Designation: B650 – 23

Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates[1]

This standard is issued under the fixed designation B650; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers the requirements for electrodeposited chromium coatings applied to ferrous alloys for engineering applications.

1.2 Electrodeposited engineering chromium, which is sometimes called "functional" or "hard" chromium, is usually applied directly to the basis metal and is much thicker than decorative chromium. Engineering chromium is used for the following:

1.2.1 To increase wear and abrasion resistance,

1.2.2 To increase fretting resistance,

1.2.3 To reduce static and kinetic friction,

1.2.4 To reduce galling or seizing, or both, for various metal combinations,

1.2.5 To increase corrosion resistance, and

1.2.6 To build up undersize or worn parts.

1.3 *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.*

1.4 *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]

B117 Practice for Operating Salt Spray (Fog) Apparatus

B177 Guide for Engineering Chromium Electroplating

B183 Practice for Preparation of Low-Carbon Steel for Electroplating

B242 Guide for Preparation of High-Carbon Steel for Electroplating

B320 Practice for Preparation of Iron Castings for Electroplating

B374 Terminology Relating to Electroplating

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

B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method

B507 Practice for Design of Articles to Be Electroplated on Racks

B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry

B571 Practice for Qualitative Adhesion Testing of Metallic Coatings

B602 Guide for Attribute Sampling of Metallic and Inorganic Coatings

B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings

B762 Guide of Variables Sampling of Metallic and Inorganic Coatings

B849 Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement

B850 Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement

D3951 Practice for Commercial Packaging

E8 Test Methods for Tension Testing of Metallic Materials [Metric] E0008_E0008M

F1459 Test Method for Determination of the Susceptibility of Metallic Materials to Hydrogen Gas Embrittlement (HGE)

[1] This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.03 on Engineering Coatings.

Current edition approved Nov. 1, 2023. Published December 2023. Originally approved in 1978. Last previous edition approved in 2023 as B650 – 95 (2023). DOI: 10.1520/B0650-23.

[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.

2.2 *Other Standard:*
MIL-S-13165 Shot Peening of Metal Parts[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *significant surfaces*—all surfaces upon which a deposit of controlled thickness is required.

3.1.1.1 *Discussion*—When a controlled deposit is required in holes, corners, recesses, and similar areas, special racking, auxiliary anodes or shielding, or both, will be necessary. With the best practices there will be areas where a controlled deposit is impossible.

3.2 Definitions used in this specification are in accordance with Terminology B374.

4. Classification

4.1 Electrodeposited chromium coatings in accordance with this specification are classified by the thickness of the coating as follows:

Class No.	Chromium Thickness, µm	Typical Application
1	2.5 to 25	reduce friction; anti-galling, light wear resistance
2	>25 as specified	buildup to dimension specified for salvage or as required for severe wear resistance

4.2 Unless otherwise specified by suitably marked drawings or samples, only those surfaces that can be touched with a 20-mm diameter ball shall be considered significant. In holes, corners, recesses, and other areas where a controlled deposit cannot be obtained under normal electroplating conditions, the thickness of the deposit may be that which results from control on the significant surfaces.

5. Ordering Information

5.1 The purchaser shall exercise the desired options of this standard. Ordering documents shall specify the following information:

5.1.1 Title, ASTM designation, and issue date of this specification,

5.1.2 Alloy and metallurgical condition of the product to be chromium plated,

5.1.3 Ultimate tensile strength of the material to be plated,

5.1.4 Heat treatment required for stress relief and whether it has been performed or is required,

5.1.5 The significant surfaces if different from the 20 mm ball rule (see 3.1.1),

5.1.6 Thickness of the deposit or class (see 4.1),

5.1.7 Control record requirements,

5.1.8 Preproduction test specimens, if required,

5.1.9 Sampling plan, if different from that specified in Test Method B602 (see Section 8),

5.1.10 The number of test specimens for destructive testing (see 7.1),

5.1.11 Thickness, adhesion, porosity, and hydrogen embrittlement tests required (see Section 6),

5.1.12 Whether separate test specimens will be used (see 7.1 and 7.5),

5.1.13 Where required, any special requirements for parts that are subsequently ground to size,

5.1.14 Where required, the base metal finish in terms of center line average (CLA) or arithmetic average (AA), and

5.1.15 Where required, dimensional tolerances allowed for the specified coating thickness or class.

5.2 The manufacturer of the parts to be electroplated shall provide the electroplating facility with test specimens (see Section 7) to be electroplated for conformance tests as requested for preparation, control, inspection, and lot acceptance unless other arrangements have been made between the purchaser and the electroplating facility.

6. Coating Requirements

6.1 The appearance of the chromium coating on the significant surfaces of the product shall be smooth and free of visual defects such as blisters, pits, roughness, cracks, burned deposits, uncoated areas, or macrocracking of the deposit that is visible without magnification. The boundaries of electroplating that cover only a portion of the surface shall, after finishing as indicated on the drawing, be free of beads, nodules, jagged edges, or other irregularities that will interfere with the functioning of the plated part. Imperfections and variations that arise from surface conditions of the basis metal (scratches, pores, roll marks, inclusions, etc.) and that persist in the finish despite the observance of good metal finishing practices shall not be cause for rejection.

NOTE 1—Applied finishes generally perform better in service when the substrate over which they are applied is smooth and free of torn metal, inclusions, pores, and other defects. It is recommended that the specifications covering the unfinished product provide limits for these defects. A metal finisher can often remove defects through special treatments such as grinding, polishing, abrasive blasting, chemical treatments, and electropolishing, which are not normal in the treatment steps preceding the application of the finish and will add to the cost. When they are desired, they are the subject of a special agreement between the purchaser and the seller.

6.2 In cases where design for maximum fatigue life is a consideration the parts should be shot peened (see MIL-S-13165C) or given an alternate mechanical treatment to compressively stress the surface.

6.3 *Stress Relief Treatment* (See headnote at the beginning of this specification.):

6.3.1 All steel parts having an ultimate tensile strength of 1000 MPa (150 000 psi—approximately 32 HRC) or greater, that may contain residual stress caused by various fabrication operations such as machining, grinding, straightening, or cold forming, will require one of the stress relief heat treatments prescribed in Specification B849 prior to electroplating. In all cases, the duration of heat treatment shall commence from the time at which the whole of each part attains the specified temperature.

6.3.1.1 The treatment selected, of necessity, must be based upon experience with the part or empirical test data. Therefore, Class SR-0 treatment is provided for parts that the purchaser wishes to exempt from treatment. However, many, if not most, steels with a tensile strength in excess of 1000 MPa will

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.