

# SUMITOMO ALZINC<sup>®</sup> for Automotive Parts

by

**Shinya Hikino** / Sheet Product Development Sec., Wakayama Steel Works

**Takahiro Matsunaga** / Sheet Product Development Sec., Wakayama Steel Works

**Hirohito Masumoto** / Cold Rolling & Galvanizing Technology Sec., Wakayama Steel Works

**Masamitsu Matsumoto** / Assistant Research Manager, Sheet Products Research Dept., Corporate R&D Lab.

**Tamotsu Toki** / Research Manager, Sheet Products Research Dept., Corporate R&D Lab.

## Synopsis

SUMITOMO ALZINC<sup>®</sup> (hot dipped 55% Al-Zn alloy coated steel sheet ; denoted as AZ, or AZ sheet) has three to five times higher corrosion resistance and durability than ordinary galvanized steel sheet. It is a good material such as roofing, walls etc. in harsh environments. Demand for AZ has been increasing steadily in recent years.

For an automotive industry, AZ sheets are not common materials in Japan, however, it is widely used in many countries. AZ sheets are expected to apply for outer and inner parts of automobiles i.e. exhaust system parts, where high temperature corrosion resistance (maximum temperature at 400°C) is necessary. In this paper, we introduce the performance of AZ sheet for automotive applications.

## 1. Introduction

AZ, which is hot-dipped 55% Al-Zn (exactly 55% Al-43.4% Zn-1.6% Si) alloy plated steel sheet, is used for various applications with high corrosion resistance. In 1995 total consumption of this plated steel sheet reached about 2.7 million a year all over the world. We started production and sales of AZ from August, 1994.

AZ sheet has excellent corrosion resistance in harsh environment, such as severe marine or industrial atmosphere (Fig. 1). AZ coating has complicated layered structure which consists of Al-rich phase Zn-rich phases (Photo 1). AZ has both aluminum passivation and zinc galvanic protection Zn, therefore it shows good anti-corrosion performance.

Furthermore, AZ shows good heat resistance and high-temperature oxidation resistance, since AZ coating layer consists of 80 vol% Al. AZ sheet, therefore, is good material for heat-resistant parts with high corrosion resistance. In this paper, we introduce the various performance and applications for automotive parts exposed in high-temperature and corrosive environment.

