



Cosmetic Coating, Black Zinc-Nickel Based

1 Scope

1.1 Material Description. This finish is a bulk-applied finish for small ferrous parts. It consists of an electroplated zinc-nickel layer with passivation and topcoat.

1.2 Symbols. Not applicable.

1.3 Applicability. This coating is intended primarily for bulk-processed small steel parts, such as bolts, screws and nuts used on exterior and interior visible parts (cosmetic applications). The finish is especially suitable for internal drive (cross recess, hexalobular (six-lobed) socket, etc.) threaded fasteners and other parts with small recessed features. This specification covers requirements for a corrosion-resistant black finish for small parts.

1.4 Remarks.

1.4.1 Electroplating may not be suitable for all materials and applications. Each application must be reviewed with the responsible Materials Engineer before usage.

1.4.2 Use of this coating system on threaded surfaces and/or bearing surfaces of joints could affect the torque-tension relationship. It is recommended that a torque-tension study of the fastener joint be performed before releasing this finish on any new application.

1.4.3 This finish is suitable for temperatures up to +120 °C. Applications with exposures above this temperature shall be reviewed with the responsible Materials Engineer before usage.

1.4.4 High-strength or high-hardness steel parts are susceptible to hydrogen embrittlement. While certain precautions and post-plate de-embrittlement baking are generally effective in protecting the parts from hydrogen embrittlement, they are time sensitive and require extra care during processing.

Electroplating of steel parts with hardness above 46 HRc is not recommended.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

AIAG CQI-11/CQI-12	ISO 2813	ISO 16047	SAE/USCAR-7
ASTM D523	ISO 4892-1	ISO 17025	
ASTM F1470	ISO 4892-2	SAE J2527	
ISO 1463	ISO 9227	SAE/USCAR-5	

2.2 GM Standards/Specifications.

GMW3059	GMW14333	GMW14729	GMW14872
GMW14270	GMW14700	GMW14829	

2.3 Additional References.

- GM Drawing Numbers 11570102, 11548270, 11612005, 11611954, and 11611987.
- GM Global Primary Gloss Master – PGH (available at store.thierry-corp.com/store).

3 Requirements

The parts coated to this specification shall meet the following technical requirements and demonstrated by the test methods described. The appropriate tests for different situations: New chemical approval, new applicator approval, Production Part Approval Process (PPAP), and regular process control testing, are described in

Appendix A, Table A1. Procedures and requirements for new chemical and applicator approval are described in Appendix B.

3.1 Appearance. This finish shall have a uniform black appearance.

3.1.1 For new chemical approval and referee purposes, the finished parts shall be visually compared to the GM Global Primary Gloss Master - PGH. The finished parts shall appear more chromatic in color and higher in gloss.

3.1.2 For new chemical approval testing, electroplate and coat both fasteners and gloss panels. The fasteners must be plated and coated in an automated barrel process in a production environment. The panel may be hand-processed. Before electroplating, the gloss level of the steel panels shall have a maximum gloss level of 150 using a 60° gloss meter per ASTM D523 or ISO 2813. Coated fasteners and gloss panels shall be submitted to the responsible GM Materials Engineer for evaluation. The coated gloss panels shall have a gloss level of ten (10) or higher when measured by a 60° gloss meter per ASTM D523 or ISO 2813.

3.2 Plating and Coating Thickness.

3.2.1 The plating layer thickness is defined as the metallic zinc-nickel layer measured after all specified supplemental treatments are completed. However, the measurement of plating thickness does not include the topcoat. The zinc-nickel plating layer shall contain (12 to 17)% nickel. The plating layer thickness on significant surfaces shall be a minimum of 10 µm.

3.2.2 For bolts and screws, the significant surfaces includes the head and other exposed surfaces after installation. For referee purposes, in cases when it is not possible to accurately measure the plating thickness on the head (e.g., the plating is mechanically damaged or it was already exposed to a corrosion test), the tip of an unexposed thread may be measured and compared to a reference part plated in the same process. On nuts, the plating thickness shall be measured on the spanner flats.

3.2.3 For parts other than threaded fasteners, the plating thickness requirement applies to significant surfaces as specified on engineering drawings. If the significant surfaces are not defined, then all surfaces are considered significant.

3.2.4 For threaded fasteners, the maximum total thickness of the plating and topcoat is limited by the basic thread size (tolerance h or H). After plating and topcoat, parts must gauge with appropriate basic size GO thread gage. Threads may be produced undersize/oversize to accommodate the coating, provided that the finished product meets all specified mechanical properties. Where mechanical properties are not specified, undersizing/oversizing is subject to approval by the responsible fastening engineer, and all undersize/oversize shall be within permissible limits as agreed upon.

3.2.5 Recess Fill Test. The total coating system shall not adversely affect the drive system (internal recess dimensions, hex size, etc.) or function of the fastener.

Using a batch (minimum batch size of (ten) 10) of uncoated hexalobular internal drive pan head screws (Part Number 11548270 or similar M4 size recess drive tapping screw with installed washer wider than 16 mm), measure the recess penetration depth against drawing requirements to ensure conformance. Coat the parts in a production process and lot size. (Coating the test parts with other similarly sized parts to reach production lot size is acceptable.) Measure the recess penetration depth after coating. All measurements must meet the drawing requirement after coating. For Part Number 11548270, the maximum NO-GO gage penetration depth for the drive recess is 0.51 mm.

