GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW15613

Decorative Nickel Chrome Plating on Stainless Steel

1 Scope

This specification covers the basic requirements for nickel chromium plating on stainless steel. The properly applied finish provides excellent adhesion and corrosion protection. Nickel-chrome plating on other metals is covered by GMW14672.

1.1 Material Description. Not applicable.

1.2 Symbols. Not applicable.

1.3 Applicability.

1.3.1 Code A: Primarily applicable to exterior fasteners, moldings and other trims made of austenitic stainless steel (300 series per SAE J405 or regional equivalent). The stainless substrates may not need buffing and provide excellent color match for surrounding plated trim. Coating consists of four (4) layers; a woods nickel strike (necessary for proper adhesion of plating to stainless), bright-nickel, microporous nickel, and chromium.

1.3.2 Code B: Primarily applicable to austenitic stainless steel (300 series) screws and bolts and to stainless steel components for interior use only. Coating consists of three (3) layers including woods nickel strike, bright nickel, and chromium.

1.3.3 Code C and Code D: Primarily applicable for a specific corrosion resistance requirement and color match, and may be used for exterior (Code C) or interior (Code D) applications.

1.3.4 Code E: Primarily applicable to coatings whose purpose is to color match other parts. Chromium thickness, therefore, is not specified. Code E may be used for interior trim applications.

1.3.5 Code F: Primarily applicable to exterior and interior moldings and other trims made of Ferritic Stainless Steel (Types 434 – Unified Numbering System (UNS) S43400 and 436 - UNS S43600). The stainless steel substrates may not need buffing and provide excellent color match for surrounding plated trim. Coating consists of four (4) layers which include a woods nickel strike, bright nickel, microporous nickel, and chromium.

1.4 Remarks. Type 434 and Type 436 stainless steel, as well as those used with Code C, Code D, and Code E (chrome flash), normally require mechanical finishing (pre-buff strip, part buffing) to meet component appearance requirements. The mechanical finishing requirements shall be agreed upon between stainless steel supplier and user.

2 References

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

2.1 External Standards/Specifications.

ASTM B456	ASTM B764	ISO 2177	SAE/USCAR-5
ASTM B490	ASTM F1470	ISO 3497	SAE/USCAR-7
ASTM B571	ISO 1463	SAE J405	

2.2 GM Standards/Specifications.

GMW3059	GMW14458	GMW14829
GMW3286	GMW14672	GMW14872

2.3 Additional References.

TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

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3 Requirements

3.1 Requirements on Test Specimens. Not applicable.

3.2 Plating Thickness.

3.2.1 Measurement. Thickness shall be determined by the microscopic method (ISO 1463) or the electrochemical method (ISO 2177) or by the x-ray method (ISO 3497). In cases of disagreement between the purchaser and supplier, the microscopic method shall be the umpire method. The x-ray method is generally preferred for chromium thickness.

3.2.1.1 Minimum plate thickness for various codes is shown in Table 1. The plate thickness requirement shall apply to all low current density and high current density areas of significant surfaces as specified on appropriate part drawings. Such surfaces are those normally visible, directly or by reflection, on the finished part when assembled in the vehicle position, or which can be the source of corrosion deposits that deface visible surfaces on the assembled vehicle.

3.2.1.2 Minimum thickness and corrosion resistance performance requirements for textured finishes (matte vapor blast, brush, etc.) apply after texturing.

Table 1: Plating Construction and Performance Requirements

Base Metal	Type of Plate	Code	Plate Thickness on Significant Surfaces (minimum)			Corrosion Resistance (minimum hours)
			Total Note 1	Nickel	Chrome Note 2	
			µm	µm	µm	
Corrosion Resistant Steel	Nickel-Chromium	A Note 3	20.25	20.0	0.25	44 Cupric Chloride Acetic Acid Salt Spray (CASS)
			8.25	8.0	0.25	96 Neutral Salt Spray (NSS)
		B				
	Chromium	C D E	0.25 0.12 -	- - -	0.25 0.12 -	16 (CASS)
	Nickel-Chromium	F Note 3	25.25	25.0	0.25	44 (CASS)

Note 1: Total includes all nickel and chrome thicknesses.
Note 2: Maximum chrome thickness 0.5 µm. If applied over microcracked nickel, minimum chrome thickness is 0.3 µm.
Note 3: Chromium shall be applied over micro particulate nickel deposit.
CASS: Cupric Chloride Acetic Acid Salt Spray.
NSS: Cupric Chloride Acetic Acid Salt Spray.

