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Superhard Boron-Rich Boron Carbide with Controlled Degree of Crystallinity in Microwave Plasma CVD[1] KALLOL CHAKRABARTY, WEI-CHIH CHEN, PAUL A. BAKER, VINEETH M. VIJAYAN, CHENG-CHIEN CHEN, SHANE A. CATLEDGE, University of Alabama at Birmingham — Materials based on the light elements of carbon, nitrogen, oxygen and boron having strong covalent bonds comprise some of the hardest known materials. These light elements can form short bond lengths with each other and are inclined to form directional covalent bonds, making the structures they form difficult to compress or distort. In this study microwave plasma chemical vapor deposition (MPCVD) was used to synthesize superhard boron-rich boron carbide coatings on silicon substrates under controlled conditions that led to either disordered or crystalline structure. By simply modifying the sample stage design inside the MPCVD crystallinity of the synthesized coatings was manipulated. X-ray diffraction analysis of the crystalline coating provides a good match with a $B_{50}C_2$-type of structure in which two carbon atoms replace boron in the α-tetragonal B_{52} structure, or in which the carbon atoms occupy different interstitial sites. Density functional theory predictions were used to evaluate dynamical stability of potential $B_{50}C_2$ structural forms that are consistent with measurements. Nano-indentation measurements reveal an average coating hardness 34 GPa with several measurements greater than 40 GPa.

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