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Carbon fabric reinforced propargyl ether/phthalonitrile composites produced by vacuum infusion

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Experimental

Characterization.

Mechanical tests were carried out using Hounsfield H100KS, H5KS and Instron 5985 testing machine. The reported mechanical property values were based on an average of at least five tests. Determination of flexural mechanical properties was carried out using the three-point bending method according to the ASTM D790 at 1.28 mm/min crosshead rate. Fracture toughness in terms of critical-stress-intensity factor (K_{1C}) and energy per unit area of crack surface or critical strain energy release rate (G_{1C}) were determined according to the ASTM D5045 on single-edge-notch bending (SENB) specimens. The SENB specimens were initially notched by milling. Their notch root was sharpened by a fresh razor blade before they were loaded at a crosshead speed of 10 mm/min. DMA was performed using TA Instruments DMA Q800 in 3-point Bending regime with 1 Hz frequency and amplitude 40 μm with heating rate of 5 K/min. Melt viscosity was measured with Brookfield C2000þ Viscometer with cone 7 at 200 rpm.

The mechanical properties of CFRP were investigated on Instron 5985 and Hounsfield H100KS testing machines with an environmental chamber for testing at 300-400°C. All specimens were prepared from cured laminates by precision cutting with a diamond wheel or milling on a CNC machine. Tension tests (σ_{11}^{+}) of 0° specimens (250 × 25 mm2) were carried out at a crosshead speed of 2 mm/min according to ASTM D 3039. Compression strength (σ_{11}^{-}) was measured on flat coupons (140 × 12 mm2) compressed at a constant displacement rate of 1.3 mm/min according to ASTM D 6641. The interlaminar shear strength (τ13) was measured by the short-beam method described in ASTM D2344. V-notched rectangular specimens (76 × 19 mm2) were tested to determine in-plane shear strength (τ_{12}) at a constant cross-head speed of 1 mm/min according to the specifications of the ASTM D 5379. At least 7 specimens were tested per test condition. When testing at elevated temperature the specimen was inserted in the fixture and heated in the chamber to the desired temperature. It was held at this temperature for 30 minutes prior to the start of the test to allow for uniform heating through the laminate thickness. The temperature on the specimen surface during testing was controlled by a thermocouple.

CFRP manufacruting

Stainless steel plate with dimensions 500×700×4 mm^3 coated with release agent (except for the edges) was used to produce CFRP by vacuum infusion process. Sealing tape was secured along the perimeter. Silicone rubber tubes for resin feed and evacuating channels were installed on the opposite edges of the plate. At the side of the feed channel 12 layers of 200 g/m^2 carbon fabric twill 2x2 (Toho Tenax HTA40, σ = 4 GPa, E = 240 GPa) were placed and covered with peel ply and distribution medium. Further, vacuum film was attached to the sealing tape, the vacuum bag was placed in the oven, connected to the vacuum pump and heated to 130 °C. Upon reaching 10 mm. Hg inside the vacuum bag, degassed preheated to 130 °C resin was infused via feed channel. After 10–15 minutes the resin exited the vacuum bag into the vacuum channel, which indicated the end of impregnation. After the completion of the infusion process, the temperature was raised to 180 °C at the rate of 1°C/min and held for 8 hours. After that the package was disassembled and the cured sample was postcured at 375 °C as described above. In alternative procedure vacuum bag with impregnated fabric was sealed, placed into heating press and cured by the same temperature program and under pressure of 2 atm.

Collected Data

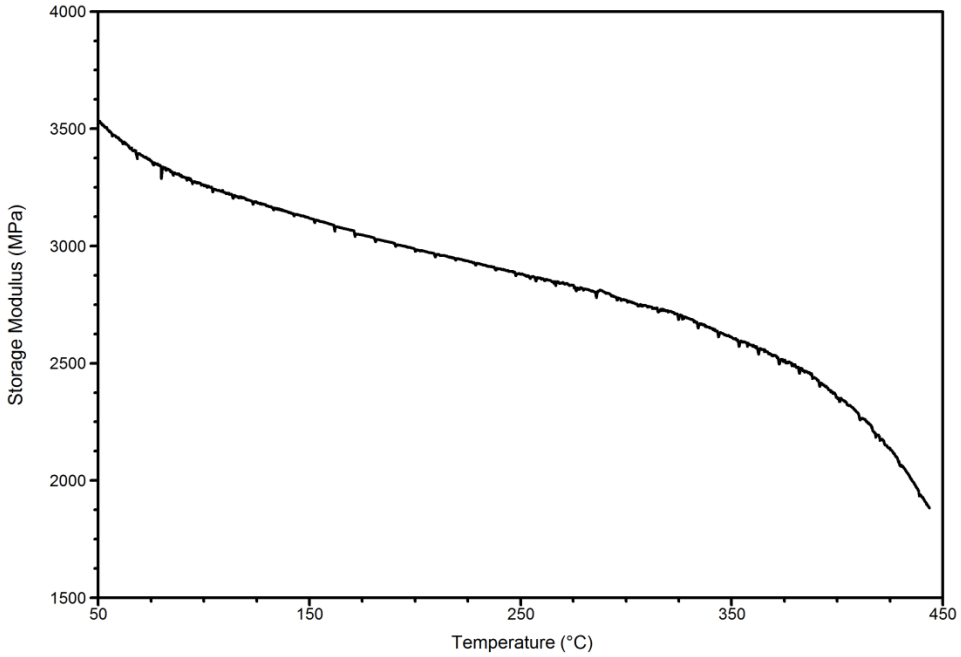

Figure S1 DMA curve for PPN.

