

Microstructural Tailoring of Nacre-Inspired Alumina Composites Via Molecular Layer Deposition and Hot Pressing

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Nacre, or mother-of-pearl, exhibits exceptional mechanical properties due to its hierarchical brick-and-mortar structure, making it a promising model for lightweight, robust composites. Alumina based systems offer high thermal stability and strength but achieving controlled microarchitecture with low porosity remains challenging. This study investigates the fabrication of nacre-inspired ceramic-polymer composites where the polymeric interlayer (mortar) was produced by molecular layer deposition (MLD). Micron-sized alumina flakes were assembled into a brick-like framework via centrifugation, followed by deposition of a conformal polyurea layer using MLD with 1,4-phenylene diisocyanate and ethylenediamine as precursors. The resulting composites were hot pressed at low temperature under varying pressures, and cross-sections were analyzed by SEM after ion polishing, with porosity quantified using Trainable Weka Segmentation in ImageJ. The MLD process successfully deposited polymeric material between the alumina platelets, albeit showing low contact angle and apparent island-like coating. Hot pressing improved interfacial contact and densified the nacre-like structures, reducing porosity compared to unpressed samples. These results demonstrate that combining MLD-based polymer deposition with low-temperature hot pressing is an effective strategy for producing low-porosity, nacre-inspired ceramic-polymer composites with controlled microstructure and enhanced structural integrity.

Professional Status of the Speaker

Doctoral or Master Student

Interest in submitting a paper in a special issue of

No interest

Invitation letter for visa

No

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