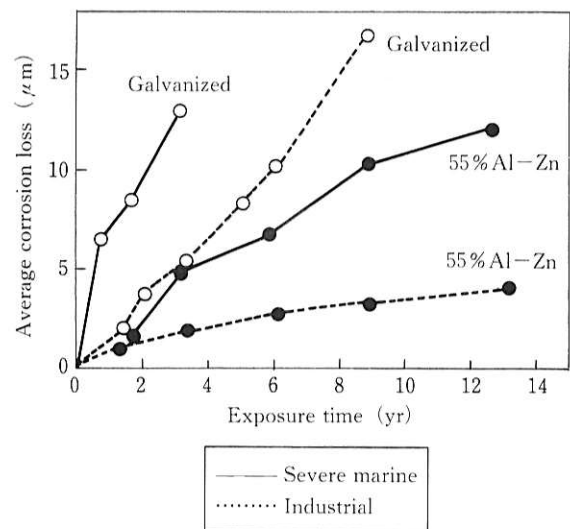


Fig. 1 Corrosion resistance in outdoor exposure test<sup>1)</sup>

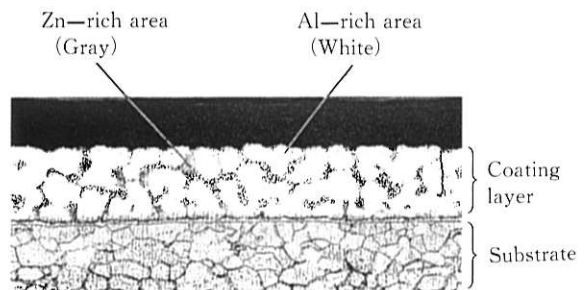


Photo 1 Cross section of AZ

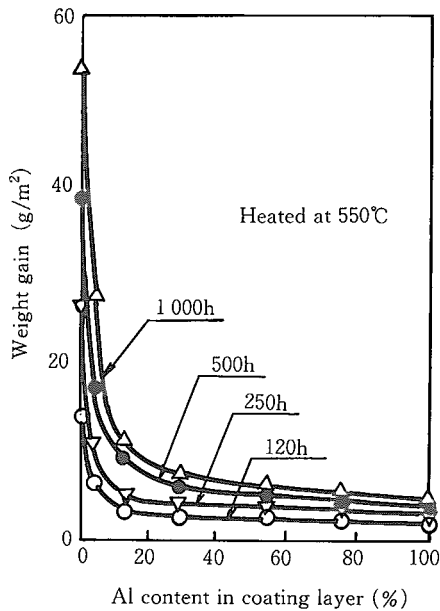


Fig. 2 High temperature oxidation resistance<sup>2)</sup>

## 2. Standards and Types

### 2.1 Standards and Types

Standards of AZ sheets are classified into common quality, drawing quality, and structural quality (tensile strength(TS)  $\geq 400\text{N/mm}^2$ ) as high tensile steel(**Table 1(a)**). Types of AZ sheets are classified according to its post-treatments, no treatment(M), chromate-treated(C) and special treatment for roll forming(U)(**Table. 1(b)**). C- and U-treatment are suitable for unpainted applications.

Table 1(a) Standards

Standard	Notation
Common quality	GLC
Drawing quality	GLDD
Structural quality (TS $\geq 400\text{N/mm}^2$ )	GL400

Table 1(b) Types of post-treatment

Type	Suffix
No treatment	M
Chromate-treated	C
Special treatment for roll forming	U

### 2.2 Special Products for Roll Forming(AZ-U)

Figure 3 illustrates AZ-U, which has lubricant resin film layer on its surface to prevent from galling on pressing without corrosion resistance deterioration. It is also possible to use press oil in combination with U-treatment in severe pressing condition.

Advantages of AZ-U

- (1) Good corrosion resistance
- (2) Good sheared edge corrosion resistance (**Fig. 6**)
- (3) Good high-temperature corrosion resistance (less than 150°C) (**Fig. 10**)
- (4) Good discoloration resistance by heating

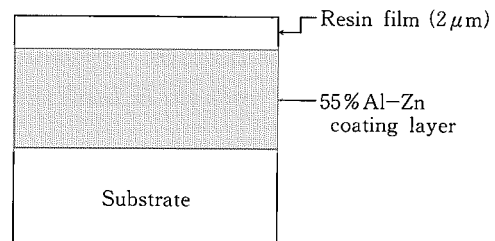


Fig. 3 Cross section of AZ-U (Special products for roll forming)

### 2.3 Chromate-Treated Product(AZ-C)

AZ-C has high-temperature corrosion resistance with spot weldability. It could be substituted materials as Al plated steel sheet which is common for heat-resistant parts such as automotive heat insulator.

Advantages of AZ-C

- (1) Good corrosion resistance
- (2) Good discoloration resistance by heating(**Table 5**)
- (3) Good high-temperature corrosion resistance (less than 400°C) (**Fig. 12 and 14**)(**Photo 2**)
- (4) Good spot weldability(**Table 9**)

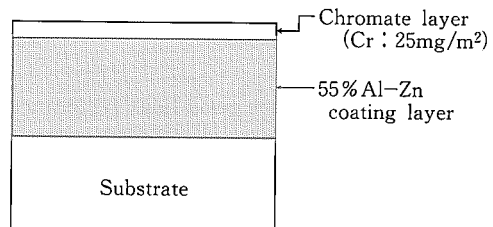


Fig. 4 Cross section of AZ-C (Chromate-treated product)

### 3. Applications Examples of AZ as Automotive Parts Outside Japan

Exhaust system : Muffler wrapper and shell, heat insulator, catalytic converter cover, etc.

(shown in Fig.5)

Circulation system : Radiator, oil filter, etc.

