**Synthesis of Novel Carbon-Based Materials using Extreme Conditions**

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Introduction

Carbon-based materials form some of the hardest known solids and offer opportunities for new materials with attractive properties. This research aims to synthesis new carbon materials by applying high pressures and temperatures to novel, non-crystalline precursor materials. By studying the behavior of carbon under extreme pressure and temperature condition, this work also contributes to our understanding of the phase diagram of carbon, which is not completely understood.

Methods

Novel disordered precursors such as glassy carbon was loaded into diamond anvil cells and compressed to pressures up ~100 GPa. In addition to room temperature compression, laser heating was performed allowing the samples to be heated to temperatures up to 4500 K during compression. The microstructure of the recovered samples was then analysis using Raman spectroscopy, X-ray diffraction and electron microscopy.

Results/Discussion

Our recent work has proven the principle of employing novel disordered precursors to access interesting materials when subjected to high pressures. A disordered precursor provides nuclei for every possible structural variation and allows the most favourable one to dominate growth. Using this approach. we showed that the novel carbon phase, hexagonal diamond, can be synthesised in a purer form and at lower temperatures than previously reported [1]. We show that nanodiamonds can be formed near the surface of glassy carbon compressed to 16 GPa and heated to temperatures of ~2200 K. Some of these nano diamonds have a novel microstructure such as unusually layer stackings. The nanodiamonds increase in size and density as the temperature increases and at a temperature of ~3500 K voids and other features were observed, which provide strong evidence that the sample had melted. This result indicates that the melting line in the phase diagram of carbon may be lower than previously thought.

Conclusion

The use of novel disordered carbon precursor and extreme pressures has revealed new synthesis conditions for novel phase of carbon and has helped reveal new aspects of the phase diagram of carbon.

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**Reference**

[1] “Nanocrystalline hexagonal diamond formed from glassy carbon”, T.B. Shiell, D.G. McCulloch, J.E. Bradby, B. Haberl, R. Boehler, and D.R. McKenzie, Scientific Reports, 6, 37232, 2016.