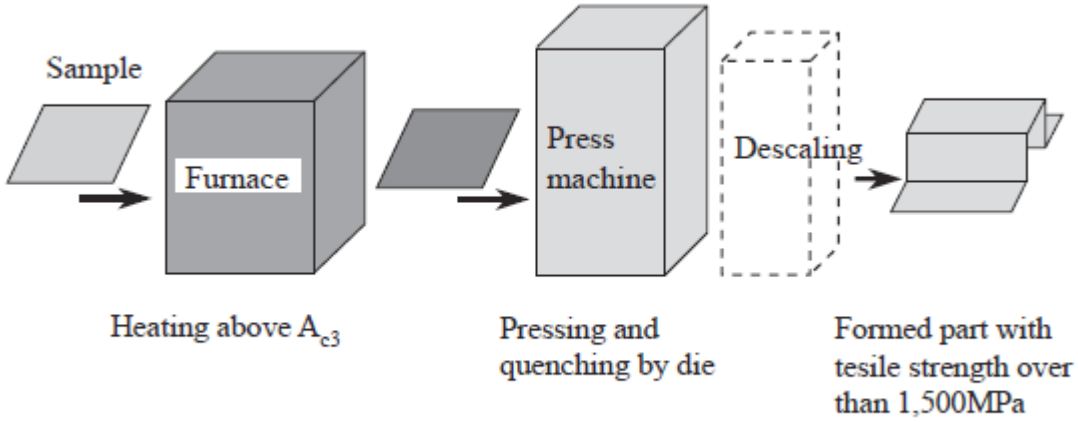


Fig. 1 Schematic illustration of hot forming process

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Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

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Table 1 Chemical composition of steel sheets used

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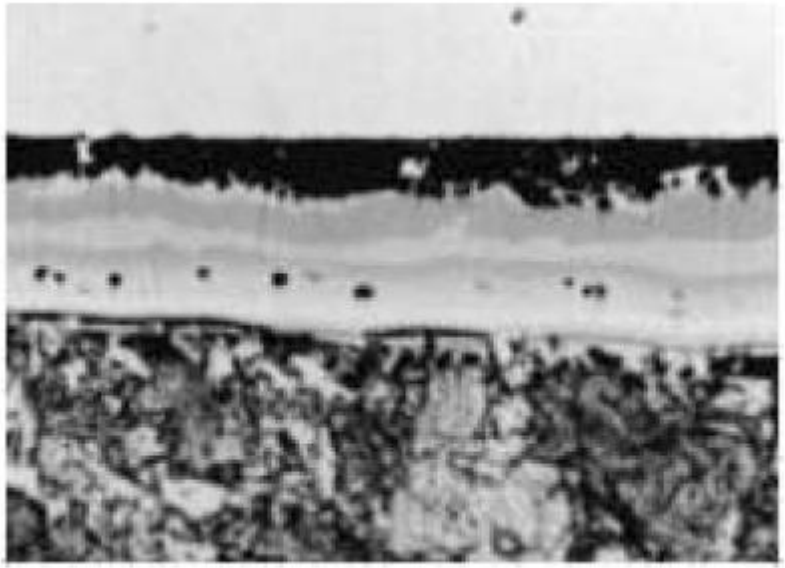
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
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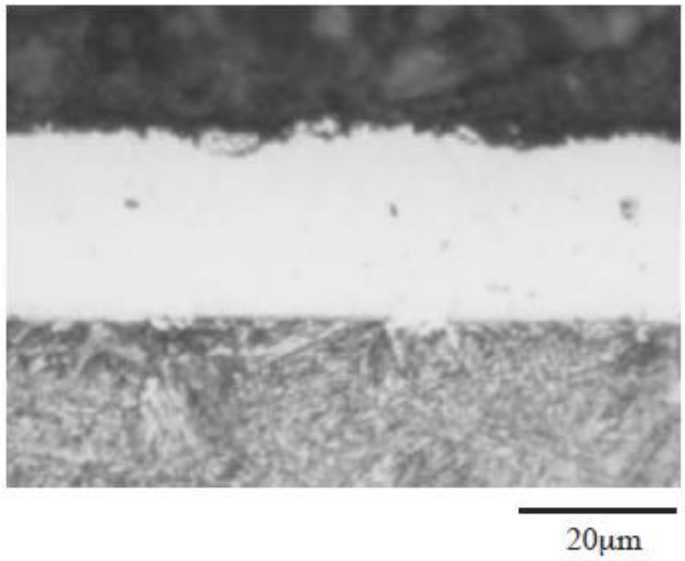
Id. at Table 1 and Table 2.

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Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current

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	and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors

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	superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

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	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

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	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

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	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[21c] (a) an interdiffusion layer having a first mean iron composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (a) an interdiffusion layer having a first mean iron composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the

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	into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be

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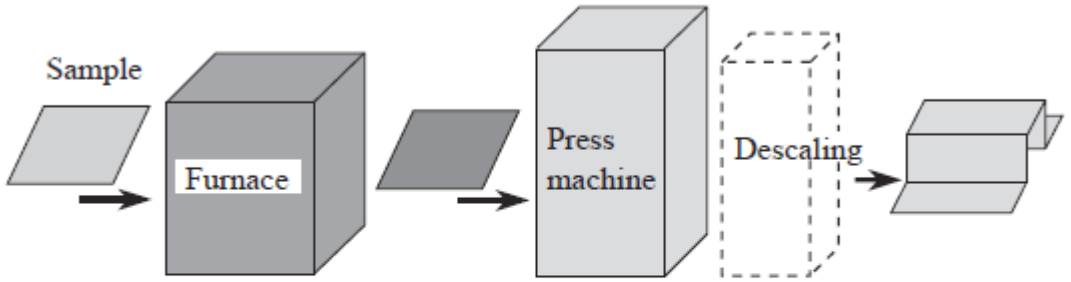


Fig. 1 Schematic illustration of hot forming process

Id. at Fig. 1.

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Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to

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Table 1 Chemical composition of steel sheets used

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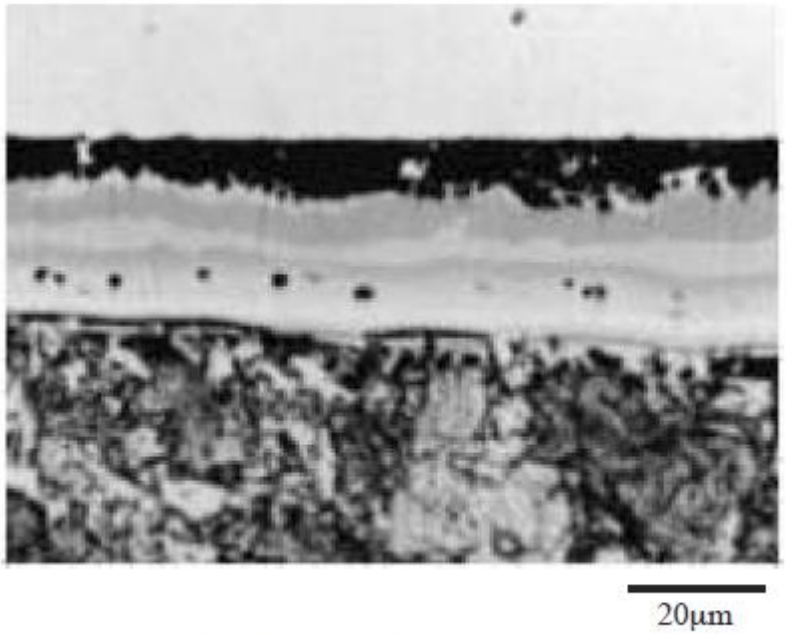
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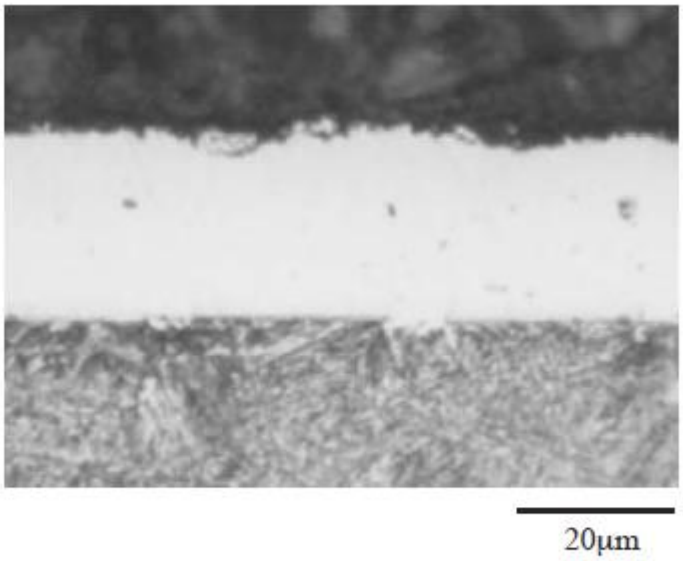
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	develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C

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	calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

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	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

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	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

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	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[21d] (b) an intermediate layer having a second mean iron composition different from the first mean iron composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (b) an intermediate layer having a second mean iron composition different from the first mean iron composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the

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	stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered

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	into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be

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	deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

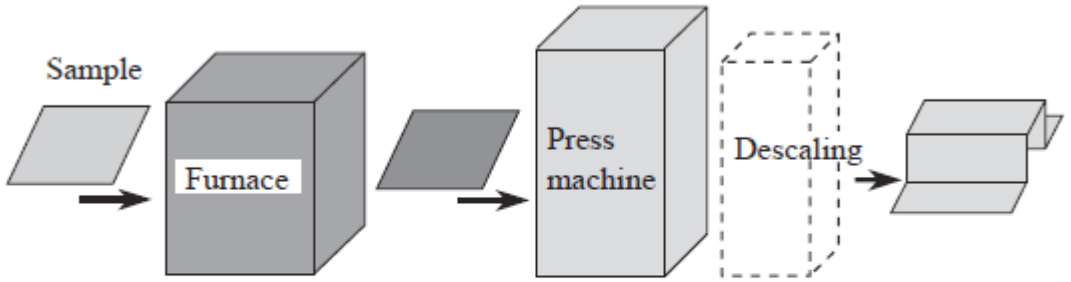


Fig. 1 Schematic illustration of hot forming process

Id. at Fig. 1.

"3. Material
Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to

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	160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

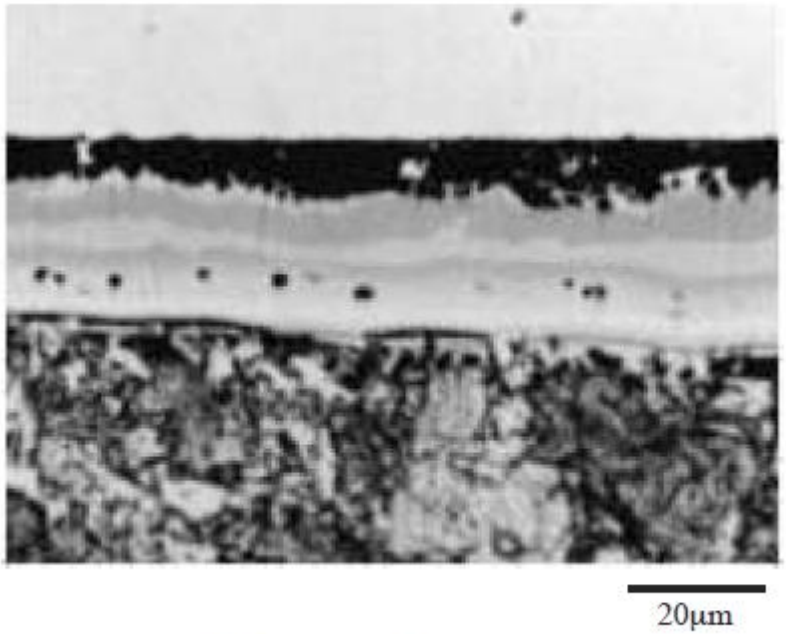
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
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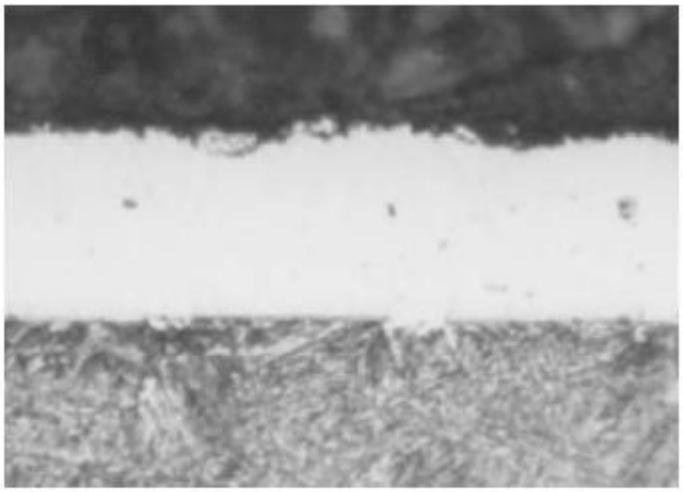
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz)