Others : Floor, wheel housing, disk brake splash shield, etc.

Applications of 55% Al-Zn coated steel sheet are often reported for automotive parts with heat-resistance, substituted materials for SUS, Al plated steel or painted steel sheet.

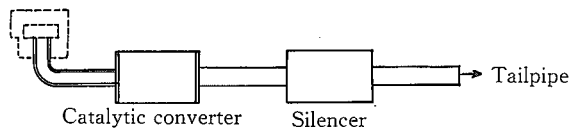


Fig. 5 Schematic illustration of exhaust system heat insulator

### 4. Performance

#### 4.1 Sheared Edge Corrosion Resistance

For automotive inner parts and frame parts, cold rolled steel sheet with electropainting (CR-ED) is commonly used. CR-ED may be substituted as AZ sheet to reduce manufacturing cost for eliminating to the coating process. However, AZ has exposed substrate steel at sheared edge, while CR-ED or other 'after-coated/painted' steel sheets are free from such a problem.

Figure 6 shows sheared edge corrosion resistance of AZ and after-coated/painted steel sheets (Table 2), which was investigated by accelerated outdoor exposure testing condition (Table 3). AZ showed good corrosion resistance even in such severe expo-

sure condition, therefore AZ is able to substitute as after-coated/painted steel sheets.

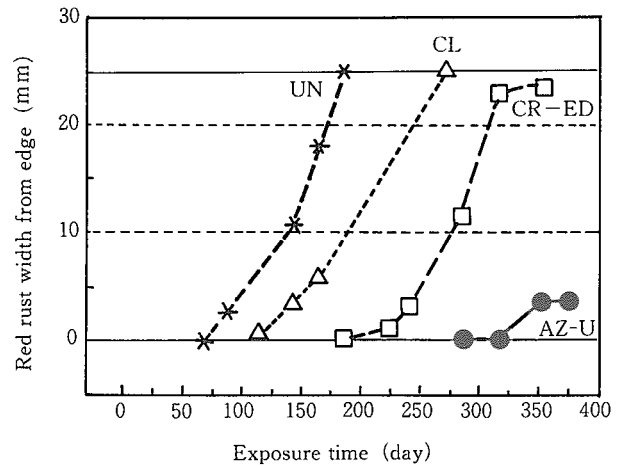


Fig. 6 Shear edge corrosion resistance

Table 3 Accelerated outdoor exposure testing condition

Site	In Wakayama Steel Works, SMI
Term	From November, 1994
Salt spray	2 times a working day (5 % NaCl aq.)

#### 4.2 Corrosion Resistance of Hemmed Model (Including Thermal Shock)

Corrosion resistance of hemmed model of AZ was investigated by corrosion testing condition at temperatures from room temperature to 150°C (Fig. 7). Figures 8 and 9 illustrate the dimension of test piece, where A indicates investigated specimen and B indicates electropainted cold rolled steel sheet. After the corrosion test, the A was torn away from the B, and maximum corrosion depth of hemmed area of the A was measured. AZ showed good corrosion resistance of hemmed model, equal to CR-ED (Fig. 10). This result indicates that AZ is suitable for automotive inner parts or covers.

Table 2 Investigated specimens

Symbol	Specimens	Coating weight	Post-treatment	Sheared edge
AZ-U	AZ sheet	80 g/m <sup>2</sup>	Special treatment for roll forming	As sheared
UN	CR* + Unichrome	30 g/m <sup>2</sup>	Chromate-treatment	Coated or painted after shearing
CL	CR* + Painting (dipping)	20 μm (painting thickness)		
CR-ED	CR* + Electropainting	25 μm (painting thickness)		

\*CR : Cold Rolled steel sheet

A	Dry	Humidity	Dry	Humidity	Dry	Humidity	Salt spray
2 hr	4 hr	3 hr	3 hr	3 hr	4 hr	3 hr	4.5hr

A : Leaving (room temp.) → Heating(150°C,1hr) →  
 → Immersion into salt solution(room temp., instance) → Leaving

