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Special Issue on Superconductivity in CVD Diamond

Preface

Diamond is the hardest material in the world; it is an excellent material with a very high thermal conductivity. This property is attributed to the extremely high phonon frequency of diamond.

In 2004, boron-doped diamond samples that exhibit superconductivity were synthesized using a high-pressure high-temperature (HPHT) method under the direct conversion condition for the first time. Following this achievement, Japanese researchers succeeded in producing high-quality diamond superconductors using chemical vapor deposition (CVD). Samples made using this technique exhibited an increased superconducting transition temperature above 10 K. Since single-crystal diamond samples were produced with controlled concentrations of boron, the detailed basic properties and electronic states of the diamond samples were determined, leading to a greater understanding of the metal-to-insulator transition and superconducting properties.

The unique characteristics of the boron-doped diamond samples include both semiconductor and superconductor properties. The high phonon frequency greatly contributes to the occurrence of superconductivity. It has been predicted that the superconducting transition temperature of diamond can be further increased on the basis of the Bardeen Cooper Schrieffer (BCS) theory. What then controls the superconducting transition temperature? Some researchers suggest that the boron atoms introduced into the diamond lattice as a carrier dopant causes disorders, resulting in the suppression of the superconductivity in diamond.

In this special issue, the authors examine the synthesis of superconducting diamond and its basic properties, as well as the electronic states and the environment of the boron dopant using photoemission spectroscopy. Furthermore, we report a detailed analysis of the superconductivity using scanning tunneling microscopy and a theory of the effect of lattice disorders. An ideal superconducting diamond crystal free from any disorders is desirable. I hope that readers will gain significant knowledge from this work as a foundation for future work to increase the superconducting transition temperature of diamond.

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