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	and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer

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	develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C

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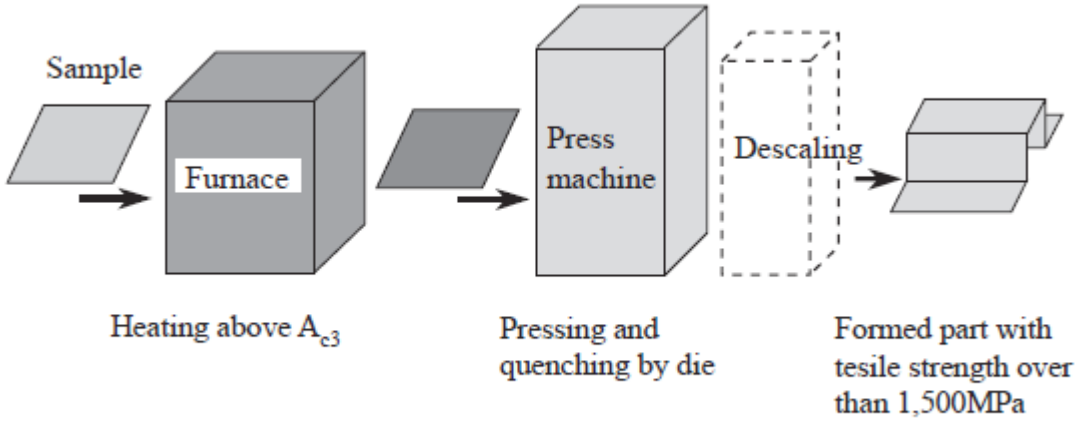
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[21e] (c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition, and	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (c) an intermetallic layer having a third mean iron composition different from the first and second mean iron compositions, the third mean iron concentration being higher than the second mean iron composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in

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	Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for

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Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
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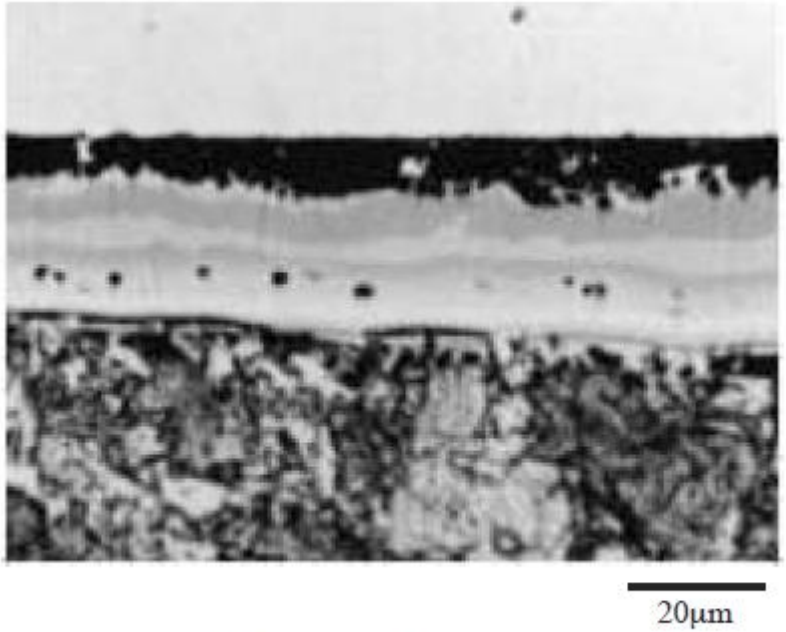
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
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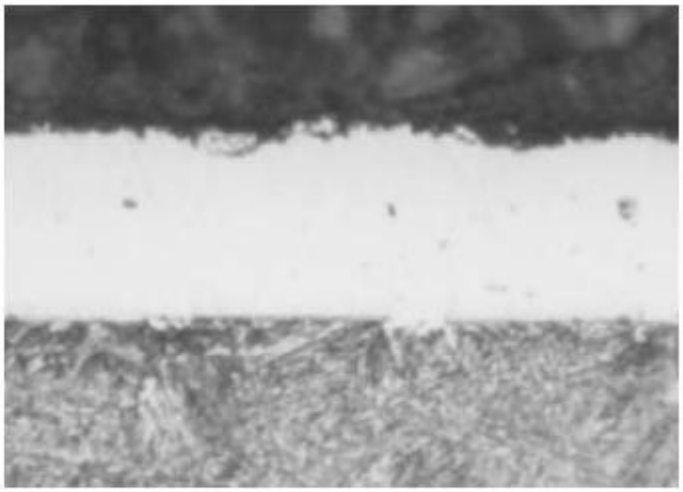
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Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes

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	of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness

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	direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12.

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	"Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

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	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

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	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

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	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[21f] (d) a superficial layer having a fourth mean iron composition different from the first, second and third mean iron compositions,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (d) a superficial layer having a fourth mean iron composition different from the first, second and third mean iron compositions. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the

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	stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered

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	into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

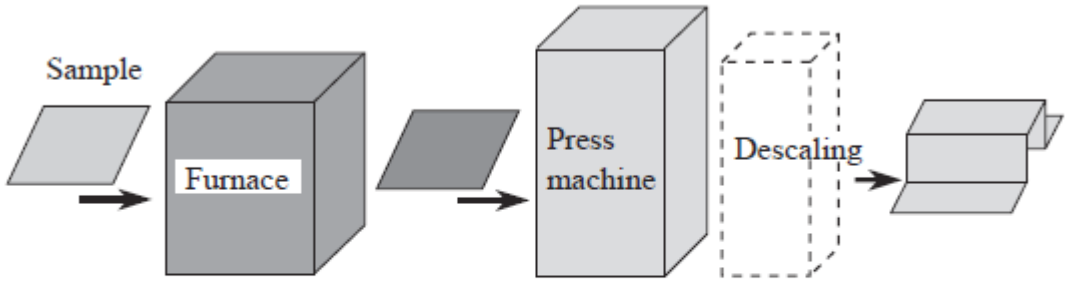


Fig. 1 Schematic illustration of hot forming process

Id. at Fig. 1.

"3. Material
Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to

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	160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

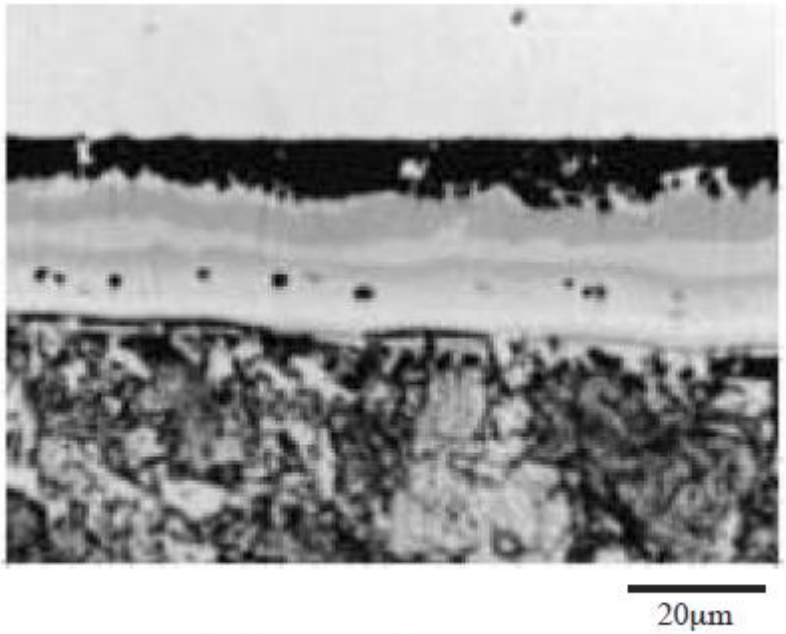
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

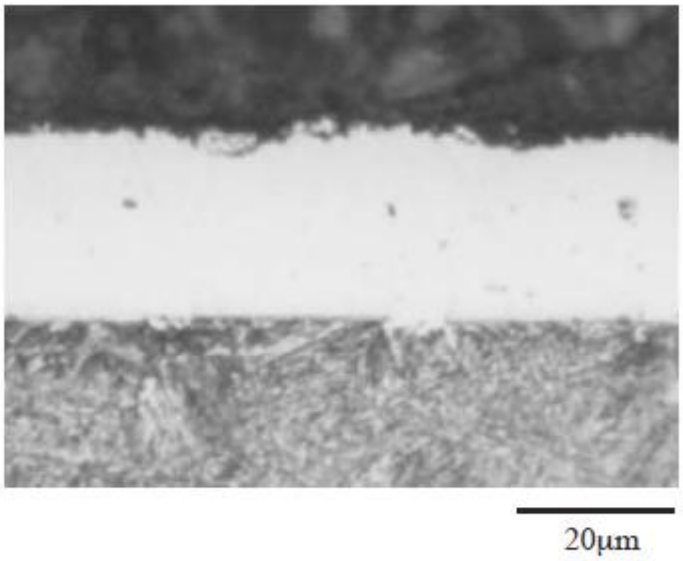
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz)

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	and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer

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	develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C

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	calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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[21g] wherein the coating has a thickness greater than 30 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose] wherein the coating has a thickness greater than 30 micrometers. For example: Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the

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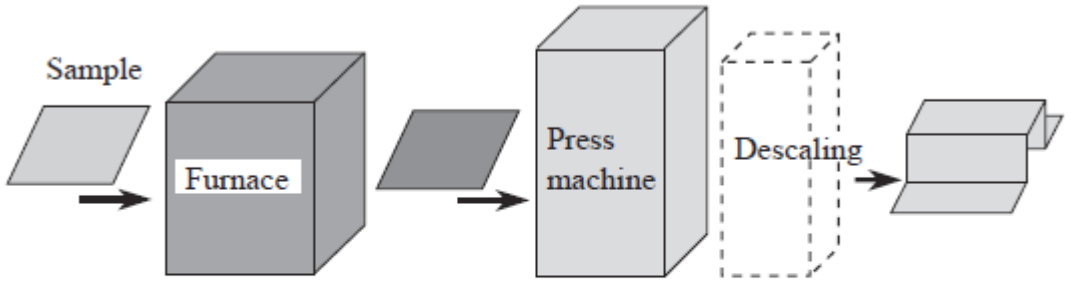


Fig. 1 Schematic illustration of hot forming process

Id. at Fig. 1.

