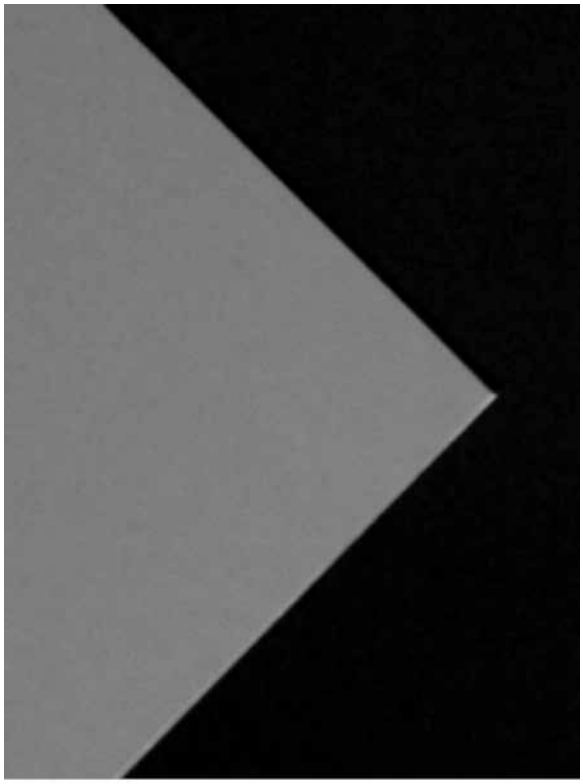
GOT RUST? GET ZAM®

By Art Bertol, Wheeling-Nisshin, Inc.



ZAM Sheet Appearance

The main objective of coating steel sheet is to add value, enhance appearance and prolong the service life---in short, to prevent rust. Wheeling-Nisshin, Inc. Follansbee, WVA believes they have a new answer to a very old problem with the introduction of their new coated steel product---ZAM®.

Market segments such as agriculture, automotive, construction, solar and numerous others battle corrosion everyday and ultimately spend billions of dollars annually dealing with corrosion. For years, the options to protect steel sheet from corrosion have been limited to galvanized, aluminum-zinc alloy coatings or reverting to costly stainless steel or aluminum substrates.

A summary report of inquiries made to Galvinfo Center stated that the predominate question asked by users of metallic-coated steel sheet is "how long will the material last in service." Those service environments included indoor and outdoor atmospheric, aqueous, in-concrete, in-soil, in contact with treated wood, and animal containment structures. Clearly the market wants to have their coated sheet products last longer.

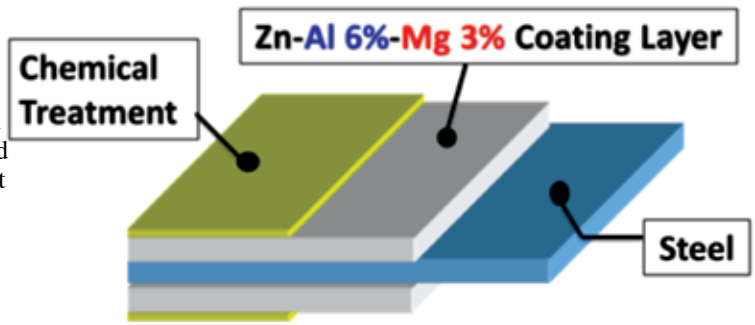
Zinc, aluminum, magnesium alloy coatings are the latest innovation to the coated steel market to fight corrosion and minimize environmental impact. There are currently about 10 such products, either commercially available or under development, in the world.

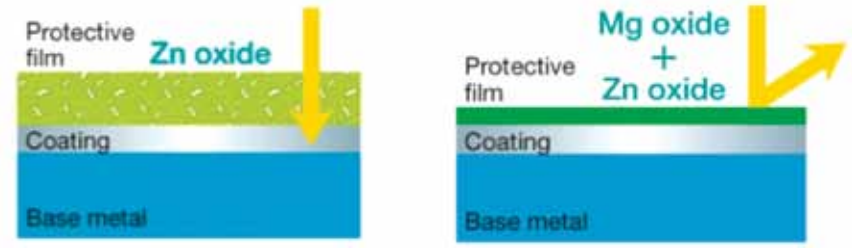
ZAM is one such hot-dipped, super-corrosion-resistant zinc, aluminum, magnesium alloy coated steel. The ZAM coating was developed by Wheeling-Nisshin's parent company, Nisshin Steel Co. Ltd. Early development of the new coating started in 1994 and commercial production was in place by 1999. The company first applied for patent in 1996 in Japan and in the U.S. in 1997. Sales of ZAM coated product for Nisshin Steel have grown over the past 15 years to over 60,000 tons per month.

