NRL licenses new polymer resin for commercial applications

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The NRL-developed polyetheretherketone (PEEK)-like phthalonitrile-resin can be used to make composite components including aircraft, ship, automotive, and wind blade structural components; battery casings; fire-resistant textiles and structural composites; robotic and autonomous systems applications; and ammunition casings and storage containers. Credit: DoD/U.S Navy

The U.S. Naval Research Laboratory (NRL) Chemistry Division and Technology Transfer Office announce today the signing of licensing agreements for the commercial manufacturing of an NRL-developed PEEK-like phthalonitrile (PN) resin composition. Inventors of the licensed patents are Teddy M. Keller, Matthew Laskoski, and Andrew P. Saab of the Materials Chemistry Branch in the Chemistry Division.

"The many attractive features of the second-generation polyetheretherketone PEEK-like phthalonitriles make these resins excellent candidates for numerous military and domestic applications," said, Teddy Keller, Ph.D., head, NRL Advanced Materials Section. "The NRL-developed phthalonitrile-based polymeric composites exhibit superior flame resistant, high temperature, and low water absorption properties that do not exist in the current marketplace."

Phthalonitrile-based polymers constitute a class of high temperature thermosets that remain strong at temperatures up to 500 degrees Celsius (C) and are easily processed into shaped fiber reinforced composite components by low-cost non-autoclave techniques.

The resin can be used to make composite components by established industrial methods such as resin transfer molding (RTM), resin infusion molding (RIM), filament winding, prepreg consolidation, and potentially by automated composite manufacturing techniques such as automated tape laying and automated fiber placement.

NRL's PEEK-like phthalonitrile resins were also measured to have excellent dielectric permittivity and loss tangent characteristics for potential high temperature radomes and other applications requiring radiofrequency transparency. The viscosity of the curing PN composition can be readily controlled as a function of the curing additive and temperature and the B-staged prepolymer intermediate can be stored indefinitely under ambient condition until ready to convert to

the thermoset polymer or to use in the fabrication of a composite component. The ability to cure to a shaped solid or composite below 200 C and the superior physical properties relative to other high temperature polymers such as polyimides enhance the importance of the phthalonitrile system.

Due to their low water absorption, processing temperatures comparable to common epoxy resins, and superior thermo-oxidative stability at temperatures in excess of 375 C, the second-generation PEEK-like phthalonitrile-based polymers can revolutionize the use of composites in applications including lightweight automobiles, ships, oil rigs, aircraft, wind blades, high temperature bearings, valves, battery and electronic casings, fire resistant textiles, robotic and autonomous firefighting on ships, ammunition casings and storage containers, and fire-resistant building materials.

A notable aspect of this second generation technology is the ability to melt the resin and to control its initial cure to the shaped solid below 200 C. This permits NRL's phthalonitriles to be processed in the same way as ordinary commercial resins, using standard industrial composite manufacturing methods—a vital technological advantage to the aerospace, ship, and other domestic industries.

The oligomeric PEEK-like phthalonitrile is a liquid above 70 C and polymerizes to a thermoset occurring above 150 C, giving it an ample processing temperature window. The rate of polymerization is controlled as a function of temperature and the amount of curing additive, and the fully cured void-free phthalonitrile polymer does not exhibit a glass transition temperature (does not melt or soften) when post-cured to temperatures greater than 375 C. NRL's phthalonitrile resins/prepolymers or resin prepregs have an indefinite shelf life without the need for refrigeration.

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Provided by Naval Research Laboratory

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