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Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to

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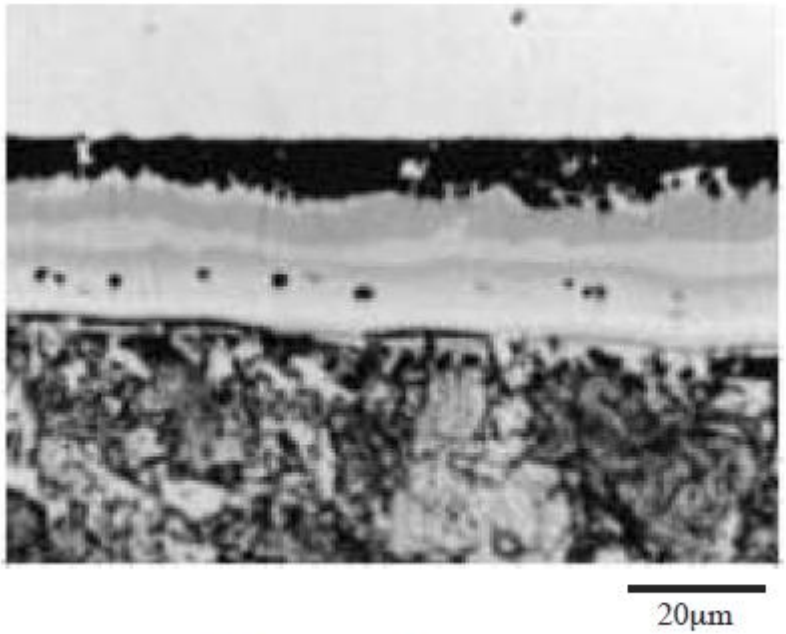
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

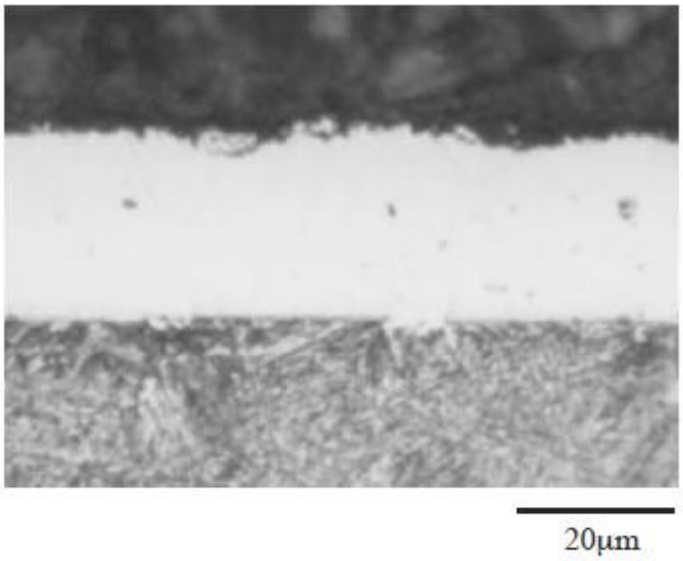
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz)

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	and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer

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	develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C

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	calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

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	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

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	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 22	
[22] The precoated steel product as recited in claim 21 wherein the fourth mean iron composition is lower than the third mean iron composition.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 21 wherein the fourth mean iron composition is lower than the third mean iron composition. For example: Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without

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	phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing

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	properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling,

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	or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

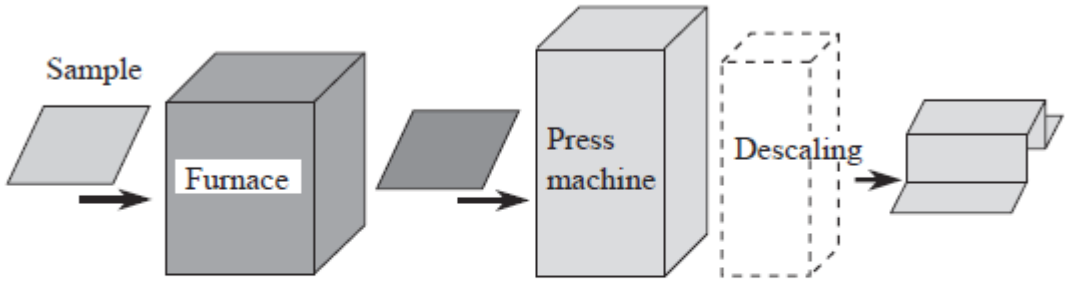


Fig. 1 Schematic illustration of hot forming process

Id. at Fig. 1.

"3. Material
Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The

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properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

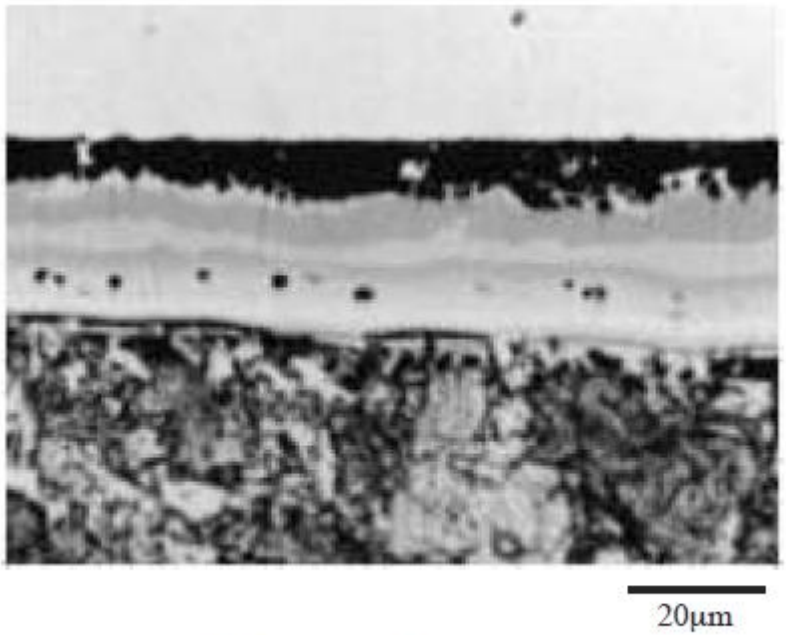
Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

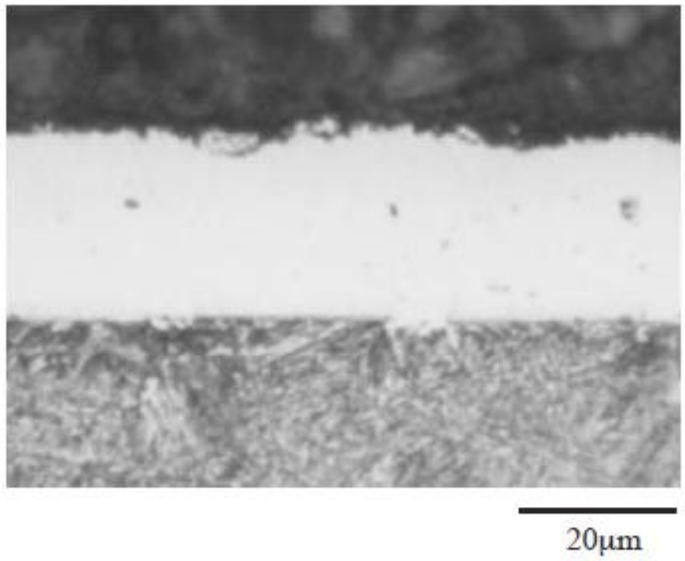
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled

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	steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations

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	of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.  **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12.

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	"Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."

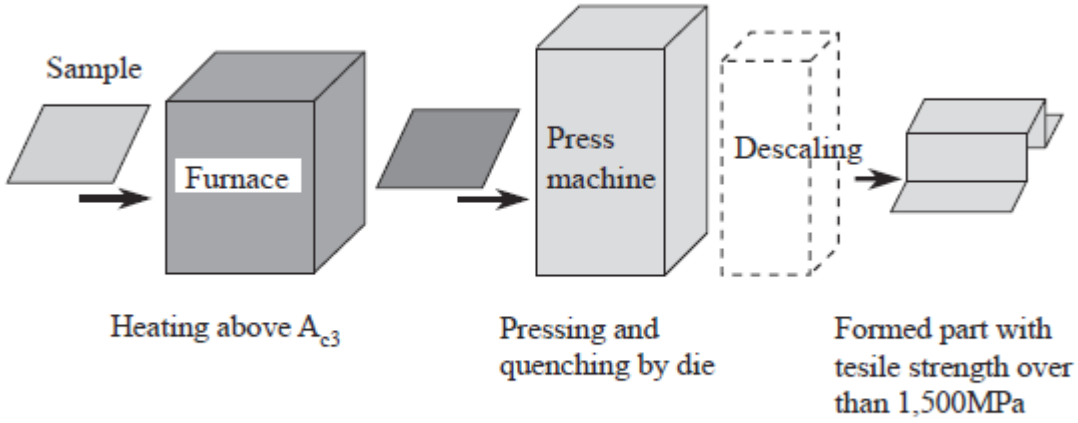
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	 **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as

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	seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When

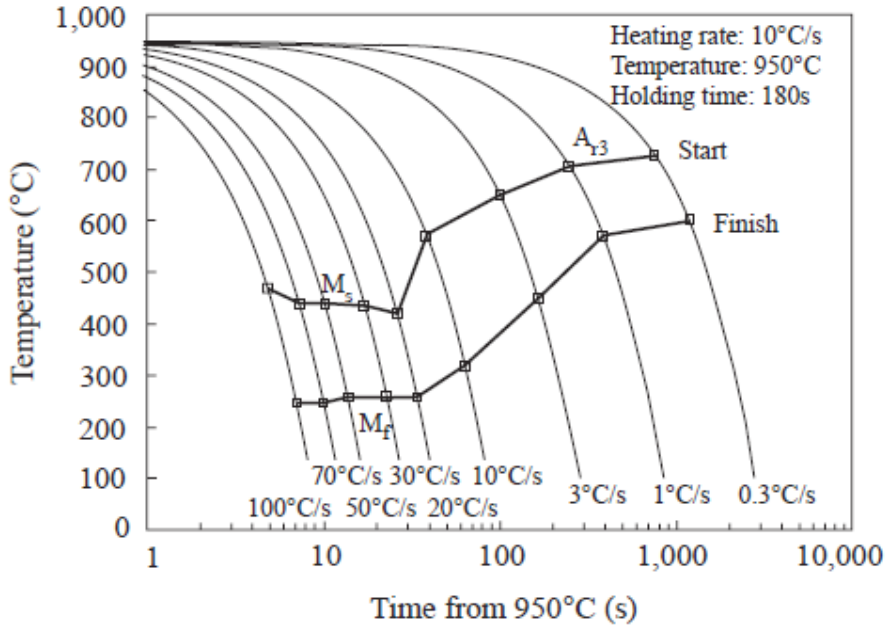
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming.

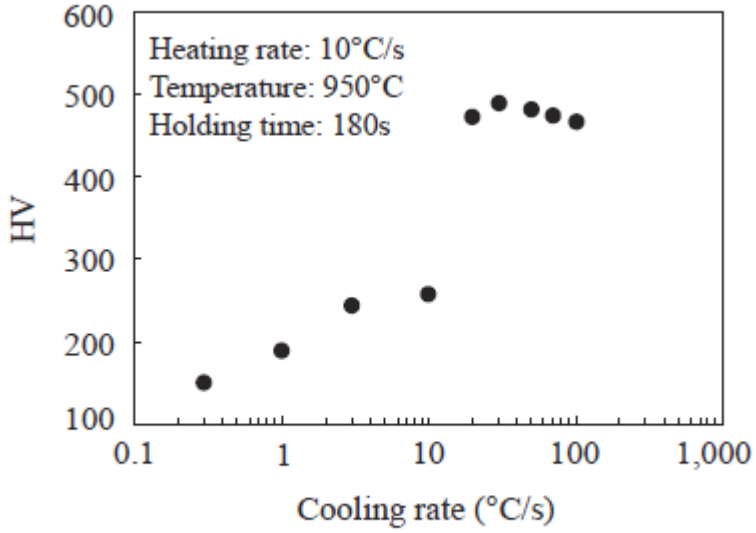
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 24	
[24pre] A precoated steel product comprising:	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. To the extent the preamble of claim 1 is found to be limiting, Surhiro II and/or one or more prior art references disclose a precoated steel product. For example: "Properties of Aluminum-coated Steels for Hot-forming." Suehiro II at Title. "Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without

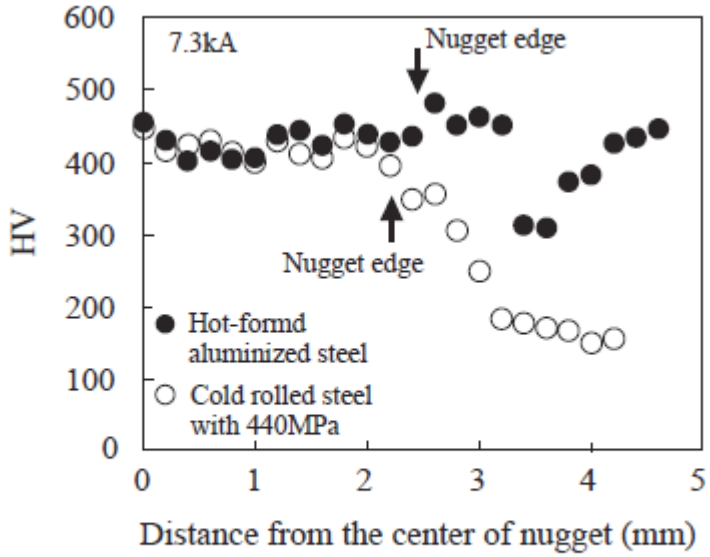
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))" *Id.* at Abstract." "In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. "2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet

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	is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently." *Id.* at 16.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1 " 3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical

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	composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. "From Figs. 3 and 4 and the results of the tests at other heating temperatures, it is understood that a sufficient hardness is obtained as far as the cooling rate during the hot forming is equal to or higher than 30°C/s. However, in actual practice, the cooling rate during the transfer from the heating furnace to the pressing machine and the time period before the commencement of the pressing work is close to that in the air. When a steel sheet with thickness of about 1.4 mm is cooled in the normal atmosphere, the cooling rate is 10 to 15°C/s. It is clear from Figs. 3 and 4 that the strength of the steel sheet is decreased when it is cooled to 600°C or lower at this cooling rate. To cool a steel sheet from 950 to 600°C it takes 23 to 35 s; therefore, a material steel sheet can be quenched if its cooling with the pressing dies is commenced within 23 s after it is extracted from a heating furnace. It should be noted that this time allowance changes depending on heating conditions, the atmosphere during the cooling and surrounding environment and for this reason, it has to be determined on the basis of actual work environment." *Id.* at 18.

