GalvInfoNote 1.2	Hot-Dip Coated Sheet Products Rev 1.1 Jan 2011

Introduction

GalvInfoNote 2.1 describes the steel sheet hot-dip coating process, explaining how it is used to make seven different types of coated products. These products, and the specifications to which they are made, are described in more detail below. For more information on the ASTM standards covering these materials (and how to obtain the standards), refer to GalvInfoNote 1.5.

Types of Hot-Dip Coatings

Coating Name	Coating Composition	ASTM Specification
Galvanize	Zinc	A653/A653M A1063/A1063M
Galvanneal	Zinc-10% Iron	A653/A653M
Aluminum-Zinc	55% Aluminum-Zinc	A792/A792M
Zinc-Aluminum	Zinc-5% Aluminum	A875/A875M
Zinc-Aluminum-Magnesium	Zn-5/13% Al-2/4% Mg	A1046/A1046M
Aluminized	Al-5/11% Si, or pure Al	A463/A463M
Terne	Lead-8% Tin	A308/A308M
General requirements for all hot-dip coatings – ASTM A 924/A 924M		

ASTM Hot-Dip Steel Sheet Specifications

A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

- Covers galvanized and galvannealed steel sheet in coils and cut lengths.
- The most commonly used type of coated-steel sheet in manufacturing and construction.

A1063/A1063M - Standard Specification for Steel Sheet, Twin-Roll Cast, Zinc-Coated (Galvanized) by the Hot-Dip Process

- Covers steel sheet produced by the Twin-Roll Cast process and galvanized in coils and cut lengths.
- Contains only galvanized sheet for commercial, structural, and high-strength low-alloy grades.

A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

- Covers 55% aluminum-zinc alloy-coated steel sheet in coils and cut lengths.
- Intended for applications requiring high corrosion resistance and/or heat resistance.

A875/A875M - Standard Specification for Steel Sheet, Zinc-5% Aluminum Alloy-Coated by the Hot-Dip Process

- Covers steel sheet, in coils and cut lengths, metallic-coated by the hot-dip process, with a zinc-5 % aluminum alloy coating.
- Coating is produced as **two types**: zinc-5% aluminum-mischmetal alloy or zinc-5% aluminum-magnesium alloy.
- Intended for applications requiring corrosion resistance, formability, and paintability.

A1046/A1046M - Standard Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process

- Covers steel sheet, in coils and cut lengths, metallic-coated by the hot-dip process, with a zinc-5-13% aluminum, 2-4% magnesium alloy coating.
- Intended for applications requiring superior corrosion resistance and paintability.

A463/A463M - Standard Specification for Steel Sheet, Aluminum-Coated by the Hot-Dip Process

- Covers aluminum coated steel sheet in coils and cut lengths with **two types** of aluminum coating.
- Type 1 coating is an aluminum-silicon alloy intended for heat resisting applications and for uses where corrosion and heat are involved.
- Type 2 coating is commercially pure aluminum intended for applications requiring corrosion resistance.

A308/A308M - Standard Specification for Steel Sheet, Terne (Lead–Tin Alloy) Coated by the Hot-Dip Process

- Covers steel sheet, in coils and cut lengths, metallic-coated by the hot-dip process, with a lead-3-15% tin alloy coating.
- Primary end use is automotive fuel tanks.

A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

- Covers the general requirements that apply to all hot-dip coated steel sheet in coils and cut lengths.
- Contains the common requirements for all types of hot-dip metallic-coated steel sheet, such as dimensional tolerances for thickness, width, flatness, etc.

Hot-Dip Galvanized Steel Sheet (A653/A653M and A1063/A1063M)

- A galvanize coating is essentially a zinc coating on steel sheet. The word “galvanize” comes from the galvanic protection that zinc provides to steel when exposed to a corroding environment.
- It is, by far, the most common hot-dip coated product with a wide range of applications.
- Zinc provides both galvanic and barrier protection. The galvanic protection is greater than for any other type of hot-dip coating on steel.
- The coating contains aluminum – typically between 0.20 and 0.30%. Aluminum is added to the molten zinc bath to control the growth rate of the alloy layer (bond zone between the steel and zinc coating). It dramatically improves adhesion of the coating to allow severe forming of the coated sheet.
- Coating may contain a small amount of lead and/or antimony for spangle development. Almost all galvanized product contains “no lead”, and if it does, the lead is less than 0.03%.
- Coating weight [mass] range available: 0.30 – 4.00 oz/ft^2 [90 – 1200 g/m^2] for A653/A653M, and 0.30 – 1.85 oz/ft^2 [90 – 600 g/m^2] for A1063/A1063M total both sides.
- Coating designations: “**G**” (Inch-Pound), “**Z**” (SI).