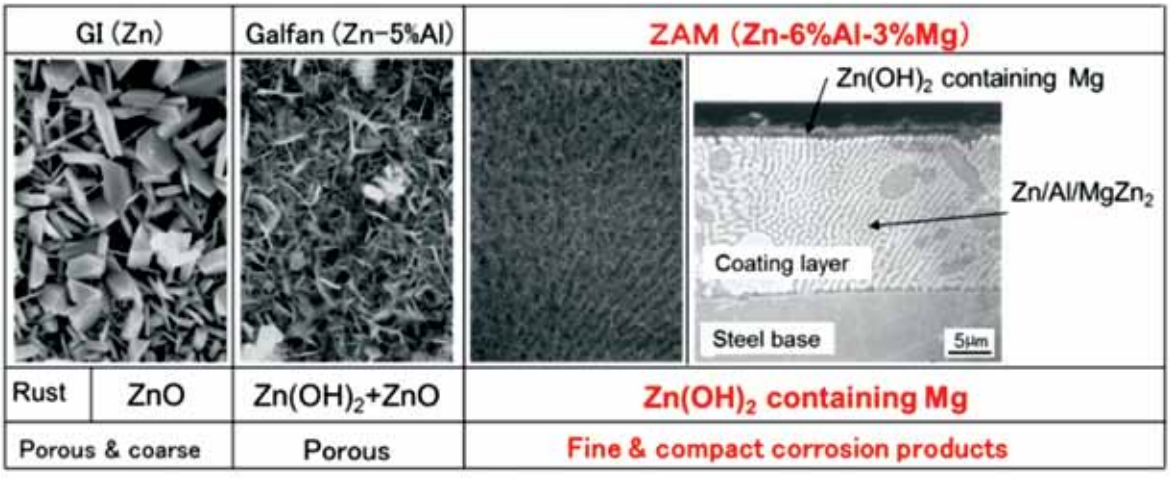
The ZAM project at Wheeling-Nisshin began in October 2012 and was fully completed one year later at a cost of $28 million. Wheeling-Nisshin is the first zinc, aluminum, magnesium (Zn-Al-Mg) alloy producer in the United States and North America. Initial (hot run) production was conducted in May, a second run in August and the final installation run in November of 2013. The ZAM project has been Wheeling-Nisshin's largest investment to their facility since the second coating line was commissioned in 1993. Wheeling-Nisshin has a hot-dip coating capacity of 700,000 tons per year of coated steel products to include Galvalume® Aluminized (type 1 and type 2), Galvanized, Galvanneal, and now ZAM.

Wheeling-Nisshin President/CEO, Noboru "Ricky" Onishi, explains that ZAM is a "natural extension for our current operations in West Virginia and allows our company and employees to grow into a new area of production." He continued saying, "we have a significant investment because we see the potential of ZAM, a potential, we think, that can be considered the corrosion protection of the 21st century."

Onishi states that "this product is five-to 10-times stronger than existing coatings and is suitable for a wide array of end-uses. It's for anybody looking for higher, better corrosion resistance. Gradually, we'll expand sales of ZAM to our customers. It's not going to happen overnight, since very few people know about it and it will be an education process."







What is ZAM, How Does it Work

ZAM is an extremely corrosion resistant alloy coating comprised of 91% zinc, 6% aluminum, 3% magnesium. This coating falls within the ASTM A1046 specification and has been shown to out perform galvanized coatings in corrosion resistance by a factor of up to 10 times. The chemistry of 6% Aluminum and 3% Magnesium is the key to ZAM's excellent performance.

