

Synthesizing c-Si₃N₄ from Extreme Temperature and Pressure Conditions

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Silicon Nitride is becoming a significant building material in many microelectronic, medical-imaging devices, and automotive parts because of its superconductive and mechanical properties. However, investigations typically heated and pressurized the sample at around 1600-1800K and 10.0 GPa. Using a Multi-Anvil Press Machine to sinter c-Si₃N₄ at a lower pressure and higher temperature could optimize the process of reaching c-Si₃N₄. A ZrO₂ octahedron stores the commercially-available a-Si₃N₄ sample in a Re cylinder, inside a BN chamber with MgO rods. Once centered around four WC cubes, it is placed in the Multi-Anvil Press until it reaches 15.5GPa and 1600C. The Raman Spectroscopy inspected the sample to indicate the material as c-Si₃N₄. The gray color of the c-Si₃N₄ should have been transparent; however, the Raman Shifts from the Raman Spectra recording matched previous research, achieving the material. While the A-sample stoke lines shift right of the B-sample by 103 cm⁻¹, they have the same frequencies and the same maximum at 602 cm⁻¹. There are more c-Si₃N₄ in the A-sample than B, according to its Rayleigh Scatter. Both a-Si₃N₄ and c-Si₃N₄ were tested and show drastically different graphs to mean different polymorphs of Si₃N₄. When replicating this experiment, using a straightedge to properly align the pyrophyllite against the WC cubes and create a black shield to prevent ambient light from entering the Raman Spectroscopy machine could refine c-Si₃N₄ better. With more trials and analysis of stress and strain states, sintering on group four elements to Si₃N₄ to improve its qualities would be the next steps.

Awards Won:

Arizona State University: Arizona State University ISEF Scholarship