3.2.2 Layer Requirements. See Appendix B, Table B1**.**

3.2.2.1 Discontinuous Chromium (Applicable to Code A and Code F Only). Active sites determination shall be performed after CASS corrosion testing, generally as described in the Appendix of ASTM B456. For active sites determination, compare the viewed sample at 100x magnification to the pore density charts shown in Appendix A, Figure A1, to determine pore count. The microporous chromium surface shall exhibit a minimum of 10 000 pores per centimeters squared (cm^2) as determined by active sites.

3.2.2.1.1 For Code A and Code F plating, microcracked chrome may be used in place of microporous, if approved by GM Materials Engineering. In this event, the cracked chromium surface shall exhibit 300 cracks/cm to 800 cracks/cm in all directions and provide a closed homogenous network in all directions.

3.2.2.1.2 The electrochemical potential difference for Code A and Code F finish between the micro particulate nickel layer and the bright nickel on all significant surfaces of all substrates is 10 mV to 40 mV with the micro particulate layer being cathodic to the bright layer. Determine the potential difference between the micro particulate nickel and the bright nickel following ASTM B764.

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3.2.3 Corrosion Resistance. Corrosion resistance shall be determined by the Cupric Chloride Acetic Acid Salt Spray (CASS) test, GMW14458, or Neutral Salt Spray (NSS) test, GMW3286. Plated components subjected to the test hours specified in Table 1 shall be free of corrosion on all significant surfaces when examined at normal reading distance with the unaided eye and uniform diffused light.

3.2.3.1 Additional Testing for Decorative Exhaust Components. These components (decorative tips, fascia bezels, etc.) must also pass 35 cycles of cyclic corrosion test GMW14872-EXT-All-4S-Method 1/2-Option 5 (Exhaust Condensate addition) with no red rust.

3.2.4 Adhesion. ASTM B571 shall be used to test adhesion (saw grind test). Plated metallic components plated (Code A, Code B, or Code F) shall be subjected to the saw grind test with no evidence of lifting or peeling between plating layers or between plating and substrate.

Place pressure sensitive adhesion tape, as described in GMW14829, approximately 10 mm to 20 mm wide over the cut edge (leaving sufficient length of tape to grasp between fingers for quick removal); quickly pull tape at approximately 90 degrees to the surface of part to remove entire strip. Examine for evidence of lifting of electroplate.

3.2.5 Thermal Shock Test. A temperature shock test to determine the adhesion must be performed. Parts shall be heated to 300 °C ± 10 °C for 1 h ± 15 minutes and then directly immersed in room temperature water (23 °C ± 3 °C). The requirement is no blistering or flaking of the coating after immersion. Parts which are exceptionally large may be cut or sectioned to fit in the oven.

3.2.6 Ductility. Ductility of electrodeposit on finished part shall be acceptable when foils (ASTM B490) plated out of bright nickel bath show ductility of 10% or greater (T/2R = 0.1).

Where:

- **T** = Foil thickness.
- **R** = Bend radius.

3.2.7 Additional Requirements.

3.2.7.1 Relief of Hydrogen Embrittlement. All electroplated parts with surface or core hardness greater than 320 HV (32 HR_c) shall be processed per SAE/USCAR-5 and tested for de-embrittlement per SAE/USCAR-7. The sample size for the SAE/USCAR-7 test shall be per ASTM F1470. The maximum material hardness in the drawing or relevant specification shall be used to determine if de-embrittlement baking is required. If a part is heavily cold worked or heat treated to high strength/hardness but is without a maximum hardness limit stated in the drawing or specification, the applicator shall obtain the hardness data from the customer in order to determine if de-embrittlement baking is required.

Note: Baking is determined by the maximum measured hardness of the lot, not the average.

3.2.7.2 Other Plating Systems. In the event that additional plating layers are used (not shown in Table 1), those must meet the following layering, thickness and electrochemical potential requirements:

- **Woods Nickel Strike:** Must be used, but no minimum thickness or Simultaneous Thickness and Electrochemical Potential Measurement (STEP) (per ASTM B764) requirement.
- **Semi-bright Nickel:** 60% to 80% of total plating thickness.
- **Bright Nickel:** 20% to 40% of total plating thickness, STEP potential 100 mV to 200 mV anodic to semi-bright.
- **Microporous Nickel:** No minimum thickness, must show STEP potential 10 V to 40 mV cathodic to bright.

4 Manufacturing Process

Not applicable.

5 Rules and Regulations

5.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations and recommendations valid in the country of usage.

5.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.

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