Fig. 7 Corrosion testing condition

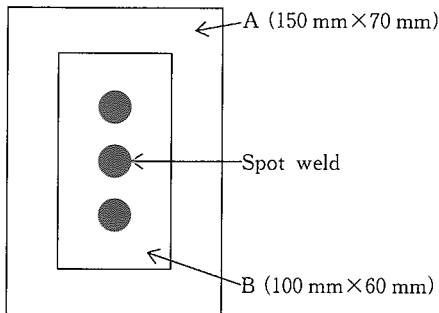


Fig. 8 Schematic illustration of test piece

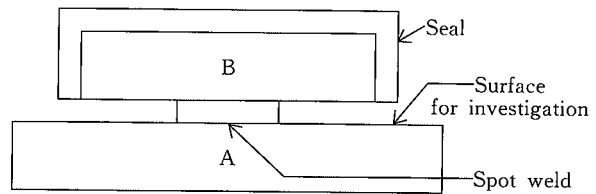


Fig. 9 Cross section of test piece

Table 4 Investigated specimens(Symbol A in Fig. 8,9)

Symbol	Specimens	Thickness	Coating weight	Post-treatment
AZ-U	AZ	0.8	80 g/m <sup>2</sup>	Special treatment for roll forming
GF-K	5% Al-Zn plated steel (SUMI-GALFAN)	1.02	90 g/m <sup>2</sup>	Chromate
GI-K	Galvanized steel (TOUGH-ZINC)	0.87	120 g/m <sup>2</sup>	Chromate
Al	Al plated steel	0.8	42 g/m <sup>2</sup>	Chromate
CR-ED	Electropainted cold rolled steel	0.8	20μm(Painting thickness)	

### 4.3 Discoloration by Heating

As shown in Table 5, AZ sheet has excellent discoloration resistance by heating.

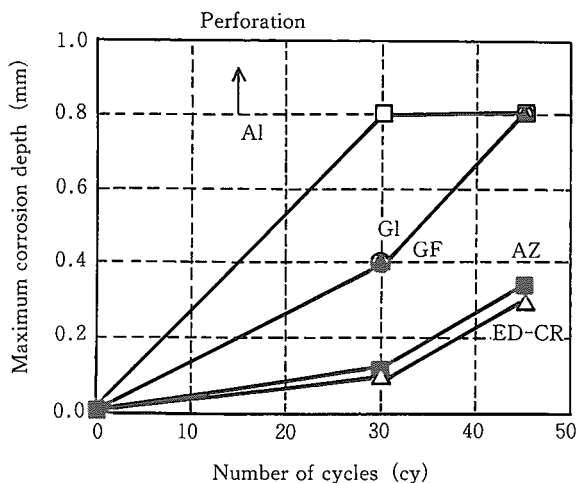


Fig. 10 Corrosion resistance of hemmed model

Table 5 Discoloration of AZ by heating

	AZ-U (Special product for roll forming)	AZ-C (Chromated product)
100 °C × 1 hr	None	None
200 °C × 1 hr	None	None
250 °C × 1 hr	Slightly yellow	None
300 °C × 1 hr	Slightly yellow	None

### 4.4 Spot Weldability

It is possible to spot-weld AZ with appropriate welding current. The range of AZ is slightly narrower than that for galvanized or Al plated steel sheet (shown in Table 6-8). AZ-C has better spot weldability than AZ-U due to its higher conductivity.

