#30

ToolKit

www.coilcoating.org

A Publication of the National Coil Coating Association

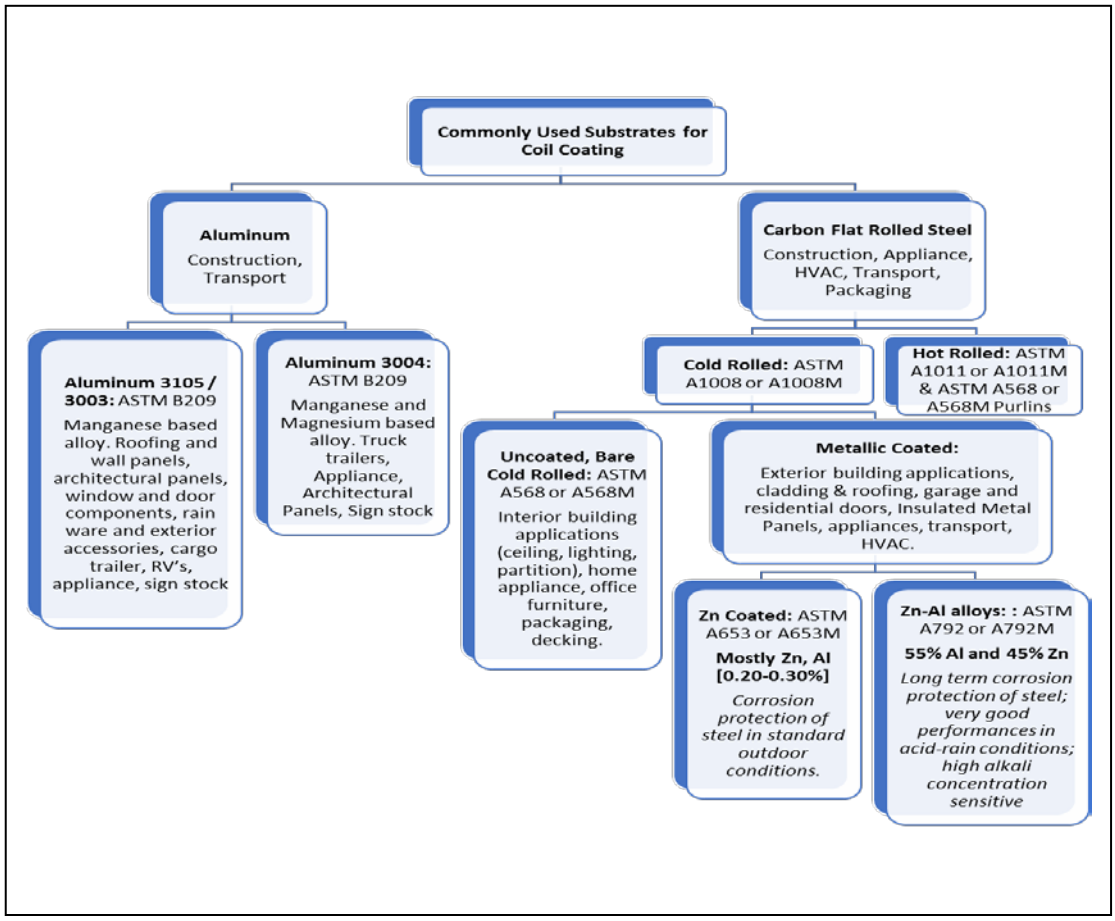
National Coil Coating Association

Guide to Metal Substrates for the Coil Coating Industry

Introduction

This toolkit provided relevant information for the coil coating industry regarding the differences and technical specificities of metal substrates, especially as they run through a paint line.

This document includes information about aluminum and flat carbon steel used as substrate for coil coating. Please note that stainless steel products are not covered in this paper.



This Tool Kit is part of a series of educational aids developed by the members of the National Coil Coating Association. NCCA is a trade association of coil coaters and suppliers of raw materials and equipment used in the coil coating process. The association concentrates its efforts on providing educational resources and assisting its members in providing superior products and services to their customers. NCCA Tool Kits are informational tools and should not be used as substitutes for instructions from individual manufacturers. Always consult with individual manufacturers for specific instructions regarding their products and equipment.

