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MECHANICAL PROPERTIES OF POLYMER-DERIVED CERAMICS MODIFIED BY ACTIVE AND  
PASSIVE NANO-PARTICLES**Abstract**

Polymer-derived ceramics (PDCs) address the shaping limitations of traditional ceramic processing techniques and result in near-net-shape manufacturing of ceramics with complex geometries. One of the major limitations of PDCs is their brittleness. Four different types of nanoparticles were evaluated as fillers to improve the mechanical properties of a commercial PDC, polysilazane (PSZ). Different concentrations of either active fillers (silicon nitride and alumina nano-particle) or passive fillers (boron nitride nanotubes and carbon nanotubes) were added to the PSZ, which was subsequently thermally cross-linked and pyrolyzed under hydrostatic pressure. Nano/micro indentation measurements show that adding silicon nitride nano-powders improves the fracture toughness of the PDCs up to 3 times and adding alumina nano-powders improves the modulus and hardness of the PDCs up to 1.5 and 2.6 times, respectively. The ceramics made with sufficient concentration of active fillers have clearly lower void content than unfilled PSZ, which is attributed to the reaction of these nanoparticles with pyrolysis by-products. Addition of nanotubes, which are passive fillers not expected to react, leads to some mechanical improvement but not the increased density or decreased instance of voids that was achieved with the active fillers. The ceramics developed in this study show interesting combinations of properties and can easily take different shapes. Therefore, they are of interest in protective armor, propulsion, thermal protection, device packaging and bio-material systems.