The alloy coating starts to oxidize when it is exposed to air, and the subsequent formation of corrosion products creates a fine, dense protective barrier on its surface. The percentages of aluminum and magnesium used in the Zn-6%Al-3%Mg alloy facilitate the formation of optimum corrosion products--that is, basic zinc compounds (basic zinc aluminum carbonate) and amorphous compounds containing aluminum and magnesium that are composed of very fine crystal structures.

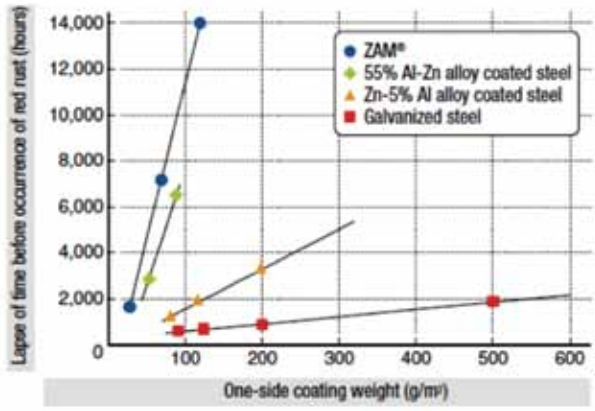
The superior corrosion stability of the Zn-Al-Mg alloy is related to the presence of oxide layers with better protective properties than those of zinc-based oxide layers.. This layer provides long term corrosion resistance by suppressing further oxidation, which inhibits corrosion of the underlying Zn-6%Al-3%Mg alloy coating.

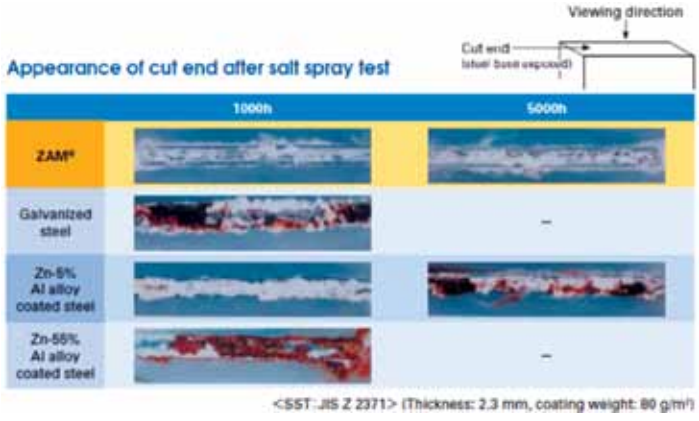
Accelerated testing of ZAM coating demonstrates the unique and remarkable protection provided by the alloy.

The same corrosion product film that forms on the surface of ZAM also protects any exposed (cut) edge. Over time, this film flows over cut edges with the aid of moisture. This effect is dependent on how wet the environment is, so the more humid an environment the sooner the cut the cut edge will be protected by this film. It should be noted that, since ZAM is 91% zinc, the cut edges would be protected in the interim by galvanic reaction, where the zinc will sacrifice itself prior to the base steel rusting.

This attribute can extend the life of the base metal and coating by many years. It also allows ZAM to be used where particular applications previously required post dipping or heavy galvanized coatings.

The improved corrosion protection of ZAM makes possible lower ZAM coating weights as replacement for heavier conventional coatings--thus saving cost and resources. This product has also been proven to be remarkably resistant to high chlorides (marine), high ammonia (agriculture) and high sulfur dioxides (industrial)





environments. No other metallic coating offers better protection than ZAM. Due to the exceptional corrosion resistance, Wheeling-Nisshin offers a limited long-term warranty for ZAM steel sheeting.

Many independent studies have been conducted to review the significance of Zn-Al-Mg alloy coatings. An April 2008 report published by the French Institute of Corrosion titled "Zn-Mg Automotive Steel Coatings", reported that the alloying of zinc coatings with magnesium and aluminum significantly improves their corrosion resistance under atmospheric conditions. Red rust appearance and onset of paint delamination from defects were delayed in comparison to traditional zinc coated steel with comparable coating thickness.