1. Aluminum Substrates

a. Product Characteristics

There are two methods for producing aluminum: primary production, which involves mining bauxite that eventually becomes aluminum, and secondary production, which makes new aluminum from recycled scrap products. The most commonly used alloys for prepainted products are typically produced using the secondary production method. Scrap materials are melted, mixed with primary raw materials to meet alloy specifications, and rolled into sheet/coil products. Recycled aluminum products require only 8% of the energy and create only 8% of the emissions as compared with primary production. 75% of all aluminum ever produced is still in use today.

	Aluminum 1100	**Aluminum 3105 / 3003**	**Aluminum 3004**	**Aluminum 5052**
Coil coating	Limited Applications	Mainstream	Mainstream	Limited Applications
Alloy Composition	99% purity Excellent workability, and conductivity.	Manganese is major alloying element. All-purpose alloys. Good workability. *3105 and 3003 are typically interchangeable alloys.*	Manganese and Magnesium are the major alloying elements. Used when moderate to good strength is needed. *3004 can often be used in traditional 5052 applications*	Magnesium is major alloying element. Excellent strength characteristics, weldable.
ASTM Specification	B209	B209	B209	B209
End-use markets	Pipe Jacketing, Fin stock, Electrical components	Roofing and wall Panels, Architectural Panels, Window and Door Components, Rain ware and exterior accessories, Cargo Trailer, RV's, Appliance, Sign stock	Truck trailers, Appliance, Architectural Panels, Sign stock	Transportation and Sign stock

2. Metallic Coated Steel Substrates

a. Product Characteristics

The most commonly used zinc-alloy metallic coated steel products are Galvanized steel and Galvalume™ (Aluminum-Zinc). There are other metallic coating options offered by the mills, such as Galfan (Zinc-Aluminum) and Zinc-Magnesium (ZM) coatings, but their shares in the North American coil coating landscape are anecdotal. Table 1 below summarizes the typical metallic coated steel products.

In addition, based on the application, the metallic coating can be produced with minimized (no) spangle. It can also have a light to heavy metal alloy coating for additional corrosion protection. Inline or post temper rolling operations may be required if a smoother surface is required.

	Galvanize (GI)	Aluminum-Zinc (GU – Galvalume™)	Zinc-Aluminum (GF – Galfan)	Zinc-Aluminum-Magnesium (ZM)
Coil coating	Mainstream	Mainstream	Not common place	New, limited applications
Coating Composition	Mostly Zn, 0.20-0.30% Al	55% Al, ~45% Zn	~95% Zn, 5% Al	Zn [99.1-83%] Al [0.5-13%] Mg [0.4-4%]
ASTM Specification	A653/A653M	A792/A792M	A875/A875M	A1046/A1046M
End-use markets	Used in all market segments	Mostly used in North America for building products (cladding & roofing)	Small in the coil coating industry in North America	Developed in Europe and Asia as bare and painted material depending on the alloy composition
Typical coating weights for prepainted steel sheets	G30 (Z100), G40 (Z120), G60 (Z180), G90 (Z250)	AZ50 (AZM150), AZ55 (AZM165)	ZA255	Varies depending on the alloy composition

Table 1: Typical metallic coated steel products

b. Coating Operations

Hot Dip Galvanize (HDG) products are produced at numerous galvanizing facilities in North America using continuous lines by passing pre-heated steel strip through a bath of molten zinc or various zinc alloys. The required metallic coating thickness for different coating specifications and compositions is achieved as the result of passing the hot dipped strip through a variable low pressure, high volume air stream called an “air knife” prior to solidification of the zinc coating.

Resources/Links:

1. The Aluminum Association: https://www.aluminum.org/
   Standards and Data book is available at The Aluminum Association bookstore
   https://www.aluminum.org/resources/faqs-information/bookstore-news-and-login
   Mechanical properties of each alloy and temper is listed in Table 7.1
   Aluminum in Green Buildings
   Environmental Product Declarations
2. Corrosion Performance of Metallic Coated Steels – ArcelorMittal Dofasco Publications
   https://dofasco.arcelormittal.com/~/media/Files/A/Arcelormittal-Canada/documents/corporate-publications/corrosion-english.pdf
3. Galvanize, Galvanneal, & Electrogalvanize Steel Fact Sheet – ArcelorMittal Dofasco Publications
   https://dofasco.arcelormittal.com/~/media/Files/A/Arcelormittal-Canada/documents/corporate-publications/galvanie-galvanneal.pdf
4. GalvInfoNote 1.2- Hot-Dip Coated Sheet Products – GalvInfo Center https://www.galvinfo.com/wp-content/uploads/sites/8/2017/05/GalvInfoNote_1_2.pdf
5. GalvInfoNote 1.5-ASTM Standards for Coated Sheet Products https://www.galvinfo.com/wp-content/uploads/sites/8/2017/05/GalvInfoNote_1_5.pdf
6. NCCA Toolkit #4, Fundamentals of Corrosion and Their Application to Coil Coated Metal,
   https://www.coilcoating.org/download.php/education/toolkits/tool-kit-4
7. NCCA Toolkit #5, Cut Edge Protection Using Prepainted Sheet,
   https://www.coilcoating.org/download.php/education/toolkits/tool-kit-5
8. NCCA Toolkit #18, Corrosion and Corrosion Tests,
   https://www.coilcoating.org/download.php/education/toolkits/tool-kit-18

