

Additive Manufacturing of Polymer-Derived Ceramics at NRC Canada: Toward variable-composition and difficult-to-print ceramics

Preceramic polymers enable both the use of polymer processing and shaping methods, and molecular-level control over the composition of the resulting polymer-derived ceramics (PDCs). While slurry-based 3D printing methods – using high-resolution printing approaches based on photopolymerization with ceramic particle suspensions in a sacrificial resin binder – have proven effective for ceramics such as alumina, a PDC approach can be particularly advantageous for compositional flexibility and for dark ceramics, which are otherwise difficult to print by such methods. Here we show 3D printing of preceramic polymers using digital light processing to achieve ceramic structures with complex lattice geometries. A range of compositions have been achieved to date, including silicon-based, non-oxide ceramics. The structures exhibit fine features, low porosity, stability above 1500 °C and good performance under compression, demonstrating the potential of the approach for a broader range of difficult-to-print ceramic compositions.

Michael Jakubinek (BSc Chemical Physics; MSc, PhD Physics) is a Senior Research Officer in Division of Emerging Technologies at the National Research Council Canada and Adjunct Professor of Mechanical & Aerospace Engineering at Carleton University in Ottawa. His research activities are focused on nanocomposite and multifunctional polymer-based materials – most recently extending into polymer-derived ceramics – and their applications for aerospace and defence. He collaborates extensively with NRC's Aerospace Research Centre and Defence R&D Canada and, since 2020, has served as an expert on multifunctional materials for Canada within the Five Eyes S&T Program. Dr. Jakubinek's work on interdisciplinary science and engineering teams has been recognized several awards, including a Public Service Award for Scientific Achievement, NRC's Rising Star Award for Early Career Leadership, and an NRC IP Advancement Award. He has co-authored over 100 publications and delivered more than 20 invited talks.