3.2.6 For parts other than threaded fasteners, there is no limit on maximum total coating thickness, as long as the finish meets all other requirements and does not negatively affect the fit, assembly, and function of the part.

3.2.7 Measurement Method. For referee purposes, the plating thickness shall be determined by microscopic examination of cross sections taken perpendicular to significant surfaces per ISO 1463. For regular production, x-ray fluorescence (XRF) can be used for plating thickness measurement. The measurement shall be taken after the entire finishing process is complete. The measurement method shall have good accuracy and be robust to the finish material, substrate material, part size and geometry. In case of dispute, the supplier must be able to demonstrate a maximum deviation of 10% between its test method and the cross-sectioning measurement per ISO 1463 when measuring the same area of the same part.

Note: Plating layer thickness measurement shall be reported for each production lot.

3.3 Adhesion. Parts coated to this specification shall show no evidence of blistering or other appearance changes after exposure to humidity testing per GMW14729 for a minimum of 240 hours. There shall be a

minimum of 99.0% coating (topcoat) retention after the tape adhesion test per GMW14829 Method B. In the case of threaded fasteners, steel test panels shall be processed with fasteners for this test.

3.4 Corrosion Resistance. After exposure to neutral salt spray (NSS) for 240 hours, coated parts shall exhibit no appearance change and after 1000 hours shall exhibit no base metal corrosion (red rust) on significant surfaces. The test method and definition of significant surfaces are as follows:

3.4.1 Corrosion Test. Test finished parts per ISO 9227 (NSS) with the following additional requirements:

- The sample holder inside the test cabinet/chamber shall be constructed of material resistant to the test environment, i.e., acrylic and polyvinyl chloride (PVC). Also, the sample holder material shall not affect the corrosion test results, i.e., metal and wood.
- The orientation of the parts during test is slightly slanted to minimize accumulation of test solution on the finished surface.
- The placement and orientation of test parts shall be such that parts are not touching and that they are not shielding each other from the test environment.
- Test parts shall not drip on each other during the test.
- Parts to be tested shall be as close to "as shipped" condition as possible. No special cleaning or treatments allowed.
- Parts shall be aged at the ambient laboratory conditions ($+23 \pm 3$) °C and relative humidity of (45 ± 10)% for at least 24 hours before the test.

3.4.2 Significant surfaces for test evaluation of fasteners shall be all exposed surfaces of the fastener when installed, including, but not limited to, fastener heads, socket recess, SEMS washers and external surfaces of nuts. Fastener threads and points are excluded unless otherwise specified on the drawing.

3.4.3 Significant surfaces on parts other than threaded fasteners shall be all surfaces except deep recesses, such as blind holes and the interior of tubes, are excluded unless otherwise specified on the drawing.

Note: NSS testing shall be performed in-house as part of the applicator's process control plan to ensure that parts meet the corrosion resistance requirements consistently.

Note: For chemical approval, externally threaded fasteners shall be power-driven into a tapped hole or nut against a steel panel (simulating production usage), removed, then installed finger-tight or with a hand driver with proper drive bit into acrylic plastic or other inert panel, and exposed in salt spray at an angle of (15 to 30) degrees from the vertical.

3.4.4 Temperature Resistance. After heating the parts for 24 hours at +150 °C (part temperature) the corrosion-resistance requirements as specified in 3.4 shall be met.

3.5 Stone chip and cyclic corrosion Test. Parts coated to this specification shall exhibit resistance to stone chipping and abrasion.

3.5.1 Part Number 11548270 or similar hexalobular internal drive pan head screws coated with production process shall be used for testing. The test screws shall be power driven and seated with production-type tooling into plastic test panels that are unreactive to the following corrosion test environments. The test screws shall be installed in a horizontal row seated a minimum of 25 mm apart and then tested per 3.5.2 and 3.5.3.

3.5.2 Pre-condition the test screws (mounted on the test panel) to GMW14700 Method C, using one (1) L and two (2) pt of gravel.

3.5.3 After pre-conditioning, test parts to GMW14872 EXT, Exposures C and D. After Exposure C, the screw heads shall exhibit no red rust and 30% maximum white corrosion coverage. After Exposure D, the screw heads shall exhibit 10% maximum red rust coverage and 50% maximum white corrosion coverage. Note that all exposed surfaces of the seated screw heads, including screw head edges and recesses, shall be included in the evaluation.

3.6 Aluminum Galvanic Corrosion Test. The test fasteners coated with this finish in production environment shall be power driven and seated with production-type tooling into an aluminum test panel (AA 6061 or AW 6082 grade, (4 to 10) mm thick). The test fasteners shall be installed in a horizontal row seated a minimum of 25 mm apart. The fasteners shall be tested per GMW14872 EXT, Exposure D. After exposure, measure the pit depth in the aluminum test panel under each test fastener. The maximum pit depth shall not be greater than 0.2 mm.