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	 **Fig. 3 CCT curves** *Id.* at Fig 3.

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	 **Fig. 4 Influence of cooling rate on hardness** *Id.* at Fig 4.

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	 **Fig. 10 Hardness distribution near spot-welded portion** *Id.* at Fig. 10.

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Table 3 Evaluation of paint adhesion

	Surface preparation	Primary adhesion*	Secondary adhesion**
Hot-formed aluminized steel	Phosphated	100/100	100/100
Hot-formed aluminized steel	Degreased	100/100	100/100
Galvannealed steel	Phosphated	100/100	100/100
Steel	Phosphated	100/100	100/100

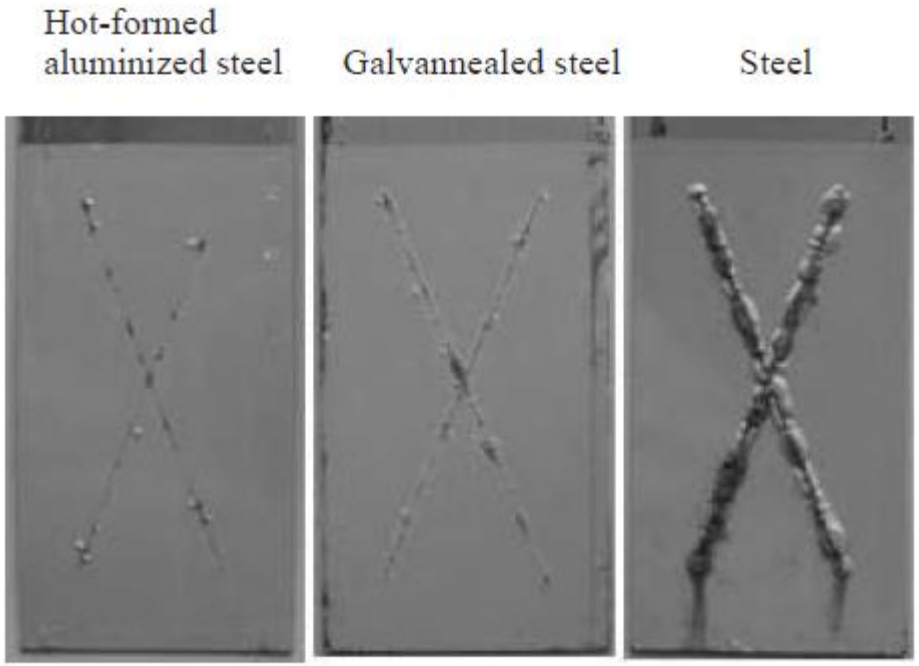
*Primary adhesion test: 100 grid cross-cutting by 2mm and taping after painting

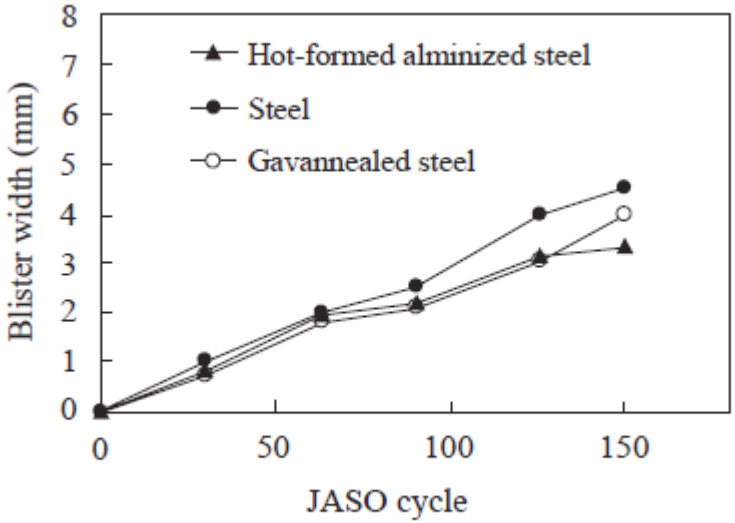
**Secondary test: dipping at 40°C water for 10 days and cross-cutting and taping

Id. at Table 3.

"6.2 Paintability and corrosion resistance after painting
Steel sheets are used an automobile components after painting by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 µm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id.* at 20.

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	 **Fig. 17 Appearance of samples after 50 days of CCT according to JASO** *Id.* at Fig. 17.

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	 **Fig. 18 Change of paint blister width during CCT according to JASO** *Id.* at Fig. 18.

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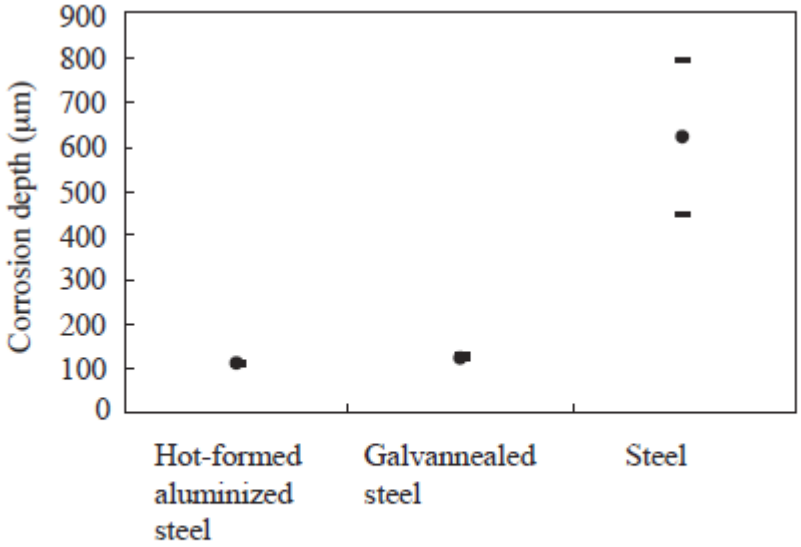


Fig. 19 Change of corrosion depth after 50 days of CCT according to JASO

Id. at Fig. 19.

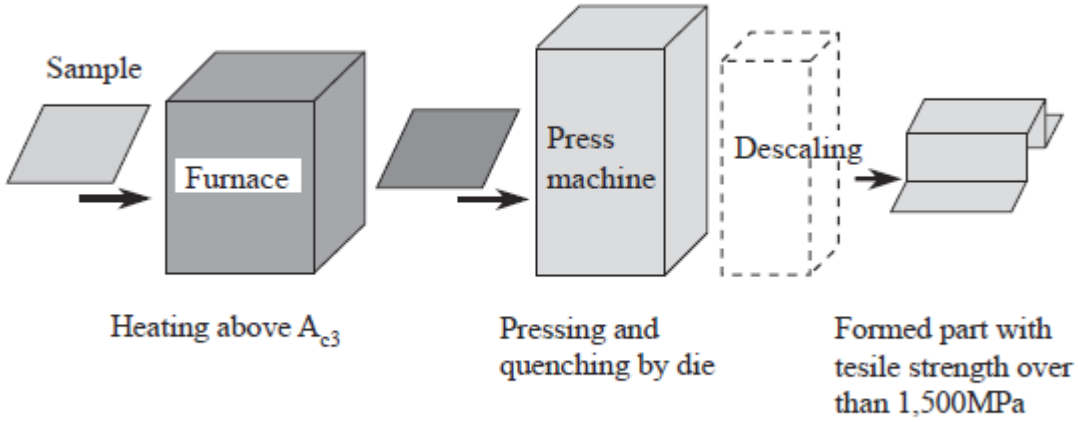
" 6.3 Corrosion resistance of spot-welded portion
Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test

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	(SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id.* at 21. " 7. Summary The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id.* at 21.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
[24a] a strip of base steel having a first side and a second side; and	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose a strip of base steel having a first side and a second side. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." Suehiro II at Abstract. "1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures

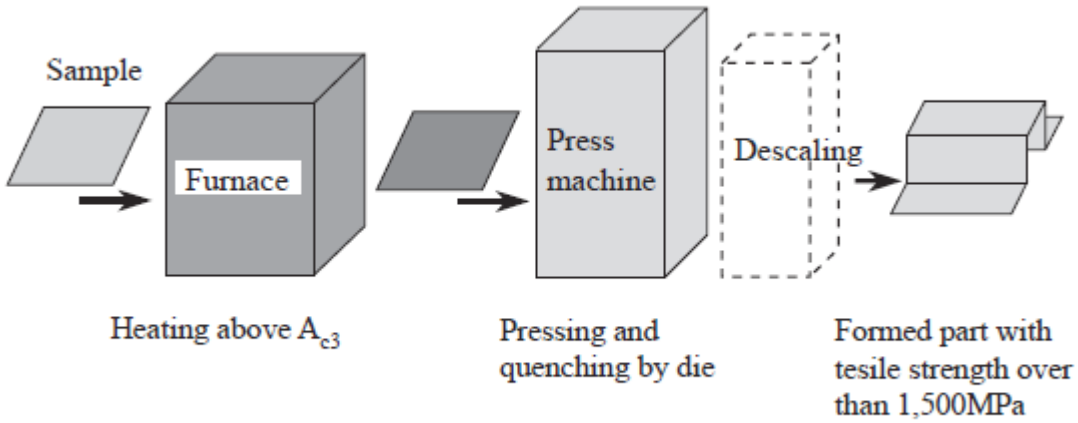
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. "2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.

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	 **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1.
[24b] 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:	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose 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. For example: "Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than

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	1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References

the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

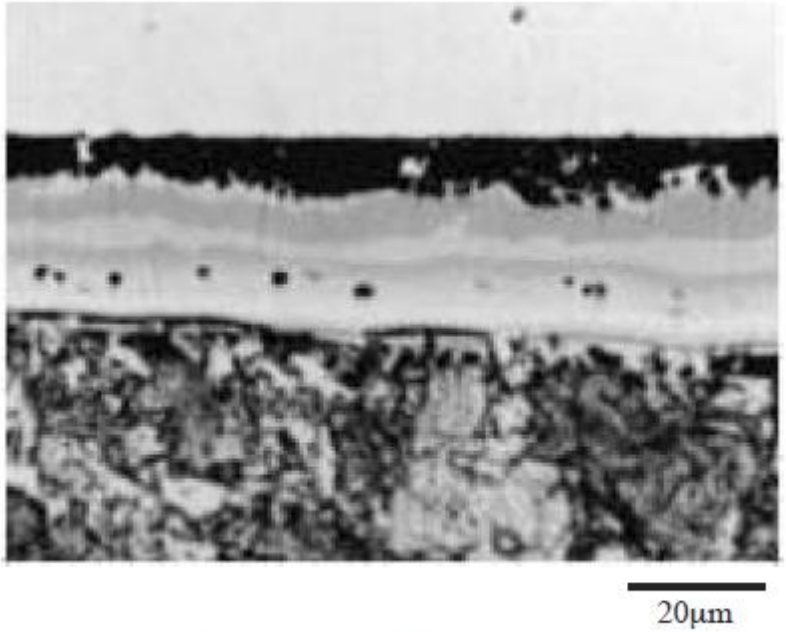
Id. at Table 1 and Table 2.

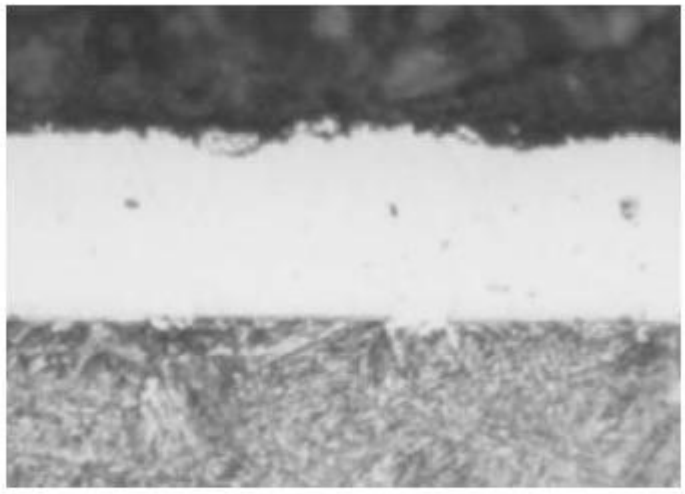
"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then

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	quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19.