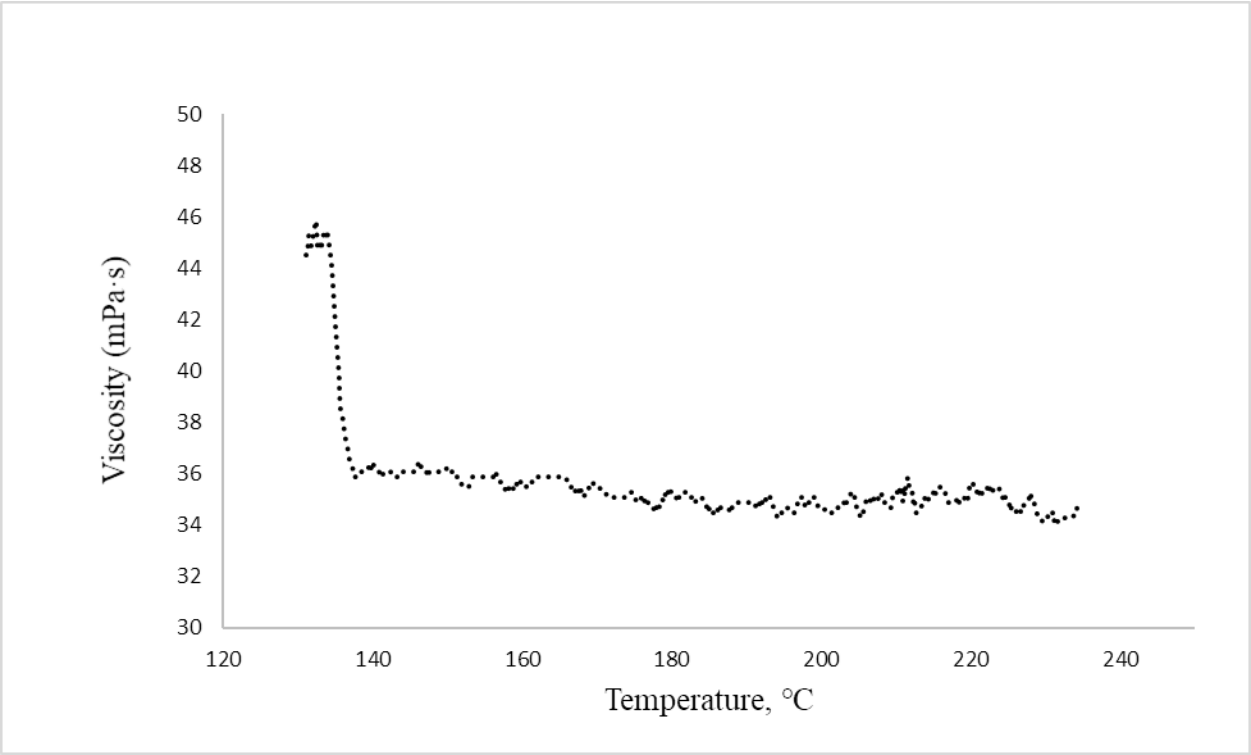

Figure S2 Temperature viscosity profile for PPN10.

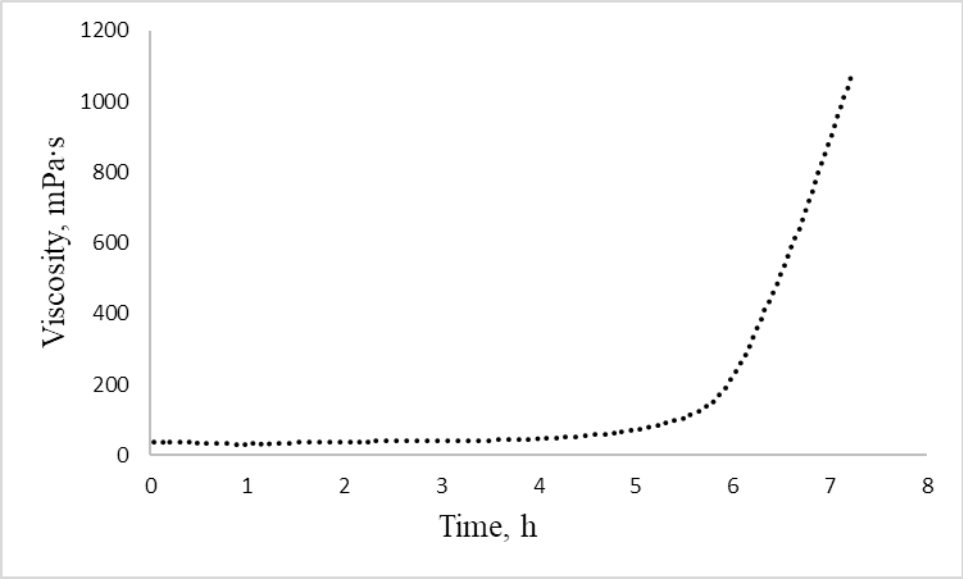

Figure S3 Isothermal viscosity of PPN10 at 180℃.