

## **EMERGING DIAMOND TECHNOLOGY AND THE SCIENCE OF EXTREME CONDITIONS\***

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Diamond is a singularly important material for exploring matter under extreme conditions of pressure and temperature. Static compression techniques made possible by using diamond as a window and anvil provide the ability to investigate materials to ultrahigh pressure of >3 Mbar (300 GPa) and at variable temperatures from cryogenic to many thousands of degrees. The increasing array of measurements that can be performed with these high-pressure techniques have resulted in new findings in structure, bonding, and dynamics in solids, liquids, and fluids, as well as allowing the creation and recovery of new materials. To address the need for larger, stronger, and more versatile diamond for these experiments, microwave plasma chemical vapor deposition techniques have been developed to fabricate large single-crystal diamond at very high growth rates (to >100  $\mu\text{m}/\text{h}$ ). Single crystals >1 cm in thickness and >10 carats in size can now be produced having a range of optical and mechanical properties. This diamond can be tailored to possess high fracture toughness, and high  $P$ - $T$  annealing can significantly increase its hardness. The process has also been optimized to produce diamond with improved optical properties in the ultraviolet to infrared range. This material will also be important dynamic compression experiments, including gas gun, laser, and magnetically driven shock compression experiments. There are also prospects for additional scientific and technological applications.

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