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	"Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

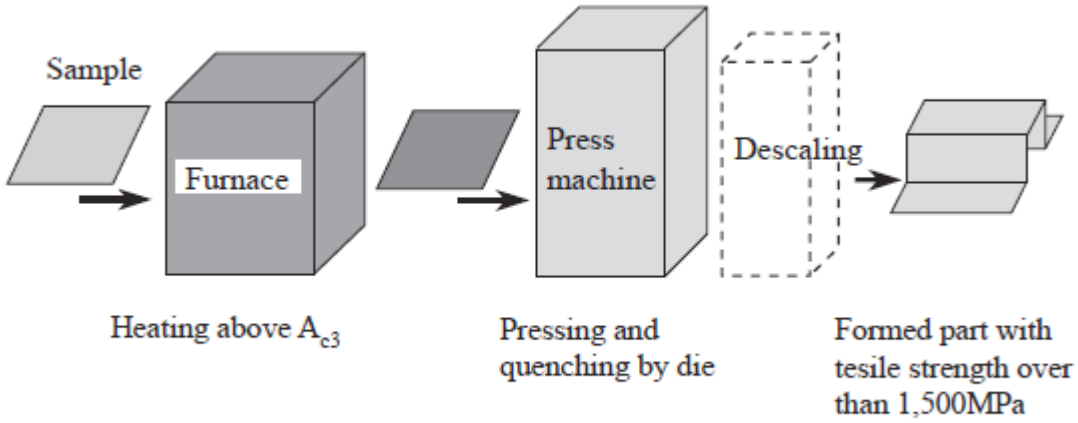
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
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[24c] (a) an interdiffusion layer having a first mean aluminum composition,	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (a) an interdiffusion layer having a first mean aluminum composition. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have

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Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

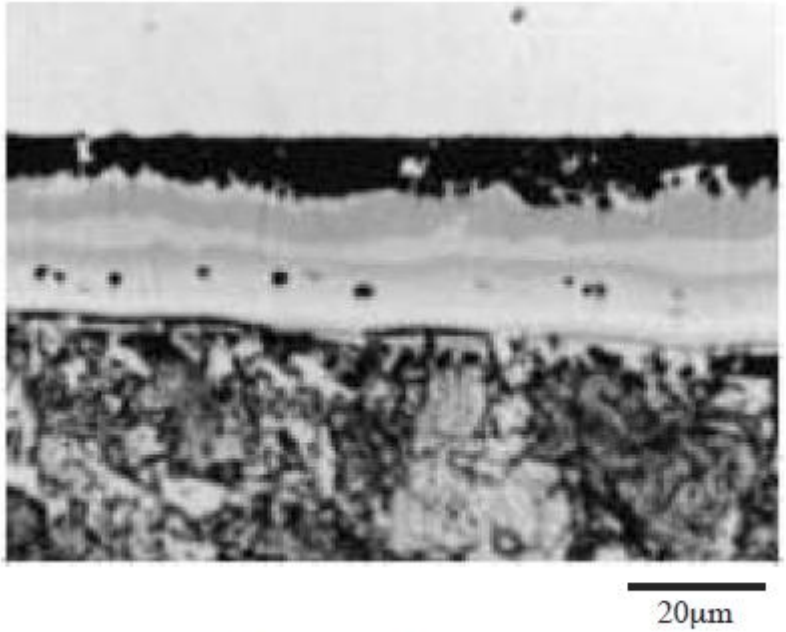
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
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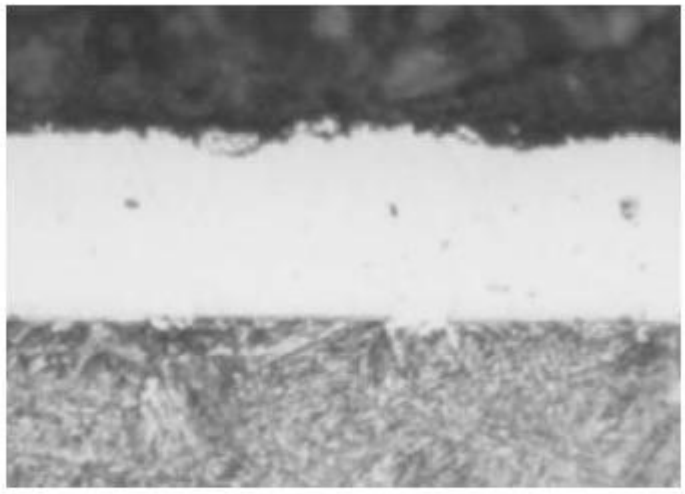
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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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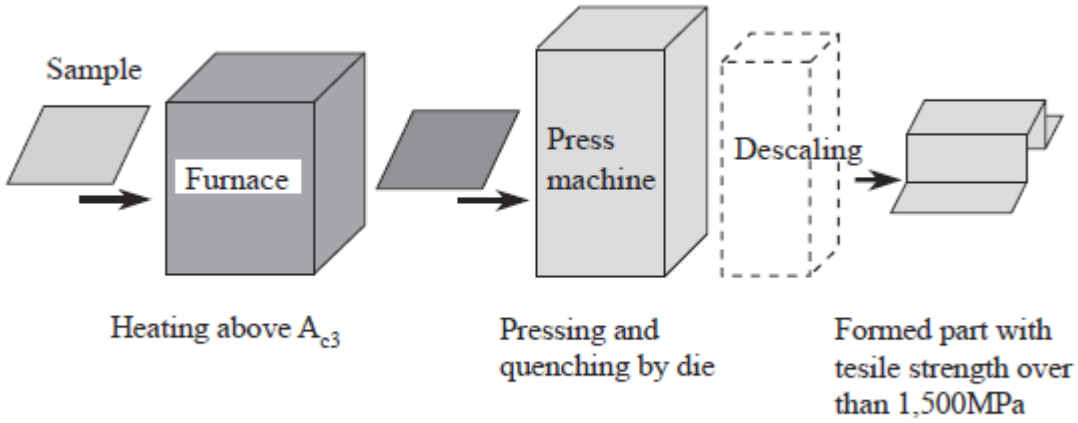
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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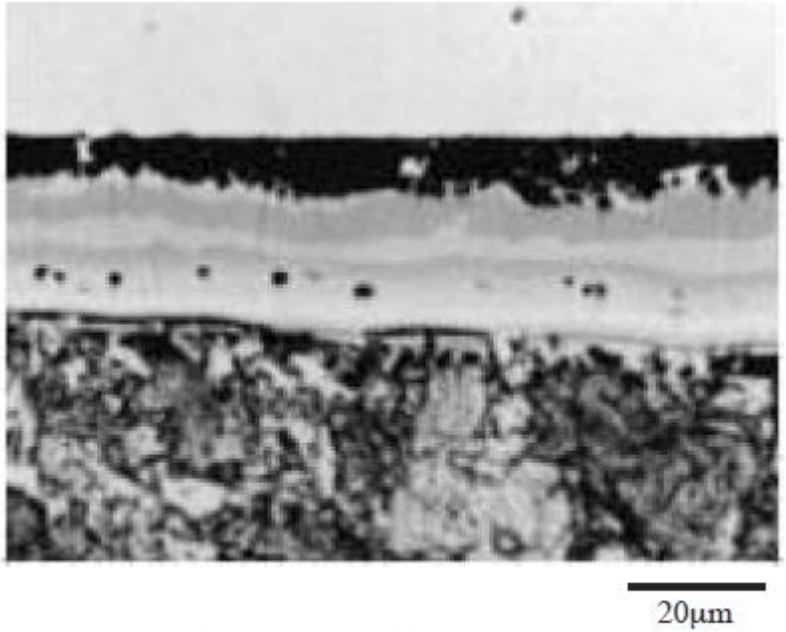
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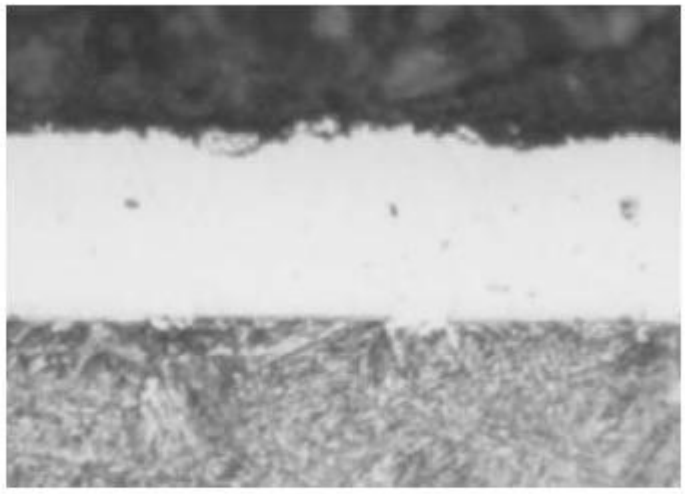
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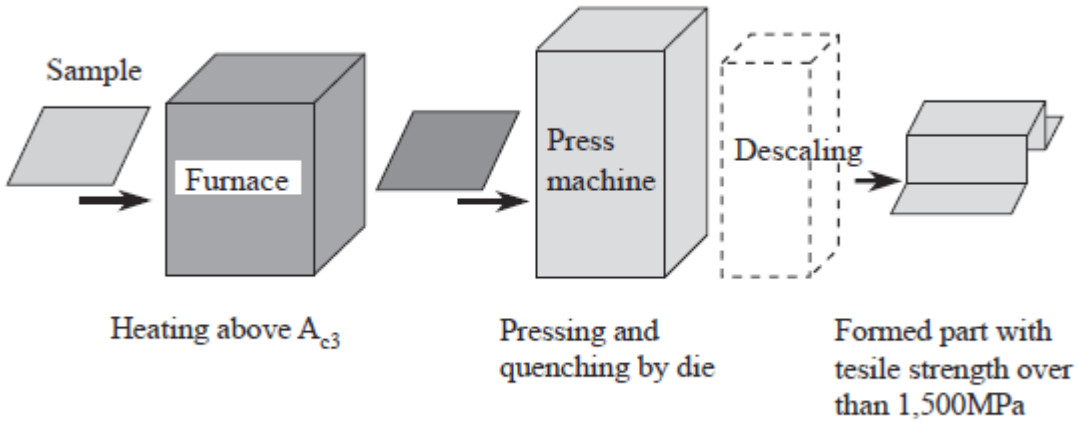
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[24e] (c) an intermetallic layer having a third mean aluminum composition different from the first and second mean aluminum compositions, and	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (c) an intermetallic layer having a third mean aluminum composition different from the first and second mean aluminum compositions. For example: "Abstract

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	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

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	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

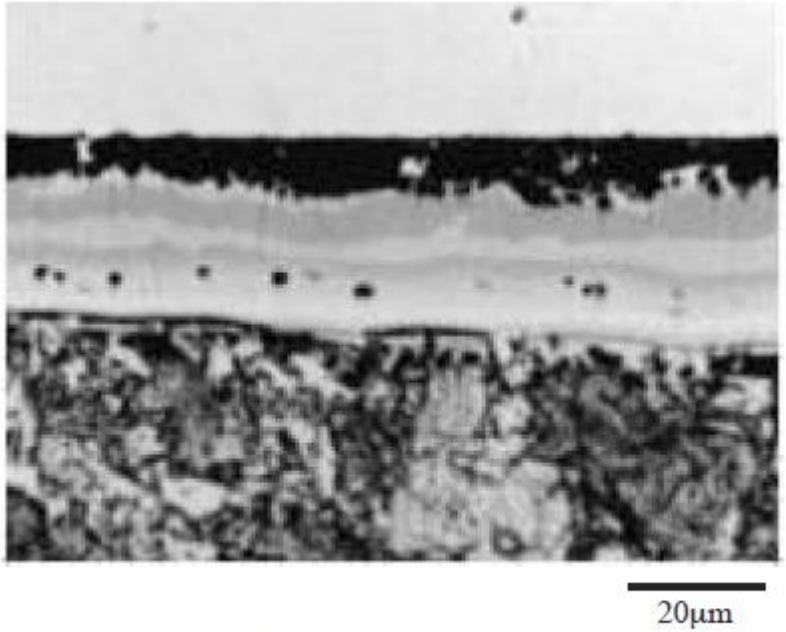
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

