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AEROSPACE RECOMMENDED PRACTICE

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FABRICATION OF CARBON FIBER/POLYSULFONE RESIN COMPOSITE STRUCTURES

1. SCOPE:

1.1 This document describes the materials, equipment, and processing techniques used in fabricating high-strength or high-modulus carbon-fiber-reinforced polysulfone laminates for structural applications for service up to 120 °C (248 °F).

1.2 The carbon fiber/polysulfone resin materials are supplied as impregnated tape and sheet conforming to AMS 3899 and the specified detail specification.

1.3 This document applies primarily to fabrication by hand layup methods, but may be used for machine layup fabrication.

1.4 Safety-Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

CANCELLED 10/95

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2635	Radiographic Inspection
AMS 2645	Fluorescent Penetrant Inspection
AMS 3892/1	Tow or Yarn, Carbon (Graphite) Fibers for Structural Composites, GF 400 (2760) Tensile Strength, 33 (228) Tensile Modulus
AMS 3892/2	Tow or Yarn, Carbon (Graphite) Fibers for Structural Composites, GF 300 (2070) Tensile Strength, 50 (545) Tensile Modulus
AMS 3899	Graphite Fiber Tape and Sheet, Polysulfone Resin Impregnated
ARP1611	Quality Inspection Procedure, Composites, Tracer Fluoroscopy

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-I-6866	Inspection, Penetrant Method of
MIL-STD-453	Inspection, Radiographic

3. GENERAL:

3.1 Polysulfone matrix composites are classified as high-performance specialty materials offering unique advantages over many thermosetting materials.

3.2 The thermoplastic behavior of polysulfone can result in reduced fabrication time associated with ply-by-ply contoured thermosetting materials to form large complex-shaped parts. A common approach with carbon fiber/polysulfone resin materials is to stack and mold flat panels in a heated platen press. The panel is then postformed using heat and pressure, either in matched molds, under vacuum, or under autoclave pressure.

3.3 The thermoplastic behavior of polysulfone resin contributes to ease in making repairs to laminates with delaminations, tears, or punctures, by locally heating and fusing additional plies under heat and pressure using simple shop equipment, such as heat guns, heat irons, and vacuum pumps. Similarly, imperfectly formed parts may be re-formed to the proper contour, a process not possible with thermosetting composite materials.

3.4 Properties of interest to the fabricator which may be of assistance in facilitating manufacture are as follows:

3.4.1 Glass Transition Temperature: While the glass transition temperature (Tg) of polysulfone resin is 170 °C (338 °F), the melt viscosity of the resin above the Tg is relatively high, therefore requiring molding or consolidation temperatures in excess of 315 °C (599 °F) and postforming temperatures between 260 and 300 °C (500 and 572 °F).

3.4.2 Tack: Carbon fiber/polysulfone resin impregnated materials are tack-free as supplied by the impregnator. The separator film is usually applied prior to complete cooling and retains sufficient residual tack to retain positioning during handling. During stacking operations, heat augmentation may be required to maintain the integrity of the stack. Warmed molds or heat irons are used to develop tack. The use of solvents to develop tack should be avoided.

3.4.3 Drape: There is no drape and the material at room temperature is quite boardy. If drape is required during stacking, heat irons or heat guns may be used.

3.4.4 Flow: The flow of polysulfone resin is quite low compared with other resin types. The low flow is a result of the high melt viscosity and does not ordinarily create fabrication problems.

3.4.5 Volatile Content: Polysulfone resin impregnated materials are received with comparatively high volatile contents of 3 to 5%. These materials are normally prepared from high-boiling-point solvents and suppliers may have difficulty in removing this solvent during the impregnation process. The quality of a completed structure may depend on the ability of the fabricator to remove the residual volatile material. A procedure in 4.4.8 describes a method for solvent removal during processing.

3.4.6 (R) Solvent Resistance: Solvent resistance of polysulfone resins is acceptable for most fabrication processes; however, it should be noted that polysulfone resins are soluble in chlorinated hydrocarbons and solvents such as n-methyl pyrrolidone (NMP) and di-methyl formamide (DMF). The use of these solvents and shop degreasing tanks are to be avoided. Suitable organic solvents may be used for cleaning surfaces to be joined.

4. PROCESS RECOMMENDATION:

4.1 (R) Fabrication Environment:

All fabrication should be conducted in a clean room.

4.2 Equipment:

4.2.1 Platen Press: A hydraulic-actuated heated-platen press should be used that is capable of maintaining temperature control at 340 °C ± 5 °C (644 °F ± 9 °F) and pressure controls at 250 psi ± 10 psi (1724 kPa ± 69 kPa).

4.2.2 Autoclave: An autoclave should be used that is capable of maintaining temperature controls at 340 °C ± 5 °C (644 °F ± 9 °F) and pressure controls at 250 psi ± 10 psi (1724 kPa ± 69 kPa). The autoclave should be equipped with a complete vacuum system, including pump, gages, controls, manifold, and outlets.