Appendix 1 – Less Commonly Used Metal Substrates in the Coil Line Process

Electrogalvanize: Previously annealed continuous strip is passed through a series of plating cells where zinc is electrolytically plated onto the strip. By regulating the amount of electricity used, a precise uniform coating of zinc or zinc alloy is applied to the strip. The zinc or zinc alloy coatings produced are light weight coatings with no spangle, have a uniform appearance, and are used primarily for surface-critical painted applications for the automobile industry.

ASTM Standard: A879/A879M for Electroplated zinc-coated sheet with 100% zinc; A918 for Electroplated Zinc/Nickel alloy with 9-16% nickel and the balance of zinc.

Galvanneal: In this case after zinc coating, the strip is passed through an annealing furnace which transforms the zinc into a zinc-iron alloy coating on the steel surface. The zinc-iron alloy coating has no spangle, has a uniform grey matte appearance, and the coating weights are typically less than most HDG products.

ASTM Standard: A653/A653M for hot dip galvanized steel with 10% Iron

Aluminized coating:

ASTM Standard: A463/A463M for aluminum coating with 5 to 11% of silicon content or pure aluminum

Appendix 2 – Corrosion Performance of Galvanized (GI), Aluminum-Zinc (GU), Zinc-Aluminum (GF) and Zinc-Aluminum-Magnesium (ZM) Metallic Coated Steels

Bare or painted, the measure of any metallic coated steel's durability is its resistance to corrosion. Metallic-coated steels offer two important layers of protection to the underlying steel: galvanic and barrier protection. These properties of the zinc coating protect the base steel and any cut edges from corrosion and provide a good surface for paint for additional barrier protection and aesthetics.

First, let's examine **barrier protection**. For zinc-rich coatings, as is the case with GI, GF, and ZM products, the coating provides an impervious barrier to the steel substrate. However, since zinc is highly reactive, it also oxidizes and corrodes (although more slowly than the steel) and eventually over many years erodes away. Coatings containing aluminum, on the other hand, form a much more durable oxide layer. For example, GU's high aluminum content means more aluminum oxide is formed, resulting in a more stable, more tightly adhering and more non-corroding barrier.

Next, let's examine **galvanic protection**. Zinc essentially sacrifices itself (oxidizes) to protect the steel substrate. The more zinc, the greater the galvanic protection. Therefore, the GU coating clearly exhibits less galvanic protection than a galvanized coating. However, being less galvanic in nature, a GU coating is less reactive. This is one reason why the life of this coated product is considerably longer in most cases than a galvanized coating of comparable thickness. This behavior of a 55% aluminum zinc alloy coating is the reason why it is being used successfully for painted roofing applications.

Other corrosion performance considerations:

- **Environment:** The high aluminum content in the GU coating provides superior protection in acidic environments (acid rain) for industrial applications. However, there are specific niche applications where it should not be used, particularly alkaline (basic) environments such as against wet concrete and for animal confinement.
- **Cut-edges and scratches:** Any exposure of the metallic coating underneath the paint layers, due to a cut edge or severe scratches, will not result in corrosion of the steel until the adjacent metallic coating has been consumed. A little time is needed before the metallic coating can "flow" over these cut edges to protect them from further corrosion. How effectively each type of metallic coated steel does this largely depends on the thickness of the material and width of the scratch. Of the other four coating types, ZM coatings most effectively suppress cut edge corrosion on heavy gauge materials only (>2mm/.079").
- **Proven long-term performance in natural exposure:** GU and GI prepainted products have been successfully used for more than 30 years in Canada and the U.S., covering a range of building applications in various environments from severe marine to industrial to rural.