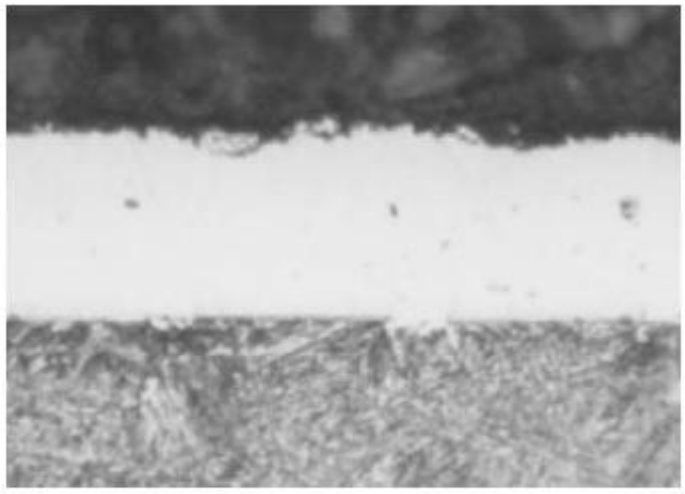
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

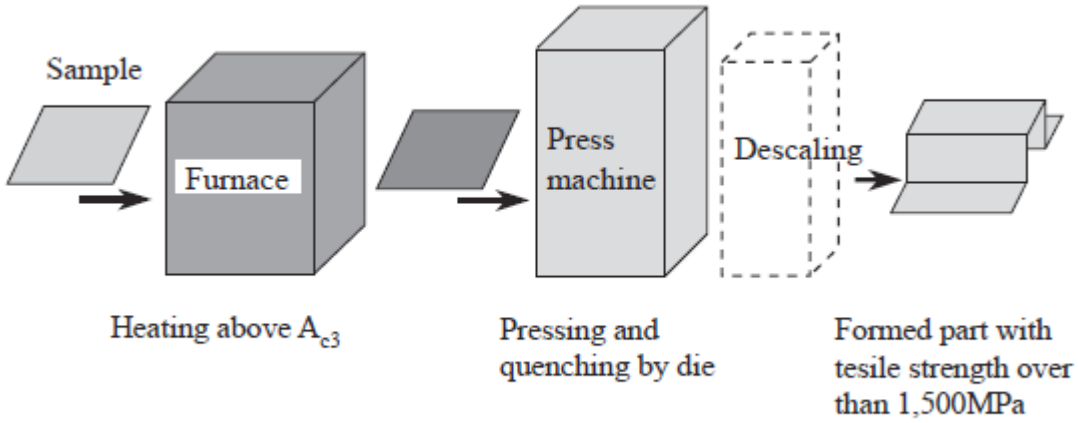
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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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[24f] (d) a superficial layer having a fourth mean aluminum composition different from the first, second and third mean aluminum compositions, the second mean aluminum composition being greater	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose (d) a superficial layer having a fourth mean aluminum composition different from the first, second and third mean aluminum compositions, the second mean aluminum composition being greater than the third mean aluminum composition. For example:

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than the third mean aluminum composition;	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

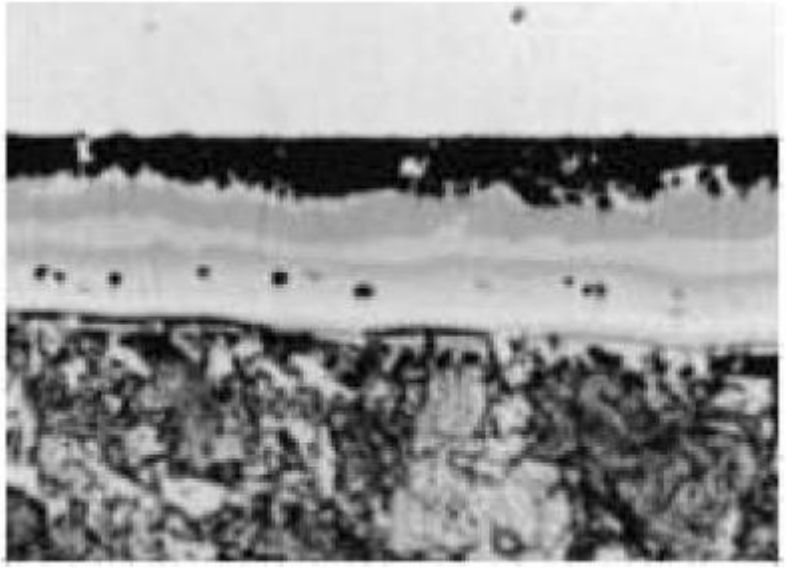
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

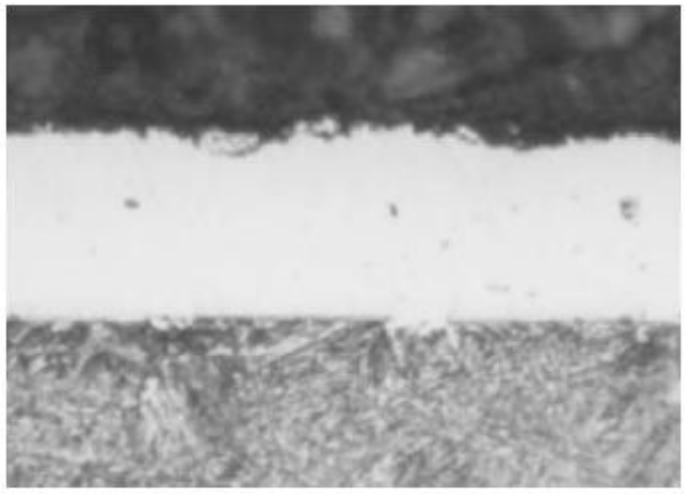
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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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	Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C Mn Cr B 0.22 1.2 0.15 0.002 **Table 2 Tensile properties before and after quenching** Yield strength (MPa) / Tensile strenght (MPa) / Elongation (%) As coated: 394 / 615 / 26 As formed: 1,280 / 1,530 / 8 *Id.* at Table 1 and Table 2.

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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

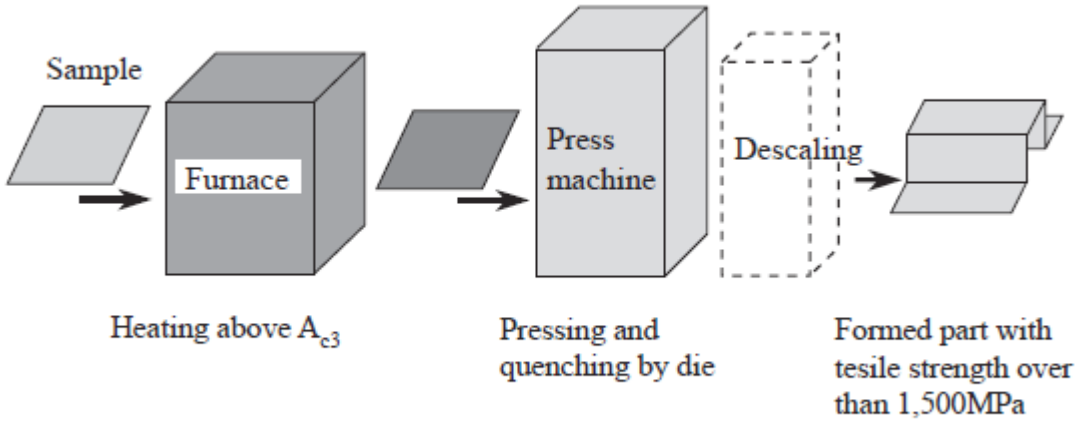
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
[24g] wherein the coating has a thickness greater than 30 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose wherein the coating has a thickness greater than 30 micrometers. For example: "Abstract Production of parts with high strength by means of hot-forming process has been

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature.

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	Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet

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	surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References

good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

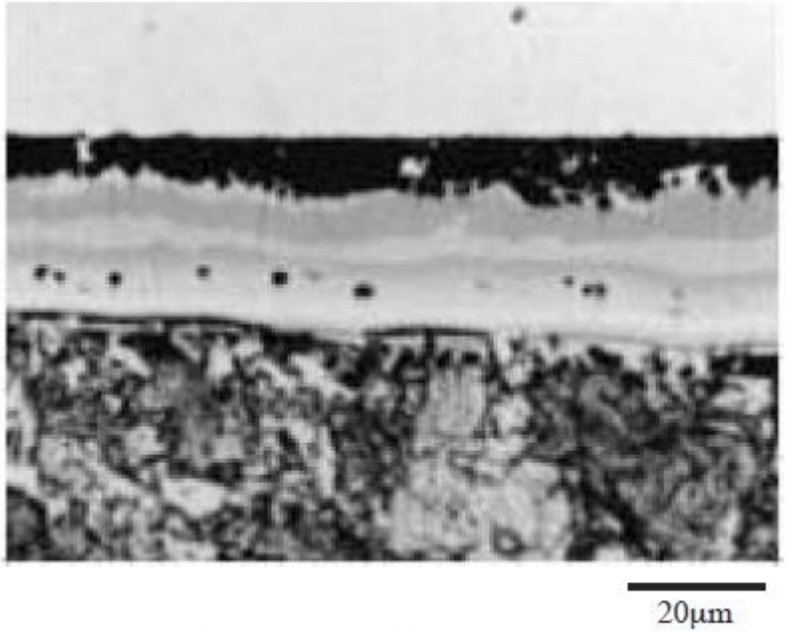
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

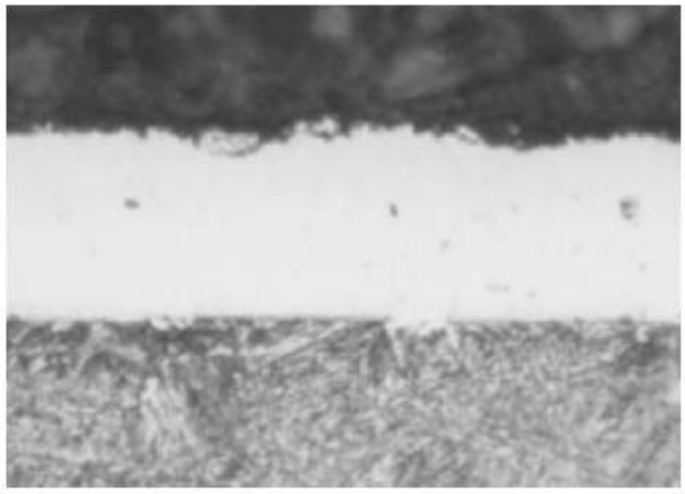
Id. at Table 1 and Table 2.

"5. Spot Weldability
Test pieces for spot welding tests were prepared by heating aluminized

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	steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere

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	is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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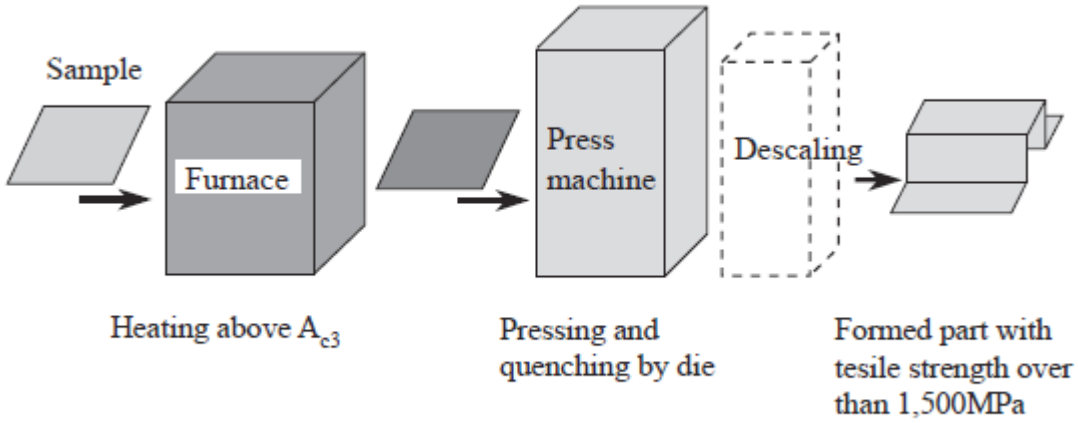
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 25	
[25] The precoated steel product as recited in claim 24 wherein the fourth mean aluminum composition is less than the second mean aluminum composition.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 24 wherein the fourth mean aluminum composition is less than the second mean aluminum composition. For example:

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	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

