

ADHESIVE, INDUCTION CURE, EPOXY, STRUCTURAL - METAL

9985599

1 SCOPE. This specification details the physical properties and performance requirements of a 1 component, heat curing (induction or oven), thermosetting, epoxy based, structural adhesive paste modified to reach sufficient handling strength (metal distortion) in a normal induction cure cycle. The adhesive is commonly used to bond steel body components such as inner/outer body panels on doors, hoods, deck lids and other components.

1.1 The adhesive shall be a non sag material capable of adhering and bonding through all common oils and drawing compounds approved by CPC Engineering for use on steel components. The material is compatible with plain steel (cold rolled), zincrometal or hot dipped and electrocoated galvanized steel. The adhesive must be homogeneous and free of lumps or unmixed particles. The uncured material when applied in a hem flange section must withstand production zinc phosphating, ELPO processing and the subsequent bake temperatures of up to 204°C. The adhesive can also be cured with a min 30 minute bake @ 160°C with or without a prior single 4 s induction cure cycle in a normal, hairpin coil, designed fixture run at 3 kHz. Other induction cure coil designs may necessitate longer dwell times for the cure cycle. The adhesive is also capable of being robotically applied in a hem flange area under normal fabricating plant conditions. Provisions should be made in the fabrication process to monitor hem flange temperatures during induction heating to insure that the level of cure required is met.

2 REFERENCED STANDARDS.

GM9021P	GM9751P	ASTM D1002
GM9505P	GM9761P	SAE J243
GM9511P	9984000	
GM9749P	ASTM D638	

3 REQUIREMENTS.

3.1 Properties.

3.1.1 Color. To be determined at time of approval.

3.1.2 Odor. The adhesive must not have a toxic or noxious odor and shall not have any adverse effects on personnel handling it. There must also be no perceptible odor from the adhesive during or after cure.

3.1.3 Solids Content (ASTM D1084).....98% by mass min

3.1.4 Specific Gravity, room temperature.....1.32 ± 0.05

3.1.5 Viscosity (GM9021P). When tested with a flowmeter at a pressure of 448 kPa with 2.64 mm dia orifice.

Initial: 10 to 25 s
168 h @ 40°C: 30 s max
30 days @ 35°C: 30 s max

3.1.6 Stability. When conditioned as stated below, the adhesive shall be capable of meeting all the requirements of the specification:

3.1.6.1 Elevated Temperature Stability. The adhesive as received be capable of withstanding a temperature of 54°C for 72 h without any deleterious effects.

3.1.6.2 Low Temperature Stability. The adhesive as received shall be capable of being frozen (0°C) indefinitely without any deleterious effects on the adhesive performance.

3.1.7 Pressure Stability (GM9761P). The adhesive must be capable of withstanding pumping pressures without adversely effecting its flow characteristics. The material must not cake and or separate after being subjected to 13 790 kPa for 24 h.

3.1.8 Sag Characteristics (GM9749P). The material shall not exhibit any perceptible slump or movement with a 6 mm dia bead applied over an oiled, plain, steel, zincrometal, galvanized or aluminum panel. In addition when a 6 mm dia bead of adhesive is sandwiched between oily pieces of steel 6 mm apart, the material must not run or flow out during the production baking operation.

3.2 Material Properties (Cured State). The adhesive for the testing in this section of the specification should be applied in mock up hemmed panels as shown in Figure 1. Adhesive bond line thickness will be 0.127 to 0.254 mm. The steel used in these panels should be of the various types outlined in the general description section of the standard coated with all the approved mill oils and drawing compounds. The adhesive should be cured in an induction cure test fixture with 2 direct access coils (hairpin design) run for 4 s min with 3 kHz power. (Unless otherwise noted, the strength and performance requirements of the adhesive in this standard are determined with only an induction cure.)

3.2.1 Phosphate Resistance. Coat 3 sets of hem simulated panels outlined in Figure 1 (0.75 mm metal gauge) made from CRS, zincrometal and galvanized with all the currently used fabrication plant inner/outer drawing compounds and lubricants (30 mL/m²). Apply beads of adhesive (4 to 6 mm) in the hem flange area of the panels and then induction cure as specified. Pass the panels hung vertically through a production cleaning and phosphating system where direct impingement of the spray occurs on the hemmed areas. Panels are to be hung at heights representative of top, center and bottoms of a vertically hung hood. The beads of adhesive in the hems must show excellent phosphate resistance with no wash out from the panels.

3.2.2 Solvent Resistance and Paintability. Process the above described panels through a production ELPO (Uniprime) paint system. Material may show some minor surface softening, but no cracking or loss of adhesion, bleeding or other deleterious effects are allowed. The material should be compatible with all electrodeposition primer systems shown on the 9984000 A and B drawing. Bake temperature to be 160°C for 30 minutes.

