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In spite of the excellent properties such as high hardness, low thermal expansion, enhanced resistance to chemical degradation and superior mechanical behavior at elevated temperature, ceramic materials usually suffer from the brittle fracture and catastrophic failure, which restrict them from being used for structural applications. While a number of researchers have strived to overcome this drawback of ceramic materials by constructing the microstructures that interfere with crack growth, recent theoretical and computational studies proposed another effective method to suppress the rapid crack propagation by reducing the specimen size down to the nanometer scale.

In this study, we investigated the mechanical properties of brittle ceramics by changing sample sizes from bulk to nanoscale with particular focus on their fracture failure. For the ease of analysis, we chose the isotropic, homogeneous and purely brittle material, i.e., diamond-like carbon. In-situ fixed-ends bending experiments were conducted with different beam thicknesses and lengths, 1μm ~ 100nm and 3μm ~ 6μm, respectively. Additionally, in order to demonstrate the feasibility to intactly transfer the superior properties emergent only at the nanoscale to the macroscopically available form, we fabricated the large-area 3D hierarchical hollow ceramic nano-architectures using proximity nano-patterning technique.