



Physical Vapor Deposition Multi-Layer Coating for Exterior Parts

1 Scope

1.1 Material Description. This specification covers the material requirements for vacuum-deposited metal coatings for decorative exterior plastic trim components. Physical Vapor Deposition (PVD) describes the metallizing process which gives the part a 'metal-like' appearance. The total coating construction requires an organic basecoat and a vacuum metallized layer. An organic topcoat is sometimes also added for additional durability or to modify appearance.

1.2 Symbols. Not applicable.

1.3 Applicability. Typical applications include decorative exterior trim components. Parts with a coating according to this specification can be classified into the following categories:

- **Type 1:** Exterior body decorative parts where stone impact resistance is not required
- **Type 2:** Exterior body decorative parts where moderate stone impact resistance is required

Note: Type 2 systems may be used in Type 1 applications.

1.4 Remarks. None.

2 References

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

2.1 External Standards/Specifications.

ASTM D7869	ISO 2808	SAE J1545	SAE J2527
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2.2 GM Standards/Specifications.

GMW3059	GMW14698	GMW14829	GMW16745
GMW14270	GMW14700	GMW14873	GMW16882
GMW14334	GMW14701	GMW15891	
GMW14458	GMW14729	GMW16585	

2.3 Additional References.

Safety and Industrial Hygiene (S&IH) Technical Standard (TS), S&IH TS 3.4-160-02

3 Requirements

See Appendix A, Table A1 for a listing of part performance requirements. Each test shall be performed in triplicate. Requirements are separated according to the following process stages:

- **Equipment/Construction Approval:** For a new layer construction that has not previously been approved by GM at any applicator. This includes the incorporation of a new layer into an existing construction (thereby changing the construction).
- **Applicator Approval:** For approval of a new applicator using an existing, GM approved construction.
- **Color Approval:** For a minor modification of an existing construction for color matching (using an approved applicator).
- **Production Part Approval Process (PPAP):** For production parts processed using approved equipment and an approved applicator.

Additional requirements are described in the remainder of this section. Appendix A, Table A2, describes requirements for quality control testing on production parts.

Before beginning testing for approval, GM and the supplier (equipment or applicator) shall agree on substrate material and thickness for test panels.

3.1 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to obtain a GM-approved International Material Data System (IMDS) submission.

3.2 Appearance. Unless otherwise specified, parts shall meet the appearance requirements of GMW16882.

3.3 Base Material/Substrate. Only plastics approved by GM for PVD may be used with this specification.

3.3.1 Substrate. The surface shall be smooth, free of surface contamination, flow lines, cracks, sink marks, craters or substrate stratifications which may influence the approved appearance or part properties. Some molding artifacts such as parting lines flash and gate marks can have a deleterious effect on the durability of the finish and must be minimized. Rework of substrate surfaces by sanding, plasma treatment or other means must be approved by GM Engineering and Supplier Quality. Before parting line rework can be approved, testing to this standard must be completed on parts which include the proposed rework process. GM Supplier Quality must review and approve any parting line rework process before use.

3.4 Coating Thickness/Construction. For each construction approval, the equipment supplier shall establish minimum, target, and maximum values for the thickness of each layer. For applicator approvals and component-level PPAP testing, layer thicknesses must be within the range specified (and validated) by the equipment supplier. Where no requirement is given, coating thickness shall conform to the requirements in Table 1 on all surfaces that are not hidden from the customer in vehicle position (GMW16882, Zones A/B/C).

Systems approved to Type 1 are required to have a basecoat followed and a metallized layer. Systems approved to Type 2 are required to have a basecoat, metallized layer, and topcoat.

Note: For some systems, the thickness of the metallized layer may be such that it cannot be measured directly by conventional means. In such cases, the supplier shall establish a correlation between color (L^* value) and the required thickness. In such cases, basecoat and topcoat thickness must still be measured as described in 3.4.

Table 1: Coating Construction Requirements

Layer	Minimum Thickness	
	Type 1	Type 2
Basecoat	15 μm (0.6 mil)	12 μm (0.6 mil)
Metallized layer	Note 1	Note 1
Topcoat	Optional	15 μm (0.6 mil)

Note 1: Metallized layer thickness shall be established as part of the equipment/applicator approval process.

