Designation: A385/A385M – 22

Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)[1]

This standard is issued under the fixed designation A385/A385M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers the precautions that should be taken to obtain high-quality hot-dip galvanized coatings.

1.2 Where experience on a specific product indicates a relaxing of any provision, the mutually acceptable change shall be a matter for agreement between the manufacturer and purchaser.

1.3 *Units*—This practice is applicable to orders in either inch-pound units (as A385) or in SI units (as A385M). Inch-pound units and SI units are not necessarily exact equivalents. Within the text of this specification and where appropriate, SI units are shown in brackets. Each system shall be used independently of the other without combining values in any way.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A123/A123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A143/A143M Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

A153/A153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A384/A384M Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

A563 Specification for Carbon and Alloy Steel Nuts (Metric) A0563_A0563M

A751 Test Methods and Practices for Chemical Analysis of Steel Products

2.2 *AISC Document:*[3]

Steel Construction Manual 15th Edition, Sections 16.1 and 16.2

2.3 *AMPP Document:*[4]

SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning

3. Steel Selection

3.1 The production of a galvanized coating has as its basis the metallurgical reaction between the steel and the molten zinc, resulting in the formation of several iron-zinc compound layers, for example, gamma (not always visible microscopically), delta, and zeta in Fig. 1. In addition, a layer of the molten zinc adheres to the surface of the compound layers as the steel is withdrawn from the galvanizing bath. Upon solidification, this adherent zinc forms the eta layer.

3.2 It is known the structural nature of the galvanized coating, as typified by Fig. 1, cannot be guaranteed by the galvanizer and may be modified in accordance with the chemical nature of the steel being galvanized. Certain elements found in steels are known to have an influence on the coating structure. The elements of carbon in excess of about 0.25 %, phosphorus in excess of 0.04 %, or manganese in excess of about 1.3 % may cause the production of coatings different from the coating typified by Fig. 1. The element with the most significant effect on the galvanized coating is silicon. This element has two composition regions that can produce thick and dull coatings. The first region is silicon concentration between 0.06 % and 0.13 % and is known as the Sandelin region. The second region is silicon concentration above 0.25 %. When producing or purchasing steels to be hot-dip

[1] This practice is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.13 on Structural Shapes and Hardware Specifications.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-2001, http://www.aisc.org.

[4] Available from Association for Materials Protection and Performance (AMPP), 15835 Park Ten Place, Houston, TX 77084, https://www.ampp.org.

***A Summary of Changes section appears at the end of this standard**

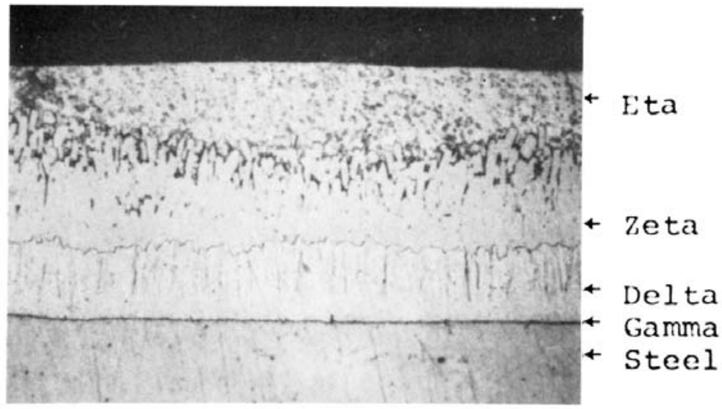

FIG. 1 Photomicrograph of Normal Galvanized Coating (X 400)

galvanized, a good practice is to aim for steels with a silicon concentration target of <0.04 % and a maximum of 0.06 % to avoid the Sandelin region and to aim for steels with a silicon concentration target of >0.15 % to <0.22 % and a minimum of 0.13 % and a maximum of 0.25 % to avoid both the Sandelin region and the high silicon region. Recent studies have shown that, even in cases where the silicon and phosphorous are individually held to desirable limits, a combined effect between them can produce a coating as shown in Fig. 2, which typically would have a mottled or dull gray appearance. The values of silicon and phosphorus in the mill test reports of steel can give an indication of the reactivity of the steel in the hot-dip galvanizing process but are not a guarantee. As defined in Test Methods and Practices A751, a cast or heat analysis (listed on the mill test report) represents only one sample taken from the heat and is known to vary from individual pieces, which are subject to product analysis. The product analysis normally allows greater deviation than the heat analysis, and individual parts can therefore vary more than the mill test report in chemical analysis and surface chemistry. When performing an evaluation of steel reactivity for galvanizing, the outcome of this variation can be significant, which may result in coatings different from those typified by Fig. 1. Fabrications made from recycled steel are also known to exhibit variations in surface chemistry which may differ significantly from the heat analysis. In some cases, galvanizing a test piece is helpful to obtain an indication of steel reactivity. It is crucial the test piece accurately represents the final part to be galvanized both in chemistry and thickness. It is also important that the dwell time in the galvanizing bath is similar for test pieces as that expected on the actual fabrication since the time in the bath can cause coating variations on reactive steel chemistry.

3.3 These elements manifest their structural effect as an accelerated growth of the compound layers, particularly the zeta layer, and the virtual elimination of the eta layer. Cosmetically, this accelerated growth is seen as a gray matte finished coating as opposed to the usual bright and smooth appearance of galvanized coatings. Sometimes, a large surface may have adjacent areas of matte finish and bright finish leading to a mottled appearance.

3.4 There is some evidence that the coatings resulting from this accelerated growth are more brittle and less adherent than normal coatings. There is also evidence that these coatings are subject to a premature red staining in atmospheric exposure; however, this staining has been found not to be associated with corrosion of the substrate steel.

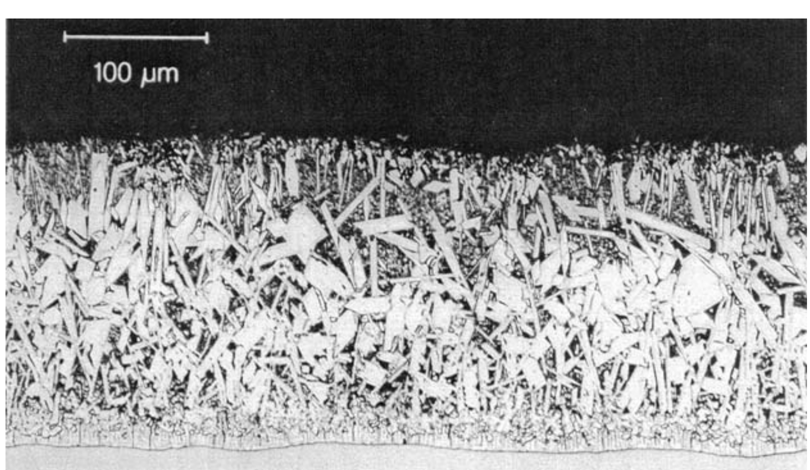

FIG. 2 Photomicrograph of Dull Gray, Thick-Galvanized Coating (X 200)