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Flame-retardant silicon-containing phthalonitrile matrix reinforced with unidirectional carbon fibers.

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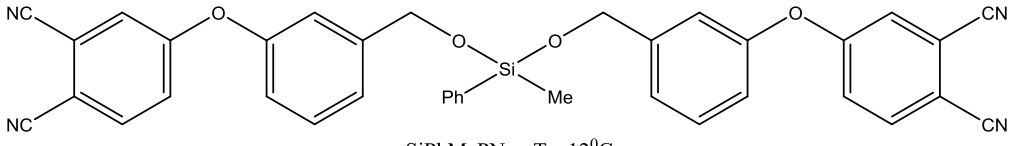
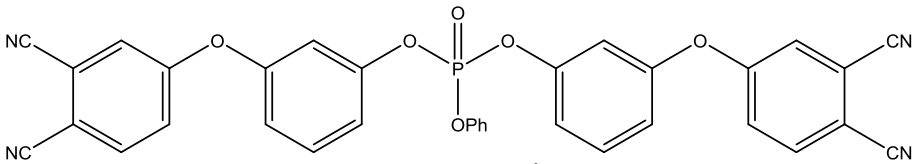
Polymer matrices developed from bis-phthalonitrile (PN) demonstrate the highest heat resistant properties among the known thermosets. Since the begining the main disadvantage of that type of resins was narrow processing window caused by high melting points of the PN monomers. The synthesis of silicon- and phosphorus-containing PN (Fig. 1, [1]) monomers allowed to develop resin compositions suitable for cost-effective injection techniques of composite manufacturing. Here carbon fiber reinforced phthalonitrile matrices obtained by resin transfer molding (RTM) are reported and discussed. The composites retain mechanical properties at temperatures up to 300°C and demonstrate incredible flame-retardant properties (LOI > 80%, [2]).



SiPhMePN, T_g=12^{0}C



RPPhPN, T_g=21^{0}C

Fig. 1. The key PN monomers used in the resin composition

The impregnation was performed at 150°C in a metal mold assisted with vacuum and pressure implementation. Composites demonstrated in-plane shear strengths of 72±7 MPa at 25°C and 61±5 MPa at 300°C.

Overall mechanical properties retention of the composites with PH matrices at 300°C was up to 85%, and thus such a materials could be considered for applications for jet engine blades or skin parts of supersonic aircrafts, spacecraft heat-shields, exhaust pipes or engine covers in automotive or interior parts of submarines.

[1] Babkin A. V., Zodbinov E.B., Bulgakov B.A., Kepman A.V., Avdeev V.V. *Eur. Polym. J. 66 (**2015**) 452–457.*
[2] Bulgakov B.A., Sulimov A.V., Babkin A.V., Afanasiev D.V., Solopchenko A.V., Afanaseva E.S., Kepman A.V., Avdeev V.V. *Mendeleev Commun. 3 (***2017***)* 257–259.