Composition of ZAM®

- Zinc – 91%
- Aluminum – 6%
- Magnesium – 3%
- Satisfies ASTM A1046
Highly Corrosion Resistant Coated Steel

Chemical Treatment

Zn-Al 6%-Mg 3% Coating Layer

Steel
Corrosion Mechanism Of ZAM®

- Mg & Al form a fine, tight protective film.

Coating Layer

Thin Zinc-Aluminum based film containing Magnesium.

Corrosion of coating layer suppressed

Excellent Corrosion resistance
Corrosion Resistance of ZAM®

Progress of corrosion:

- **Steel Base**
- **ZAM® Coating Layer**
- **GI Coating Layer**

**Zinc and zinc-aluminum based protective surface film containing magnesium**

**White rust composed primarily of zinc oxide**

**Red Rust**
# Analysis of Corrosion Products

<table>
<thead>
<tr>
<th>Environment</th>
<th>Galvanized [Zn-0.2Al]</th>
<th>Galfan [Zn-4.5Al-0.1Mg]</th>
</tr>
</thead>
</table>
| Coastal     | Basic zinc aluminum carbonate  
\[5\text{Zn(OH)}_2 \cdot 2\text{Al(OH)}_3 \cdot \text{ZnCO}_3 \cdot 4\text{H}_2\text{O}\]  
minor amounts of basic zinc carbonate  
\[3\text{Zn(OH)}_2 \cdot \text{ZnCO}_3 \cdot \text{H}_2\text{O}\]  
basic zinc chloride  
\[4\text{Zn(OH)}_2 \cdot \text{ZnCl}_2 \cdot \text{H}_2\text{O}\]  
| zinc oxide (ZnO)  
\[4\text{Zn(OH)}_2 \cdot \text{ZnCl}_2 \cdot \text{H}_2\text{O}\]  
| minor amounts of zinc oxide (ZnO) |
| Rural       | Basic zinc aluminum carbonate  
\[5\text{Zn(OH)}_2 \cdot 2\text{Al(OH)}_3 \cdot \text{ZnCO}_3 \cdot 4\text{H}_2\text{O}\]  
| basic zinc carbonate  
\[3\text{Zn(OH)}_2 \cdot \text{ZnCO}_3 \cdot \text{H}_2\text{O}\]  
Minor amounts of zinc oxide (ZnO)  
\[3\text{Zn(OH)}_2 \cdot \text{ZnCO}_3 \cdot \text{H}_2\text{O}\]  
| basic zinc carbonate  
\[3\text{Zn(OH)}_2 \cdot \text{ZnCO}_3 \cdot \text{H}_2\text{O}\]  

**Reference:**

**Bibliography**
Galvatech ’04, 6th International Conference on Zinc and Zinc Alloy Coated Steel Sheet, held April 4-7, 2004.
### ZAM® fine dense corrosion products

<table>
<thead>
<tr>
<th>GI (Zn)</th>
<th>Galfan(Zn-5%Al)</th>
<th>ZAM® (Zn-6%Al-3%Mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Zn5(OH)8Cl2 containing Mg" /></td>
<td><img src="image2.png" alt="Zn5(OH)8Cl2 containing Mg" /></td>
<td><img src="image3.png" alt="Zn5(OH)8Cl2 containing Mg" /></td>
</tr>
</tbody>
</table>

**Appearance of corrosion products after 4hrs salt spray test**  
(Coating mass : 0.30 oz/ft²)
ZAM® Corrosion on Flat Side

Red rust occurrence after salt spray test (untreated)

<table>
<thead>
<tr>
<th>ZAM®</th>
<th>Galvanized</th>
<th>Zn-5%Al</th>
<th>55%Al-Zn</th>
</tr>
</thead>
</table>

*2,500 Hours of Salt Spray (Coating Weight: .30 oz/ft² on one side)
Corrosion Mechanism on Cut Edge

ZAM® coating layer

Substrate

Initial exposure period

Long exposure period

Enlarged picture

Fine zinc-based Mg film flows over cut edge

Protective film changes to gray then gray-black
# ZAM® Cut Edge Corrosion Resistance

<table>
<thead>
<tr>
<th></th>
<th>1000h</th>
<th>4000h</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZAM®</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>GI</td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>Zn-5%Al</td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
</tr>
<tr>
<td>55%Al-Zn</td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
</tr>
</tbody>
</table>

*Appearance of cut edge after salt spray test (Gauge: 0.091”; Coating .30 oz/ft² on one side)*
ZAM® Replaces Post Hot Dip GI

Post hot-dip galvanized products

Processing → Forming → Hot-dip galvanizing → Surface finish inspection → Inspection → Delivery

Transport

ZAM® Eliminates Process = Cost Reduction
**ZAM® Best Applications & Target Markets**

**Best Applications:**
- Heavy GI coating → ZAM®
- Post dipped GI → ZAM®
- Heavy gauge GL → ZAM®
- Stainless steel → ZAM®
- Environmental → ZAM®

**Targets**
- Agriculture Related
- Animal confinement
- Swimming Pool Walls
- Solar Racking (UL2703)
- Architectural Panels
- Highway Construction
- Fence / Railing
- Automotive

**Nisshin Steel Examples:**
- Construction framing
- Green house tubing
- Solar racking
- Automotive parts/covers
- Electrical panel/cabinet
- A/C panels / base tray
- Agriculture building
### Other Mg Containing Coated Products

<table>
<thead>
<tr>
<th>Producer</th>
<th>Product</th>
<th>Mg %</th>
<th>Al %</th>
</tr>
</thead>
<tbody>
<tr>
<td>WN</td>
<td>ZAM</td>
<td>3.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>NSSMC</td>
<td>SuperDyma®</td>
<td>3.0%</td>
<td>11.0%</td>
</tr>
<tr>
<td>AM</td>
<td>Magnelis®</td>
<td>3.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Tata</td>
<td>MagiZinc®</td>
<td>1–2%</td>
<td>1–2%</td>
</tr>
<tr>
<td>TK</td>
<td>ZM EcoProduct®</td>
<td>1%</td>
<td>—</td>
</tr>
</tbody>
</table>

**ASTM A1046**

<table>
<thead>
<tr>
<th>Mg %</th>
<th>Al %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 4%</td>
<td>5 – 13%</td>
</tr>
</tbody>
</table>

Meets ASTM Specification
Benefits of ZAM®

- Longer life than other coatings
- Cut edge rust protection
- Thinner coating yet more protection
- Excellent in severe environments
- Eliminates need for post dip galvanizing
- Superior formability – harder coating
- Cost savings through less maintenance
- Bridge between stainless and heavy galvanized