3.5 Color. See Appendix A, Table A1.

3.6 Adequacy of Cure. See Appendix A, Table A1.

3.7 Corrosion. See Appendix A, Table A1.

3.8 Chip Resistance. See Appendix A, Table A1.

3.9 Oven Aging + Chip Resistance. See Appendix A, Table A1.

3.10 Gravelometer + Quick Thermal Cycle + Copper-Accelerated Acetic Acid Salt Spray (CASS). Expose samples to gravelometer (GMW14700, Method B), followed by Quick Thermal Cycle (see 3.13), followed by 48 h CASS (GMW14458). At the end of the test, samples shall show no corrosion or blistering.

3.11 Initial Adhesion. See Appendix A, Table A1.

3.12 Humidity + Tape Adhesion. See Appendix A, Table A1.

3.13 Quick Thermal Cycle. Parts shall be placed in a freezer at $-40\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for 1 h, removed and quickly (< 1 minute) placed into an adjacent oven at $90\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for 1 h. This is one (1) complete cycle. Inspect parts in five minutes or less after each complete cycle. Repeat for a total of four (4) cycles. The parts shall show no crazing, blistering, splitting, loss of adhesion to the substrate, or loss of adhesion between individual layers after testing.

3.14 Heat Aging. Samples shall be exposed to 168 h of dry oven aging at $85\text{ }^{\circ}\text{C}$, followed by 24 h of humidity per GMW14729, followed by tape adhesion per GMW14829, Method A. At the end of the test, samples shall show no cracks, blisters or other anomalies. The tape adhesion site shall have a maximum rating of 1.

3.15 Dimensional Stability. Parts shall be exposed to the following cycle two (2) times without interruption:

- $17\text{ h} \pm 0.5\text{ h}$ at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- $72\text{ h} \pm 1\text{ h}$ at $85\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- $24\text{ h} \pm 1\text{ h}$ Humidity (per GMW14729)
- $7\text{ h} \pm 0.5\text{ h}$ at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- $24\text{ h} \pm 1\text{ h}$ Humidity (per GMW14729)
- $24\text{ h} \pm 1\text{ h}$ at $22\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$

After the test, samples shall be subjected to the tape adhesion test (GMW14829, Method A). At the end of the test, samples shall show no cracks, blisters or other anomalies. The tape adhesion site shall have a maximum rating of 1.

3.16 Water Jet. See Appendix A, Table A1.

3.17 Rain X + Thermal Cycle. See Appendix A, Table A1.

3.18 Scratch Resistance. See Appendix A, Table A1.

3.19 Chemical Resistance. See Appendix A, Table A1.

3.20 Resistance to Cleaning Agents. See Appendix A, Table A1.

3.21 Accelerated Weathering. See Appendix A, Table A1.

3.21.1 Accelerated Weathering.

3.21.2 Accelerated Weathering + Humidity + Tape Adhesion.

3.21.3 Accelerated Weathering + Chip Resistance.

3.22 Natural Weathering. See Appendix A, Table A1.

3.22.1 Natural Weathering. See Appendix A, Table A1.

3.22.2 Natural Weathering + Humidity + Tape Adhesion.

3.22.3 Natural Weathering + Chip Resistance.

4 Manufacturing Process

During applicator approval and PPAP, suppliers must demonstrate that their process is consistent. If a system includes multiple rack positions, parts must be mapped across the rack to show consistent coating thickness and performance.

At PPAP, individual components must be mapped to ensure that all Zone A/B/C surfaces (as defined in GMW16882) meet coating thickness requirements. Coating thickness on the backside of each part (GMW16882, Zone D) must be sufficient to ensure part performance requirements are met, including no corrosion bleedout or loss of adhesion on Zone A/B/C surfaces.

In order to ensure consistent coverage and ability to coat more complex part geometries, vapor deposition/metallization shall be accomplished using a magnetron sputtering process. Other deposition methods, such as evaporation, are not acceptable per this standard.