Hot-Dip Galvannealed Steel Sheet (A653/A653M)

- A hot-dip galvanize coating that is diffusion-alloyed with the steel by additional heating in the tower above the coating bath.
- Typical coating contains 8 to 11% iron.
- Intended to be painted for most applications.
- Characterized by its high hardness and brittle behavior during forming.
- Easier to spot weld and paint than galvanized product.
- Performance under paint is synergistically improved because of the excellent bond formed between the paint and the surface of the coating. Compared to a galvanized product, galvanneal generally exhibits less undercutting corrosion beneath paint at exposed edges, scratches, or other defects in the paint.
- Used by a number of auto companies for body panels. (Galvanneal used for automotive end uses is ordered to auto company specifications).
- Coating weight [mass] range available: 0.30 – 0.60 oz/ft^2 [90 – 180 g/m^2] total both sides.
- Coating designations: "**A**" (Inch-Pound), "**ZF**" (SI).

Hot-Dip 55% Aluminum-Zinc Alloy Coated Steel Sheet (A792/A792M)

- An aluminum/zinc alloy coating that contains approximately:
    - 55% aluminum,
    - 43.5% zinc
    - 1.5% silicon.
- Offers excellent barrier-coating protection combined with some galvanic protection.
    - Retention of galvanic protection is an important feature.
- This particular combination of aluminum and zinc effects the formation of a coating microstructure that is very important for good performance. Provides a very good balance between galvanic and barrier protection.
- Silicon is added to control the alloy-layer growth rate. Improves adhesion during forming.
- Much higher resistance to corrosion than galvanize coatings in most environments. Long-term durability has been demonstrated.
- Coating weight [mass] range available: 0.30 – 0.70 oz/ft^2 [100 – 210 g/m^2] total both sides.
- Coating designations: "**AZ**" (Inch-Pound), "**AZM**" (SI).

Hot-Dip Zinc-5% Aluminum Alloy Coated Steel Sheet (A875/A875M)

- A galvanic coating that contains approximately 95% zinc and 5% aluminum.
- Provides approximately the same galvanic protection as galvanized and improved corrosion resistance in most environments.
- Primary attributes are the improved corrosion resistance an coating ductility vs. a galvanized coating
- Used mostly for applications that require good coating ductility – deep drawn parts and prepainted sheets and superior corrosion resistance.
- Coating weight [mass] range available: 0.30 – 2.35 oz/ft^2 [90 – 700 g/m^2] total both sides.
- Coating designations: "**GF**" (Inch-Pound), "**ZGF**" (SI).

Hot-Dip Zinc-Aluminum-Magnesium Alloy Coated Steel Sheet (A1046/A1046M)

- A galvanic coating that contains zinc, 5 to 11% aluminum, and 2 to 4% magnesium.
- Provides superior corrosion resistance in many aggressive environments.
- Used in such applications as transportation infrastructure construction, agricultural, electric power, and automotive.
- Coating weight [mass] range available: 0.20 – 2.10 oz/ft^2 [60 – 600 g/m^2] total both sides.
- Coating designations: "**ZM**" (Inch-Pound), "**ZMM**" (SI).

Hot-Dip Aluminized Steel Sheet (A463/A463M)

- Two types of aluminized coatings -
  - Type 1 – Aluminum and 5 to 11% silicon
  - Type 2 – Pure aluminum coating
- Most common form is Type 1 coating; used for applications that require heat-oxidation resistance such as furnace parts, small appliances, exhaust systems, etc.
  - Best coating on steel sheet for heat-oxidation resistance
  - Can be applied over stainless steel to offer even better high temperature performance.
- Pure Al Type 2 coating is used for exterior applications.
  - Corrosion performance is based on barrier protection; no galvanic protection in most environments.
  - Barrier corrosion protection is very good.
    - Forms a stable aluminum oxide film on the surface of the coating.
- Coating weight [mass] range available: Type 1 0.25 – 1.00 oz/ft^2 [75 – 300 g/m^2] total both sides.
  Type 2 0.65 – 1.00 oz/ft^2 [200 – 300 g/m^2] total both sides.
- Coating designations: Type 1 "**T1**" (Inch-Pound), "**T1**" (SI).
  Type 2 "**T2**" (Inch-Pound), "**T2**" (SI).

Terne-Coated Steel Sheet (A308/A308M)

- A lead-alloy coating that contains 3 to 15% tin.
- Tin is added to develop a bond between the coating and steel.
- The coating is very formable. Improves the deep drawing behavior. Also, the product is easily welded.
- Very good resistance to gasoline, although use for fuel tanks is decreasing (related to the environmental issue associated with lead; not product performance).
- Coating weight [mass] range available: 0.25 – 1.10 oz/ft^2 [75 – 335 g/m^2] total both sides.
- Coating designations: "**LT**" (Inch-Pound), "**LTZ**" (SI).