Table 6 Investigated specimens

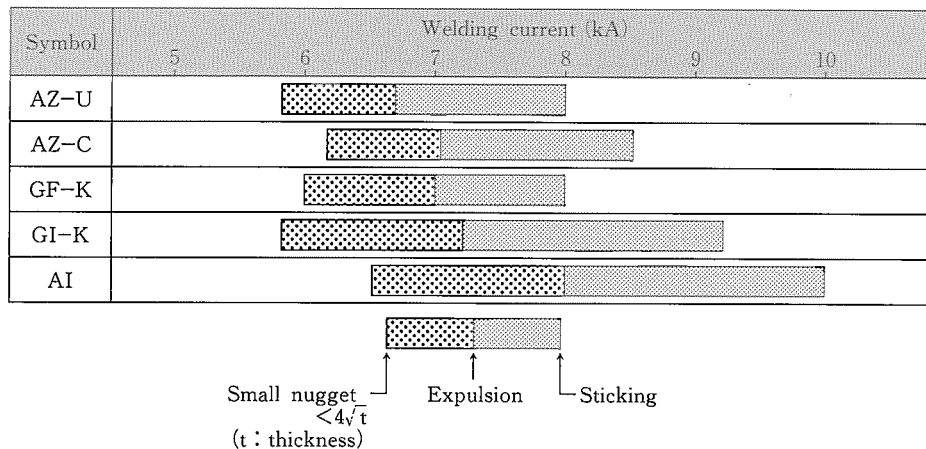
Symbol	Specimens	Thickness	Substrate	Coating weight	Post-treatment
AZ-U	A Z	0.6 mm	IF steel*	80 g/m <sup>2</sup>	Special treatment for roll forming**
AZ-C	A Z	0.6 mm	IF steel	80 g/m <sup>2</sup>	Chromate
GF-K	5% Al-Zn plated steel	0.4 mm	IF steel	90 g/m <sup>2</sup>	Chromate
GI-K	Galvanized steel	0.6 mm	IF steel	135 g/m <sup>2</sup>	Chromate
Al	Al plated steel	0.4 mm	IF steel	42 g/m <sup>2</sup>	Chromate

\*IF steel : Interstitial Free steel      \*\*Resin thickness : 1μm

Table 7 Welding conditions

Electrode	Cu-Cr, CF type(tip diameter : 3.5 mmφ)
Electrode force	150 kgf
Welding time	Welding : 12 cycles(60 Hz)    Squeeze : 10 cycles(60 Hz)

Table 8 Appropriate welding current ranges for AZ



### 4.5 High Temperature Corrosion Resistance

High-temperature corrosion resistance of AZ was investigated comparing with Al plated steel sheet (Table 9) by heat-corrosion cycle testing

condition (Fig. 11). As shown in Fig. 12 and Photo 2 show that AZ shows even or better resistance than Al at temperatures less than 400°C.

Table 9 Investigated specimens

Symbol	Specimens	Thickness	Coating weight	Post-treatment
AZ-C	AZ	0.6 mm	80 g/m <sup>2</sup> (22μm)	Chromate
Al	Al plated steel	0.6 mm	42 g/m <sup>2</sup> (16μm)	Chromate

