Synthesizing c-Si3N4 from Extreme Temperature and Pressure Conditions

Cornelio, Jeyan Francis (School: Waipahu High School)

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.

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