Polymer matrix composites (PMCs) have superior physical and mechanical properties, such as high specific strength, light weight, and good fatigue and corrosion resistance. They have become competitive engineering materials to replace conventional metallic materials in many important sectors of industry such as aircraft, naval constructions, ships, buildings, transportation, electrical and electronics components, and offshore structures. However, since PMCs contain polymer matrix, the polymer composites and their structures are combustible. PMCs will degrade, decompose, and sometimes yield toxic gases at high temperature or subject to fire conditions.

The objective of this study is to design and optimize fire retardant nanopaper by utilizing the synergistic effects of different nanoparticles. A paper-making technique that combined carbon nanofiber, nanoclay, polyhedral oligomeric silsesquioxanes, graphite nanoplatelet, and ammonium polyphosphate into self-standing nanopaper was developed. The fire retardant nanopaper was further incorporated into the polymer matrix, in conjunction with continuous fiber mats, through resin transfer molding process to improve fire retardant performance of structural composites. The morphology, thermal stability, and flammability of polymer composites coated with hybrid nanopaper were studied. The cone calorimeter test results indicate that the peak heat release rate of the composites coated with a CNF-clay nanopaper was reduced by 60.5%. The compact char material formed on the surface of the residues of the CNF-clay nanopaper was analyzed to understand the fire retardant mechanism of the nanopaper. The financial support from Office of Naval Research is acknowledged.