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Designer Diamonds: Applications in Iron-based Superconductors and Lanthanides¹

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This talk will focus on the recent progress in the fabrication of designer diamond anvils as well as scientific applications of these diamonds in static high pressure research. The two critical parameters that have emerged in the microwave plasma chemical vapor deposition of designer diamond anvils are (1) the precise [100] alignment of the starting diamond substrate and (2) balancing the competing roles of parts per million levels of nitrogen and oxygen in the diamond growth plasma. The control of these parameters results in the fabrication of high quality designer diamonds with culet size in excess of 300 microns in diameter. The three different applications of designer diamond anvils will be discussed (1) simultaneous electrical resistance and crystal structure measurements using a synchrotron source on Iron-based superconductors with data on both electron and hole doped BaFe_2As_2 materials and other novel superconducting materials (2) high-pressure high-temperature melting studies on metals using eight-probe Ohmic heating designer diamonds and (3) high pressure low temperature studies on magnetic behavior of 4f-lanthanide metals using four-probe electrical resistance measurements and complementary neutron diffraction studies on a spallation neutron source. Future opportunities in boron-doped conducting designer diamond anvils as well as fabrication of two-stage designer diamonds for ultra high pressure experiments will also be presented.

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