



Standard Specification for Chromium Free Zinc-Flake Composite, with or without Integral Lubricant, Corrosion Protective Coatings for Fasteners¹

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1. Scope

1.1 This specification covers the basic requirements for non-electrolytically applied zinc-flake composite corrosion protective coating systems for fasteners (See [Note 1](#)).

NOTE 1—The coating systems do not contain hexavalent chromium, lead, cadmium, or mercury.

1.2 This specification is intended for corrosion protection of inch and metric series threaded fasteners with minimum nominal diameters of 0.250 in. for inch series and [6.00 mm] for metric as well as for non-threaded fasteners such as washers and pins.

1.3 This coating system may be specified to consist of a zinc-flake basecoat, or a zinc-flake basecoat and topcoat (See [Note 2](#)).

NOTE 2—For threaded fasteners, the coating system will typically consist of a zinc-flake basecoat and topcoat.

1.3.1 The basecoat is a zinc-rich material containing aluminum flakes dispersed in a compatible liquid medium. The zinc-flake basecoat may be specified to contain integral lubricant.

1.3.2 Topcoats may be organic or inorganic in composition depending upon the specified requirements.

1.3.2.1 Organic topcoats consist of polymer resins, aluminum, dispersed pigments, and are colored in their applied state.

1.3.2.2 Inorganic topcoats consist of water-dispersed silicate compounds and are transparent in their applied state.

1.3.2.3 Topcoats contain integral lubricants and are applied in conjunction with zinc-flake basecoats to form a coating system with enhanced performance attributes such as increased corrosion resistance, total coefficient of friction properties, chemical resistance, and color.

1.4 These zinc-flake basecoats and topcoats are applied by conventional dip-spin, dip-drain, or spray methods to fasteners

which can be handled through a cleaning, coating, and curing operation. The maximum curing temperature is 482°F [250°C].

1.5 The friction properties of the coating system may be determined by a standard test to verify process control or by a part specific test which requires the purchaser to establish and communicate technical criteria.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[B117 Practice for Operating Salt Spray \(Fog\) Apparatus](#)

[B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section](#)

[B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals](#)

[B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry](#)

[D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces](#)

[D3359 Test Methods for Measuring Adhesion by Tape Test](#)

[E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current \(Electromagnetic\) Testing Methods](#)

¹ This specification is under the jurisdiction of ASTM Committee [F16](#) on Fasteners and is the direct responsibility of Subcommittee [F16.03](#) on Coatings on Fasteners.

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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.

F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric)

F788 Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F1624 Test Method for Measurement of Hydrogen Embrittlement Threshold in Steel by the Incremental Step Loading Technique

F1789 Terminology for F16 Mechanical Fasteners

F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners

2.2 *International Organization for Standardization (ISO)*³
ISO 16047 Fasteners – Torque/clamp force testing

3. Classification

3.1 The coating systems are classified into four (4) grades according to the requirements provided in **Table 1**. The process application parameters and cure temperatures shall be in accordance to the recommendations of the coating system manufacturer.

3.1.1 *Grade 1*—requires application of the zinc-flake basecoat only. No topcoat is applied in Grade 1. Appearance of the coating in the applied state is silver/grey.

3.1.2 *Grade 2*—requires application of the zinc-flake basecoat containing integral lubricant for friction modification. No topcoat is applied in Grade 2. Appearance of the coating in the applied state is silver/grey.

3.1.3 *Grade 3*—requires application of the zinc-flake basecoat and organic topcoat. The organic topcoat contains

integral lubricant for friction modification. Options for coating color and average total coefficient of friction (μ_{tot}) are provided in **Table 1**.

3.1.4 *Grade 4*—requires application of the zinc-flake basecoat and inorganic topcoat. The inorganic topcoat contains integral lubricant for friction modification. Appearance of the coating in the applied state is silver/grey. Options for average total coefficient of friction (μ_{tot}) are provided in **Table 1**.

3.2 Regardless of the process or materials used, the zinc-flake basecoat and organic/inorganic topcoats shall conform to all of the applicable requirements of this specification.

4. Ordering Information

4.1 Orders for materials in accordance with this specification shall include the following information:

- 4.1.1 Quantity of parts,
- 4.1.2 Grade of coating (See **Table 1**),
- 4.1.3 For Grade 3, color code of the coating,
- 4.1.4 For Grades 3 and 4, friction code of the coating when applicable,
- 4.1.5 Corrosion resistance requirement expressed in test duration hours,
- 4.1.6 Maximum coating thickness, if applicable,
- 4.1.7 Acid free processing certification, if applicable,
- 4.1.8 Part sampling plan,
- 4.1.9 Certification and test report requirements, and
- 4.1.10 Any additions to the specification as agreed upon by the purchaser and the supplier.

5. Requirements

5.1 *Appearance*—When viewed without magnification, the coating shall have a uniform appearance and be free from uncoated areas and discontinuities which affect part function such as excess coating.

5.2 *Adhesion*—The coating shall show only trace peeling or removal along incisions or at their intersection, acceptance criteria 4A per Test Method **D3359**, following the X-Cut tape adhesion test (See **Note 3**).

³ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

TABLE 1 Coating System Classification

Grade	Coating System		Color Code	Finished Appearance	Friction Code	Average Total Coefficient of Friction (μ_{tot}) ⁴
	Basecoat	Topcoat				
1	Zinc-Flake	None	...	Silver / Grey	...	...
2	Zinc-Flake w/Integral Lubricant	None	...	Silver / Grey	...	0.14±0.03
			B	Black	L2	0.14±0.03
			D	Dark Blue	L3	0.17±0.03
			G	Green	...	0.17±0.03
			K	Light Blue	...	0.17±0.03
3	Zinc-Flake	Organic	R	Red	...	0.17±0.03
			S	Silver	L2	0.14±0.03
			...	...	L3	0.17±0.03
			Y	Yellow	...	0.17±0.03
			...	...	L1	0.11±0.02
4	Zinc-Flake	Inorganic	...	Silver / Grey	L2	0.14±0.03
					L3	0.17±0.03

⁴The average result of the Total Coefficient of Friction (μ_{tot}) as determined in accordance to ISO 16047 shall lie within these limits when tested per **6.5.1** Program A. Friction values are applicable to a minimum sample set of ten tested fasteners.