●<Reference> Hardness of the coating layer
(Vickers hardness (Hv) : measurement examples)

ZAM®	140~160Hv
55%Al-Zn alloy coated steel	100~110Hv
Zn-5%Al alloy coated steel	80~100Hv
Galvanized steel	55~ 65Hv

ZAM has been promoted historically as a bare coated sheet, but a great deal of work has been done regarding the pre-painting of this new alloy coating. Nisshin Steel currently pre-paints about 1,000 tons of ZAM products each month, while several customers are pre-painting their own ZAM material with great success.

Our company is working closely with key paint related vendors to assure that best practices are developed within the U.S. market. To date, three coil coating companies (four paint lines); four paint suppliers and four pretreatment suppliers are actively painting and evaluating pre-painted ZAM.

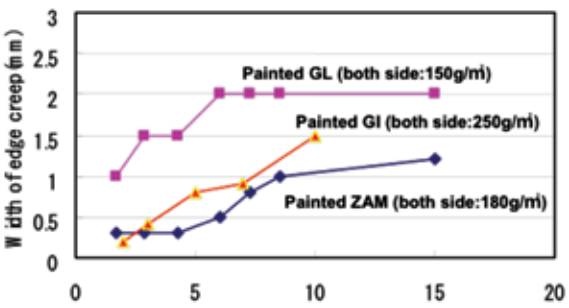
One related characteristic of the ZAM coating is the fact the coating surface is significantly harder than other conventional coatings---nearly three times harder than galvanized coating surfaces.

While all metal coatings experience some degree of cracking when formed, the harder ZAM surface is prone to microcracking when end product forming is severe---similar to the performance of Galvalume coated sheet.

Nisshin Steel's pre-paint customers have followed a full range of approaches for pre-painting ZAM sheet---from using conventional polyester paint systems to using more robust macromolecular paint systems that exhibit greater elasticity. The ZAM surface hardness should be considered when determining the very best pre-paint system to use. Clearly this has been addressed in many cases without issue.

The exceptional corrosion protection of the ZAM coating is still in play when pre-painting the product. One important improvement found with pre-painted ZAM is edge creep corrosion performance at cut edges. The width of edge creep over time (10 years and greater) is remarkable.

Edge creep depth for pre-painted ZAM is significantly less than GI and GL coatings under the exact same conditions.



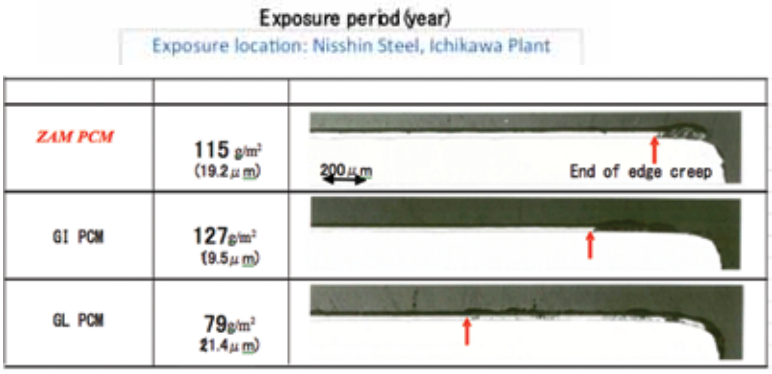
Improved Corrosion Resistance

ZAM has been developed to give improved corrosion resistance in aggressive environments, with greatly improved corrosion resistance at cut edges. ZAM coated steel offers the buyer a thinner coating, yet more protection than conventional coatings. This thinner coater can mean cost savings for the buyer. Significant cost savings can be gained due to:

- Longer service life
- Lower maintenance
- Lower coating weights than other metallic coatings, reducing cost and benefiting the environment.

Additionally, there are some important features of the product such as:

- Superior cut edge rust protection over other coated products
- Harder surface with less abrasion resulting in better formability and less tool cleaning



5 year 8 months exposure test - coastal site

• Self-healing coating---small scratches at the cutting face or surface do not rust and are self-healing
• Excellent weldability with lower coating weights.

Suitable applications for ZAM include architectural building panels, perforated panels, construction (roofing, fascia, building panels, etc.), agriculture (chicken grow out houses, swine containment, hoop buildings, grain bins and silos, etc), solar racking, automotive, school bus, electrical cabinets, sign posts, guardrail, sound/wind/snow barriers, green house structures, industrial HVAC, and many other applications.