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3.2.2.1 Corrosion Resistance. Panels processed per 3.2.1 and 3.2.2 should be exposed to the following environments for corrosion resistance:

6 weeks GM9505P
20 cycles of the Scab Corrosion Environment (GM9511P)

3.2.2.1.1 After exposure is complete, the hems should be peeled back on the test panel with the enclosed surfaces showing no sign of red corrosion products.

3.3 PHYSICAL PROPERTIES (CURED STATE). All tests in 3.3.3 and 3.3.4 should be performed on panels of the same construction as outlined in 3.2 of this standard. (Unless otherwise stated these panels should only be induction cured prior to testing.)

3.3.1 Tensile Strength (ASTM D638). 52 ± 5 MPa at a crosshead speed of 10 mm/minute after an additional 30 minute bake @ 160°C.

3.3.2 Elongation (ASTM D638). The elongation shall meet the following requirements after a 30 minute bake @ 160°C, 2% min at a crosshead rate of 10 mm/minute.

3.3.3 Shear Strength (ASTM D1002). The panels used for the testing in this section will be induction cured as previously and in the cases outlined will also be subjected to a simulated ELPO (Uniprime) bake for 30 minutes @ 160°C. The testing will be conducted on 25.4 mm widths of the hemmed panels with a crosshead movement of 10 mm/minute. The adhesive strength of the cured material shall be greater than its cohesive strength. (If lap shear testing is indicated, 645 mm² overlap shear strips cured in the above outlined procedure will be used.)

3.3.3.1 24 h Room Temperature Recovery after Induction Cure 4 s @ 190°C max Metal Temperature:

Overlap Shear	Hemmed Section
2450 N min @ 23°C (or Metal Deformation)	1700 N min @ 23°C (or Metal Deformation)

3.3.3.2 24 h Room Temperature Recovery after Induction Cure and Oven Bake:

Overlap Shear Min	Hemmed Section Min
5500 N min @ 23°C	5500 N min @ 23°C
5000 N min @ 82°C	5000 N min @ 82°C
5000 N min @ -20°C (or Metal Deformation)	5000 N min @ -20°C (or Metal Deformation)

3.3.3.3 24 h Room Temperature Recovery after Induction Cure and Oven Bake following the Listed Environmental Cycles (All panels should be phosphated and ELPO (Uniprime) primed prior to testing):

500 h neutral salt spray
8 wks @ 37.5°C/100% RH
8 wks @ 70°C
12/24 mos Florida and Arizona exposure
SCAB Corrosion (20 Cycles) per GM9511P

Overlap Shear	Hemmed Section
4500 N min (or Metal Deformation)	4500 N min (or Metal Deformation)

3.3.4 Impact Test (Use Equipment and Test Alignment per GM9751P). 323/mm² overlap shear samples will be used for testing with induction cure and simulated ELPO (Uniprime) bake.

3.3.4.1 24 h Room Temperature Recovery after Bake.....5 Nm min @ 23°C (or Metal Deformation)

3.3.4.2 At any of the following Environmental Conditions followed by a 24 h Room Temperature Recovery:

- 500 h neutral salt spray
- 8 wks @ 37.5°C/100% RH
- 8 wks @ 70°C
- 12/24 mos Florida and Arizona Exposure
- SCAB Corrosion (20 Cycles) per GM9511P: 3.0 N.m min @ 23°C (or Metal Distortion)

3.3.5 Heat Stability. There shall be no evidence of blistering, cracking, charring or embrittlement of the adhesive when beads of the material on a steel panel are exposed to a high bake temperature of 200°C.

3.3.6 Cold Adhesion. The panels for this test will be prepared as follows:

3.3.6.1 Prepare 4 or more typical reinforcement panels as illustrated in Figure 2. The bead application size is to be 4 to 6 mm dia over oily metal.

3.3.6.2 Condition the assemblies @ $23 \pm 2^\circ\text{C}$ for 24 h.

3.3.6.3 Condition 2 assemblies in a convection oven for 30 minutes @ 160°C and 2 for 30 minutes @ 200°C to simulate an overbake condition. Cool to $23 \pm 2^\circ\text{C}$.

3.3.6.4 Test assemblies for cold adhesion using an SAE J243 ADS-2 cold slam fixture.

NOTE: The attaching screws and thickness shims are removed prior to testing.

3.3.6.5 Cool assemblies to -29°C for 3 h while attached to the slam fixture.

3.3.6.6 Drop test panel from a horizontal position 4 times, then allow panel to return to room temperature.

3.3.6.7 Repeat this procedure for a total of 10 cycles.