

Bulk Crystal Growth of Hexagonal Boron Nitride from Molten Metal Solutions

J.H. Edgar, Tim Taylor Department of Chemical Engineering, Kansas State University, Manhattan, KS 66506, edgarjh@ksu.edu

While polycrystalline hexagonal boron nitride (hBN) has been a commercial product for seventy years, there is growing interest in hBN single crystals due to its extraordinary optical and electrical properties and applications in solid state devices including electronics, optoelectronics, and quantum sensors. Our group, has been studying the growth and characterization of hBN single crystals from molten metal solutions. Solvents are selected from metals with a high solubility for boron (Ni, Fe, and Co) and nitrogen (chromium). Both metallic (elemental) boron and boron nitride are suitable boron sources, while the nitrogen come from molecular nitrogen gas. The quality of these hBN crystals is comparable to the those produced by the high pressure – high temperature method, as verified by narrow Raman peak widths, high photoluminescence intensity energies greater than 5.7 eV, and low background concentrations of carbon and oxygen. Uniquely, our group grows hBN with specific boron and nitrogen isotopes to enhances its properties and expand its applications. The challenges of producing high quality hBN single crystals with tailored properties for specific applications will be discussed.

Short biography of J.H. Edgar

Dr. James H. Edgar is a University Distinguished Professor in the Tim Taylor Department of Chemical at Kansas State University. His research focus is on the synthesis, characterization, and processing of novel semiconductors. This has included the crystal growth and epitaxy of the wide band gap semiconductors gallium and aluminum nitride, silicon carbide, icosahedral boron compounds ($B_{12}P_2$ and $B_{12}As_2$), and hexagonal boron nitride (hBN). He has co-authored over 300 publications on these topics. He earned his BS and PhD degrees in chemical engineering from the University of Kansas (1981) and the University of Florida (1987) respectively. He has been at Kansas State University since 1988, and he served as the head of the chemical engineering department from 2009 to 2019. Dr. Edgar spent sabbaticals at the Naval Research Laboratory, Washington, DC (1995-1996), and Radboud University, the Netherlands (2006-2007). He was a director in the Electronic and Photonic Materials program at National Science Foundation (NSF) from 2019 to 2022. His research has been supported by the NSF, the Office of Naval Research, and the Department of Energy, among others.