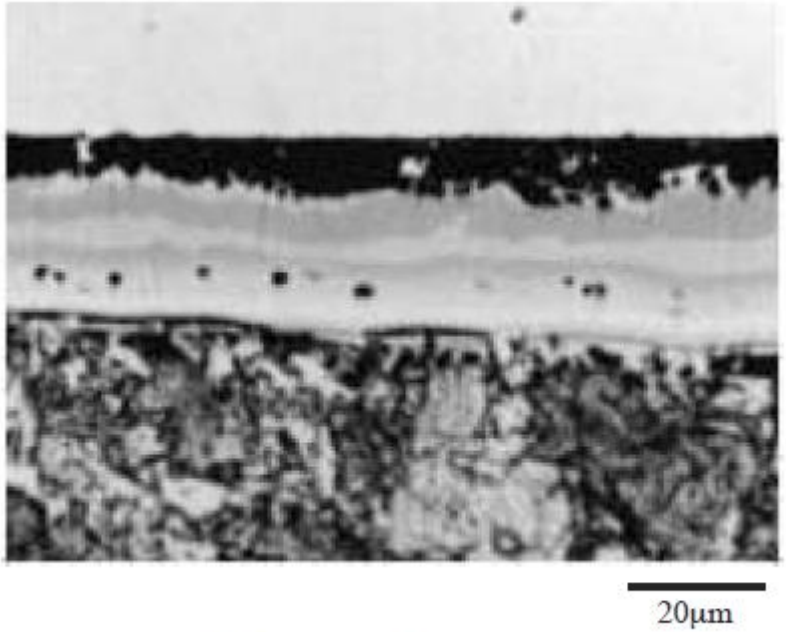
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

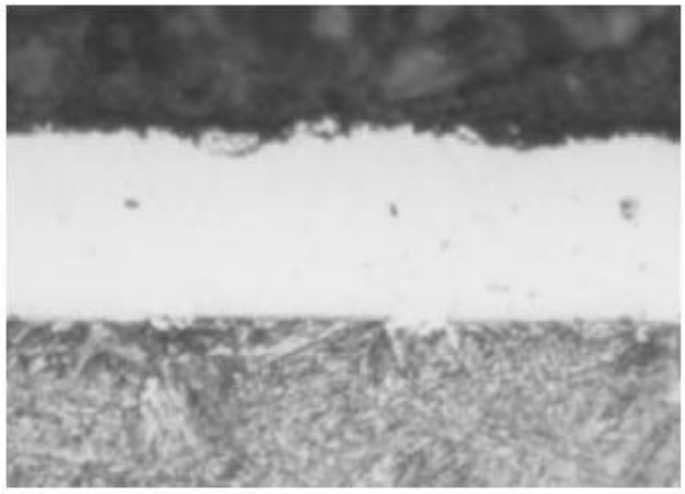
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	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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	Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C Mn Cr B 0.22 1.2 0.15 0.002 **Table 2 Tensile properties before and after quenching** Yield strength (MPa) / Tensile strenght (MPa) / Elongation (%) As coated: 394 / 615 / 26 As formed: 1,280 / 1,530 / 8 *Id.* at Table 1 and Table 2.

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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

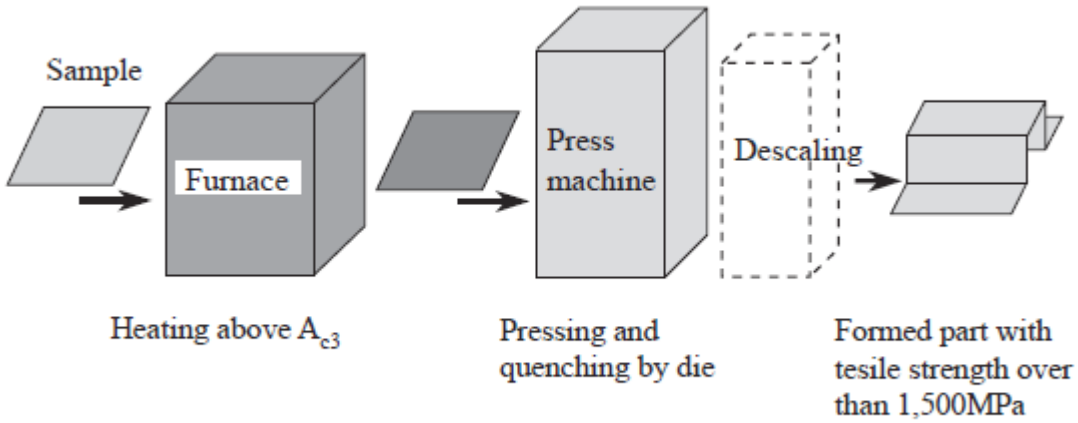
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.
Claim 26	
[26] The precoated steel product as recited in claim 24 wherein the layer (a) has a thickness less than 15 micrometers.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 24 wherein the layer (a) has a thickness less than 15 micrometers. For example: "Abstract

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching after heating it to a temperature in the austenite temperature range,

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the furnace to the pressing machine are carried out inevitably in the normal

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	atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material Since a steel sheet is rapidly cooled in the hot forming process

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for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17.

Table 1 Chemical composition of steel sheets used

C	Mn	Cr	B
0.22	1.2	0.15	0.002

Table 2 Tensile properties before and after quenching

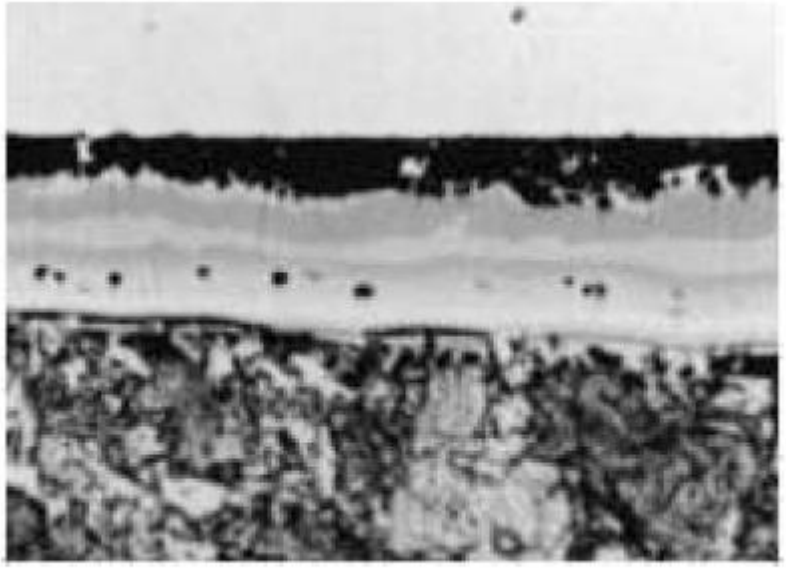
	Yield strength (MPa)	Tensile strenght (MPa)	Elongation (%)
As coated	394	615	26
As formed	1,280	1,530	8

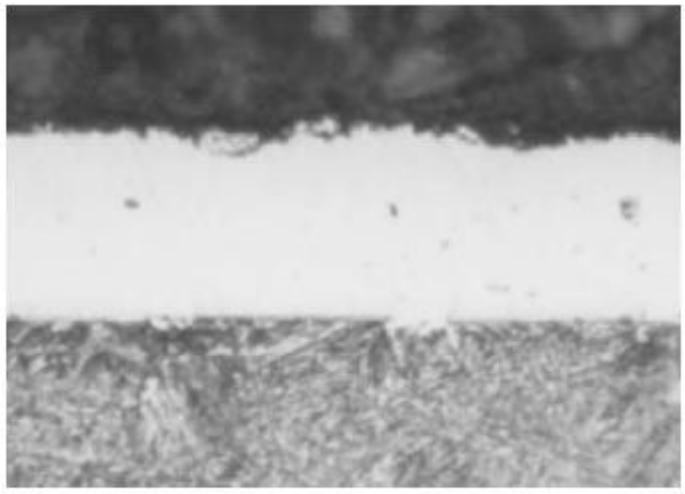
Id. at Table 1 and Table 2.

"5. Spot Weldability

'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy sticks to furnace structures. The time that is required for reaching a

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	holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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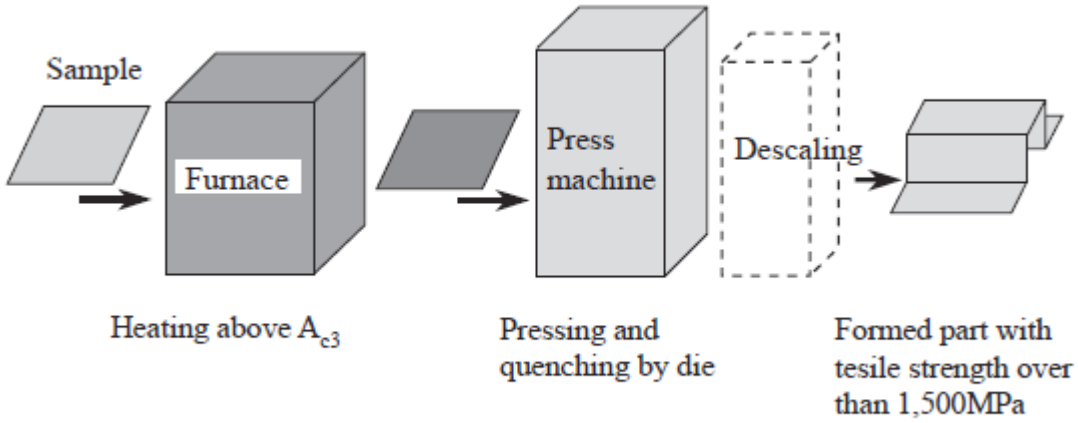
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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Claim 28	
[28] The precoated steel product as recited in claim 24 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si.	The ALJ has not yet construed the claims and therefore the meaning of the terms in the claims has yet to be resolved by the ALJ. The support identified here for this limitation is responsive to Complainant's infringement contentions, which Respondents disagree with. Suehiro II and/or one or more prior art references disclose the precoated steel product as recited in claim 24 wherein the intermediate layer comprises the following components by weight based on total weight: 39 to 47% Fe, 53 to 61% Al, and 0 to 2% Si. For example:

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	"Abstract Production of parts with high strength by means of hot-forming process has been receiving considerable attention lately. Application of aluminized steel with good hardenability for this process has been investigated*. Tensile strength over than 1,500MPa was obtained with steel containing around 0.2mass% C. Surface coated layer changed from Al-10% Si to Fe-Al(-Si) phases through the hot-forming process. The steel with Fe-Al(-Si) surface layer showed good paintability even without phosphatized treatment. After painting, they showed good corrosion resistance in JASO-CCT as galvanized steel did. The steel showed good spot weldability due to the stable surface layer at high temperature. (*license product within the frame of global strategic alliance with Arcelor (USIBOR1500))." *Id.* at Abstract. " 1. Introduction High-strength steel sheets are used more and more for automobile components in recent years to reduce the weight of an automobile to improve environmental problems and collision safety. Many car components and structural members can be made significantly lighter by using high-strength steel sheets and reducing their thicknesses. With this as a background, the strength of the steel sheets used therefor has increased from 440- or 590-MPa class to 780-MPa class. Generally speaking, as the strength of a steel sheet increases, its formability deteriorates, and to overcome this problem, various types of high-strength steel sheet products with controlled microstructures have been developed1). In spite of these efforts, however, press forming complicated shapes is difficult when the strength of a steel sheet is as high as approximately 1,500 MPa. In Europe, a forming method called die quenching, hot forming, hot stamping or hot pressing is employed for fabricating automobile structural members having a strength of 1,500 MPa or so2). By this method, the strength of a steel sheet is increased through quenching

