PROBING THE LIMITS OF STRENGTH IN DIAMONDS: FROM SINGLE- AND NANO-CRYSTALLINE TO DIAMOND-LIKE-CARBON (DLC)

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As the hardest known material, diamond represents the benchmark for the ultimate strength of materials. It is thus a very attractive material for a number of mechanical applications. Recent advances in synthesis techniques have enabled the fabrication of diamond in thin film form with various microstructures: single- and nano-crystalline and tetrahedral-amorphous or diamond-like carbon (DLC) [1, 2]. Microcompression has been demonstrated to enable the interrogation of even the strongest form of diamond - a ⟨111⟩-oriented single crystal - achieving the strength limit predicted by simulations (Figure 1) [3, 4]. Nowadays, these allotropes of carbon with high strength and low friction are used in microelectronics and micro-electromechanical systems (MEMS) as structure components [5]. However, the effects of these new nanostructures on the mechanical properties of these allotropes is mostly unknown especially at different service temperatures. In this study, the mechanical properties of single crystalline, nanocrystalline, and amorphous forms of diamond are systematically studied by conducting *in situ* microcompression at various temperatures in scanning electron microscope (SEM). This allows the investigation of thermally-activated defect behavior and activation energy for several different nanostructures of diamond. This is then correlated with the deformed structures using high resolution transmission electron microscope (HRTEM) and Raman spectroscopy to interpret the deformation mechanisms.
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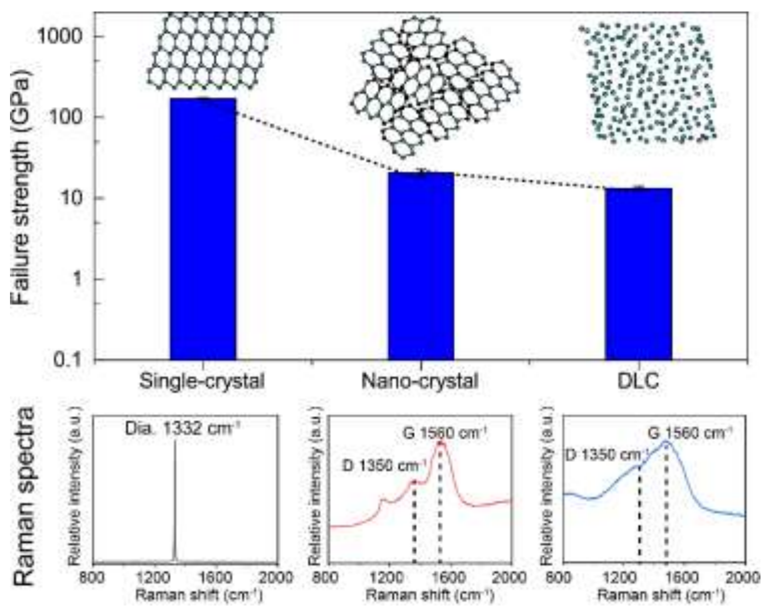

Figure 1 – Failure strength from microcompression of single-, nano-crystalline diamonds and DLC nanopillars with 0.5 µm diameter and also the corresponding Raman spectra.

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