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Nanocrystalline diamond (NCD): an insight into structure-property relationships

N. Dubrovinskaia[1], L. Dubrovinsky[2], N. Solopova[1,2], A. Abakumov[3], A. Snigirev[4], I. Snigireva[4], V. Prakapenka[5], M. Hanfland[4]

[1]University of Bayreuth, Material Physics and Technology at Extreme Conditions, Laboratory of Crystallography, Bayreuth, Germany, [2]University of Bayreuth, Bayerisches Geoinstitut, Bayreuth, Germany, [3]University of Antwerp, Electron Microscopy for Materials Research, Antwerp, Belgium, [4]European Synchrotron Radiation Facility, Grenoble, France, [5]University of Chicago, Center for Advanced Radiation Sources, Chicago, USA

Nanocrystalline diamond (NCD) is a unique material we produce by direct conversion of glassy carbon into diamond at ca. 20 GPa and 2200 K in a multi anvil press. One of precursor materials we use is commercially available in the form of glassy carbon balls with a diameter of 20 to 50 microns. NCD demonstrates superior mechanical properties (e.g. extremely high yield strength under confining pressure) and has been successfully used for ultra-high static pressure generation (above 600 GPa) in a double-stage diamond anvil cell (DAC) (Ref. 1). To elucidate structure-property relationships in this extremely strong and seemingly inscrutable material we have investigated its microstructure using HRTEM and HAADF-STEM, measured its compressibility by means of synchrotron X-ray diffraction in a DAC, and evaluated its hardness in comparison to that of the hardest known materials - single-crystal diamond and nano-polycrystalline diamond (NPD) (Ref. 2). An additional insight into the volume compressibility was obtained due to X-ray phase contrast micro-imaging using a coherent high-energy synchrotron radiation. The established structure-property relationships will be presented and analyzed.

[1] *L. Dubrovinsky, N. Dubrovinskaia, V. Prakapenka, et al. Implementation of micro-ball nanodiamond anvils for high-pressure studies above 6 Mbar. Nature Communications, 3:1163 doi: 10.1038/ncomms2160, 2012.,* ***[2]*** *T. Irifune, A. Kurio, S. Sakamoto, et al. Materials: Ultrahard polycrystalline diamond from graphite. Nature 421, 599 (2003); K. Tanigaki, H. Ogi, H. Sumya, K. Kusakabe, N. Nakamura, M. Hirao, H. Ledbetter. Observation of higher stiffness in nanopolycrys*

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