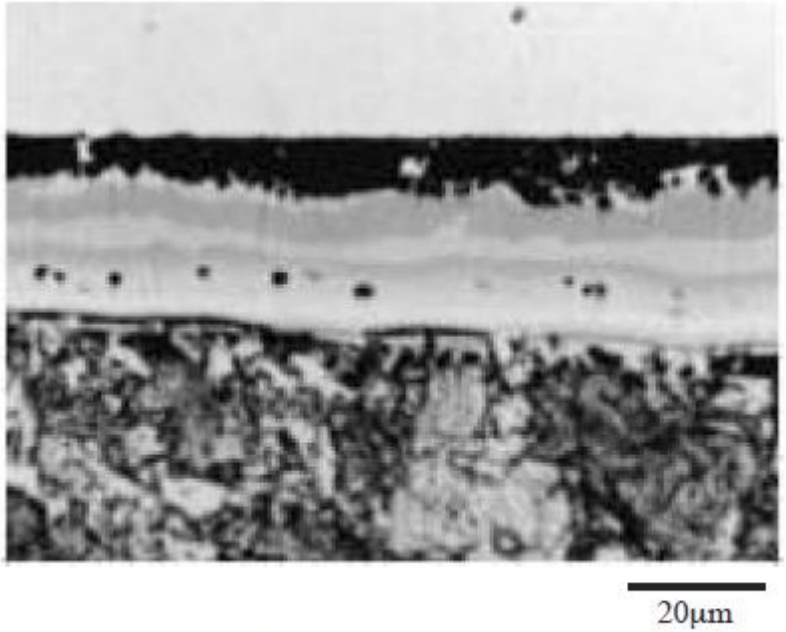
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	after heating it to a temperature in the austenite temperature range, say, around 900°C, while forming dies are maintained at room temperature. Techniques similar to this are being studied in Japan; similar processes have been studied or put into actual practice using steel sheets without surface treatment3, 4). In Europe, Arcelor has developed and commercially launched an aluminized steel sheet product called USIBOR 1500 for that application. It has excellent hot-pressing properties and corrosion resistance qualities2, 5-6). Based on a global strategic alliance with Arcelor, Nippon Steel Corporation has entered into a license agreement regarding USIBOR 1500 and studied the production technologies and properties of the product. This paper reports the results of the company's studies of the properties and characteristics that are required of aluminized steel sheet products for hot forming application." *Id.* at 16. " 2. Hot Forming Process The hot forming method is already a practical reality; the process is outlined in Fig. 1. In this method it is necessary to heat a steel sheet to a temperature in the austenite temperature range, equal to or higher than the Ac3 temperature: for example, steel containing about 0.2 mass % C must be heated to 850°C or higher. Heated steel sheet is extracted from a heating furnace, transferred to a pressing machine, formed into a prescribed shape using dies maintained at room temperature, and thus quenched. At the forming work, the press machine is retained at the lower dead point until the entire steel sheet is quenched sufficiently. In these processes, when a steel sheet without surface treatment is used, the heating must be done in a non-oxidizing atmosphere for suppressing scale formation and decarburization of its surface layers. Even in the above case, the processeses from the exit from the

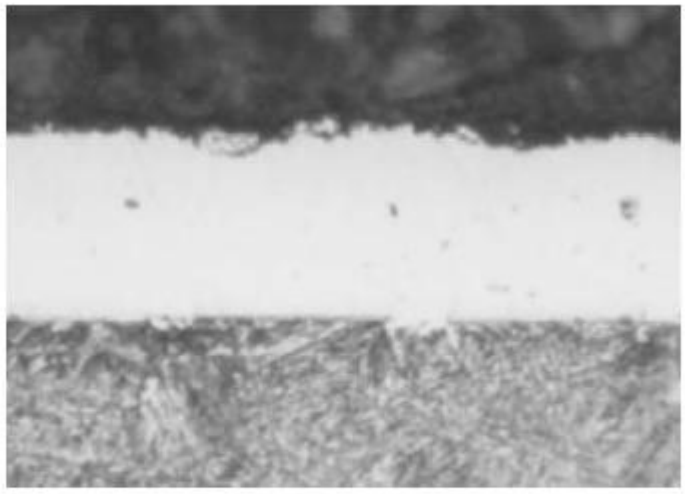
'602 Patent	Suehiro et. al., Properties of Aluminum-Coated Steels for Hot-Forming ("Suehiro II") alone and/or in view of One or More Prior Art References
	furnace to the pressing machine are carried out inevitably in the normal atmosphere and for this reason, scale forms on the steel sheet surfaces however short the processing time may be. A formed product will be finally coated for use, but the scale causes a problem for the coating work. Therefore, when a steel sheet without surface treatment is used, an additional process step for removing the scale is required. The scale removal can be done through shot blasting, pickling, or the like, but this results in considerable increases in costs. Further, if shot blasting is employed, the shape of a work may be deteriorated. If a steel sheet with heat-resistant plating is used, the additional process step can be eliminated." *Id.* at 16-17.  **Fig. 1 Schematic illustration of hot forming process** *Id.* at Fig. 1. "3. Material

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	Since a steel sheet is rapidly cooled in the hot forming process for hardening it as explained above, a material steel sheet must have good hardenability. To eliminate the furnace atmosphere control and the descaling process to simplify the work processes, the surfaces of the material steel sheet must be coated with plating layers excellent in heat resistance. An aluminized steel sheet having the chemical composition shown in Table 1 satisfies all these requirements. The properties and characteristics of the specimen steel sheets used for authors' studies, the coating weights of which ranged from 120 to 160 g/m2, are described below." *Id.* at 17. **Table 1 Chemical composition of steel sheets used** C: 0.22 | Mn: 1.2 | Cr: 0.15 | B: 0.002 **Table 2 Tensile properties before and after quenching** As coated: Yield strength (MPa) 394 | Tensile strenght (MPa) 615 | Elongation (%) 26 As formed: Yield strength (MPa) 1,280 | Tensile strenght (MPa) 1,530 | Elongation (%) 8 *Id.* at Table 1 and Table 2.

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	"5. Spot Weldability Test pieces for spot welding tests were prepared by heating aluminized steel sheets of 1.2 mm thickness having a coating weight of 120 g/m2 to 950oC, retaining at the temperature for 5 min, and then quenching by pinching them with metal dies from both the sides. The plating layers were of an Fe-Al alloy as explained in the following sections. The test pieces were spot welded to 440-MPa class coldrolled steel sheets of 1.8 mm thickness using DR6φ type electrodes of alumina-dispersed copper at a welding time of 17 cycles (60 Hz) and an electrode force of 400 kgf. Fig. 7 shows the relationship between the nugget diameter and the current density; the welding current range is roughly 3 kA from the current value at which the nugget diameter becomes 4 t relative to the sheet thickness t to that at which expulsion occurs. Fig. 8 shows the relationship between tensile shear strength and welding current, and Fig. 9 shows that between cross tension strength and the welding current. Further, Fig. 10 shows hardness distribution near a nugget. Hardness is approximately HV 480 at the inside of a nugget and the base metal, and it falls to HV 300 or so at heat-affected zones (HAZ). Because of such a hardness distribution, failure occurs at the HAZ in most cases." *Id.* at 18. "6. Coating Layer Characteristics 6.1 Alloying of coating layer during heating The coating layer of the steel sheet product is what is called the Type 1 coating layer, a plating layer of aluminum containing 10% Si. Its melting point is approximately 600°C, and the layer melts when heated quickly. However, during heating at a heating rate attainable with an electric furnace, an Fe-Al alloy having a high melting point forms from the interface with the base metal, and the alloying quickly reaches the surface and for this reason, no molten alloy

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	sticks to furnace structures. The time that is required for reaching a holding temperature in an electric furnace of normal furnace atmosphere is about 2 min in the case of a 1.6-mm thick aluminized steel sheet." *Id.* at 19. "Fig. 12 shows an alloy layer structure after retaining an aluminized steel sheet at 950°C for 0.5 min, and Fig. 13 the concentrations of Fe, Al and Si in the plating layer measured in the thickness direction by SEM-EDS. As the alloying proceeds, the coating layer develops a sub-layer structure as shown in the figure. In the case of the above heating condition, the plating layer consisted of five sublayers, and the Al concentrations in the sub-layers were 50, 30, 50, 30 and 10%, respectively, from the surface to inside. The concentrations of the elements changed continuously from the fourth sub-layer to the base metal." *Id.* at 19.

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	 **Fig. 12 Sectional optical micrograph showing plating layer structure after heated at 950°C for 30 s** *Id.* at Fig. 12. "Fig. 14 is a ternary phase diagram of an Fe-Al-Si system at 950°C calculated using Thermo-Culc7) based on the thermodynamic database of the Fe-Al-Si system presented by Z. Liu et al.8) The authors superimposed the compositions of the plots of Fig. 13 upon the phase diagram and as a result, the sub-layers in Fig. 13 were identified, presumably, as Fe2Al5, an ordered BCC phase, FeAl2, an ordered BCC phase, and a disordered BCC phase, respectively, from the surface to inside. As the holding time becomes longer, Al diffuses into

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	inner layers and finally into the base steel and as a consequence, the sub-layers disappear gradually from the outermost to inside. Fig. 15 shows a plating layer after retaining at the temperature for 5 min. Although only one layer could be observed in sectional observation, an SEM-EDS analysis revealed the existence of two sub-layers; they were presumed to be an ordered and a disordered BCC phase."  **Fig. 15 Sectional optical micrograph showing plating layer structure after retention at 950°C for 5 min** *Id.* at Fig. 15. "6.2 Paintability and corrosion resistance after painting Steel sheets are used an automobile components after painting

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	by electro-deposition. Usually, they are subjected to a chemical treatment prior to the painting for ensuring good paintability. The chemical treatment generally consists of dipping a steel sheet in a solution of zinc phosphate to form coating films of phosphate on the surfaces. However, the coating films do not form on the surface of the Fe-Al alloy layer because the alloy is very stable against acid. The surface of the Fe-Al alloy phase after the heat treatment is rough as seen in Fig. 16 and thanks to an anchoring effect of the surface, its paintability is good without the chemical treatment. Table 3 shows a comparison of the adhesion of electro-deposited paint of about 20 μm thickness between samples with and without the chemical treatment; it is clear that the aluminized steel sheets hot-formed have sufficiently good paint adhesion regardless of the application or otherwise of the chemical treatment. An aluminized steel sheet with a coating weight of 160 g/m2 was heated to 900°C for 2 min to form an Fe-Al alloy layer at the surface, immersed in a chemical treatment solution, coated with electro-deposited paint of roughly 25 μm thickness, then, after cross-cutting the paint coating, subjected to 150 cycles (50 days) of the following cyclic corrosion test (CCT) according to JASO M 610: Salt spray (5% NaCl, 35°C, 2 h) → drying (60°C, 4 h) → wetting (50°C, 2h)" *Id*. at 20. "Fig. 17 shows its surface after the CCT together with comparative samples. A cold-rolled steel sheet without surface treatment and a galvannealed steel sheet (coating weight 45 g/m2) were subjected to the chemical treatment and then, after confirming the formation of the chemical coating films, to the CCT as the comparative samples. Fig. 18 shows the change of coating blister of the above three kinds of samples during the course of the CCT, in terms of blister width on

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	one side of a crosscut line. The corrosion depths of these samples were measured in the thickness direction after 150 cycles of the CCT, at 5 points per sample, using a laser beam. The mean values and standard deviations are shown in Fig. 19. It is clear from these results that a steel sheet having coating layers of Fe-Al alloy phases is superior to a cold-rolled steel sheet and equivalent to a galvannealed steel sheet in terms of coating blister width and corrosion depth. When especially good corrosion resistance after paint coating is required, it is desirable to increase the aluminizing coating weight to 150 g/m2 or so." *Id*. at 20. " 6.3 Corrosion resistance of spot-welded portion Fig. 20 shows a sectional structure of a portion just beneath a spot welding electrode and another outside a clamped portion. From these photomicrographs it is clear that the plating layer just beneath an electrode does not change in spite of the welding heat and retains its thickness throughout the welding process. For this reason, the corrosion resistance of these portions after paint coating is the same as that of the other portions. Fig. 21 shows samples of the aluminized steel sheet with paint coating after heat-treatment of hot-forming including spot welded portions after 2,000 h of a salt spray test (SST); no corrosion is observed in any of them. In the case of other coated steel sheet products, the plating layer beneath an electrode may melt during spot welding, be squeezed out from beneath the electrode, and the plating metal can sometimes form protrusions around the portion. At such portions, paint coating applied thereafter may become thinner and there may be problems in corrosion resistance." *Id*. at 21. " 7. Summary

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	The properties of the base material and surface properties of an aluminized steel sheet for hot forming use have been explained herein. Even if the cooling rate at the die quenching is uneven during the press formation process, the base material has uniform strength after the hot forming as far as a cooling rate of 30°C/s or higher is attained. A yield strength of 1,280 MPa, a tensile strength of 1,530 MPa and an elongation of 8% can be obtained after the hot forming. The aluminum plating layer of the product transforms during the heating before the press forming into an Fe-Al alloy phase having a high melting point, and thanks to this, the spot weldability of the product is not adversely affected by the presence of coating layers. As a consequence, the consecutive spot weldability of the aluminized steel sheet product is excellent. The Fe-Al alloy phase displays a better corrosion resistance than a steel sheet without surface treatment and almost equivalent corrosion resistance to a galvannealed steel sheet. The application of the steel sheet product having the above properties to the hot-forming process will make it possible to produce automobile components excellent in strength and corrosion resistance and having comparatively complicated shapes." *Id*. at 21.