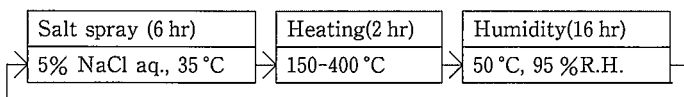


Fig. 11 Heat-corrosion cycle testing condition

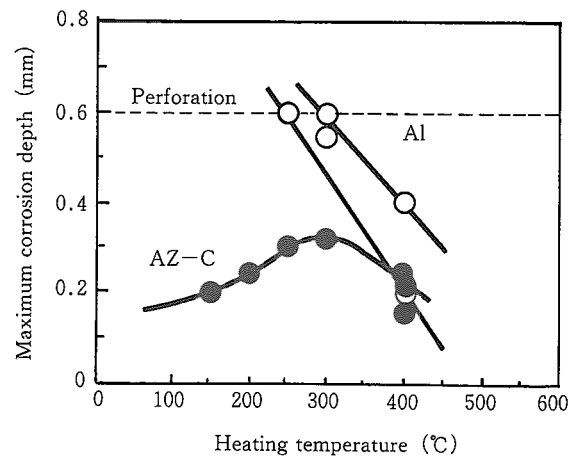


Fig. 12 High temperature corrosion resistance

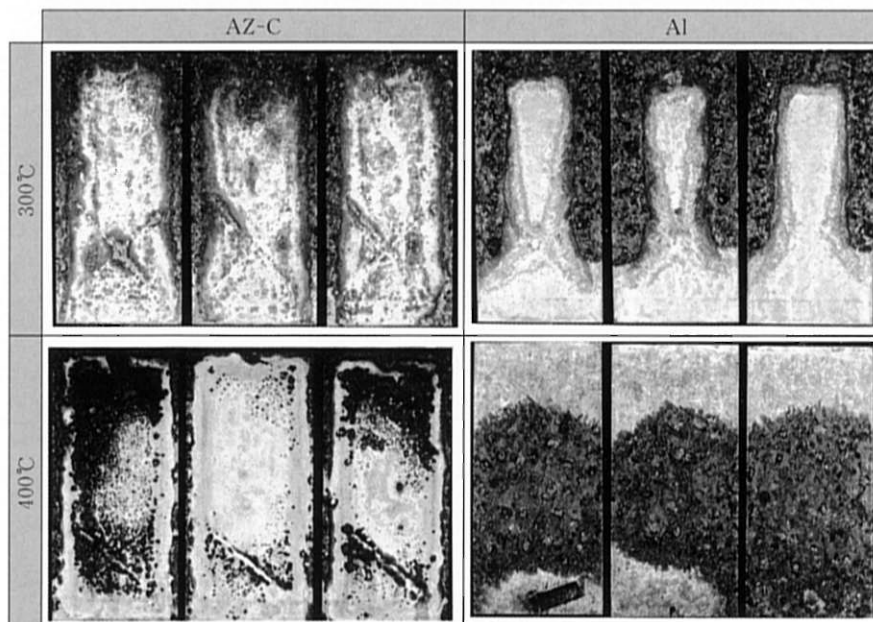


Photo 2 Surface appearance after heat-corrosion cycle test(40 cycles)

#### 4.6 High Temperature Corrosion Resistance after Spot Welding

Table 6 listed the investigated specimens. After spot-welded two of each specimen, heat- corrosion

cycle test was performed by the condition shown in Fig. 11 where heating temperature is 400°C. AZ showed equivalent resistance to Al plated steel sheet at 400°C after spot-welded (shown in Fig. 13).

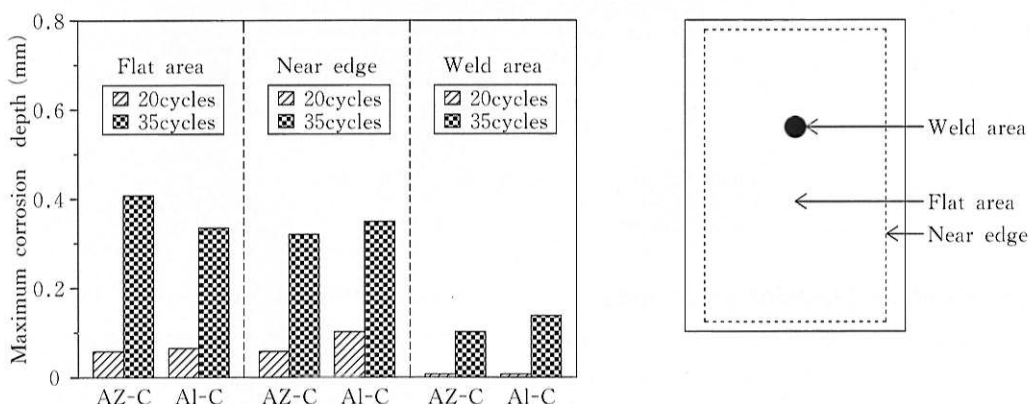


Fig. 13 Corrosion resistance of spot-welded sheets

### 5. Conclusion

AZ sheets have good performance for automotive applications, especially corrosion resistance and including high temperature less than 400°C. Though AZ is must be the next generation materials in this field.

**Shinya Hikino**

Sheet Product Development Sec.,  
Wakayama Steel Works

Phone: 0734 (51) 2509

### References

- 1) D.J.Blickwede : ISIJ, 66(1980), 821
- 2) Y.Uchida, et al. : ISIJ(1894), S478