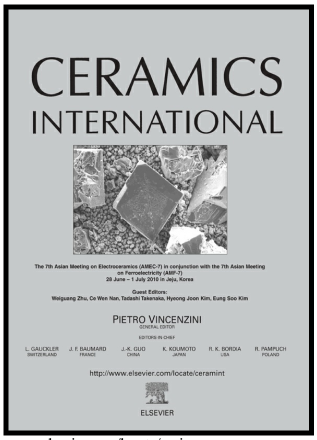

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Nano-scale elastic-plastic properties and indentation-induced deformation of amorphous silicon carbide thin film

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Abstract

Controllable low-temperature (500 °C) deposition of amorphous a-SiC ceramic films on Si(100) was achieved using a pulsed dc-magnetron puttering system in a mixture of CH_4/Ar. The nanoscale elastic-plastic response of the film upon contact loading was systematically characterized and analyzed by depth sensing nanoindentation technique using a Berkovich tip indenter. The mean values for elastic modulus and hardness were found to be 170 ± 10 and 11.0 ± 0.8 GPa, respectively. The onset of elastic-plastic transition occurred with contact loading of 70 μN at a depth of 10 nm. By coupling the Hertzian contact theory and Johnson's cavity model, the critical shear stress (7.7 GPa), yielding strength (14.4 GPa), plastic zone size (30-300 nm), and plastic work ratio (0.18-0.40) of a-SiC thin film under nanoindentation were determined. Based on the experimental results, the resolved shear stress analysis and deformation behavior were found to be consistent with the interpretation that the deformation behavior was associated