The 471st Geodynamics Seminar

Synthesis of a hydrogen-free carbon nitride with a diamond-like structure

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Abstract

Since the theoretical calculation by Liu and Cohen (1989), carbon nitride is believed to be an ultra-hard material exceeding the hardness of diamond. A number of studies based on ab initio calculation with the C_3N_4 stoichiometry and even a variety of non-stoichiometric carbon nitrides such as CN, C_2N, $C_{11}N_4$ and CN_2 have been performed for the last few decades. Many experimental works, however, failed to synthesize such ultra-hard carbon nitrides due to the critical problem of the hydrogen contamination. Therefore, it is important for the synthesis of pure carbon nitride to use a hydrogen-free starting material. Stavrou et al. reported that an orthorhombic CN phase was produced by the reaction between graphite and nitrogen at temperature above 7000 K at 55 GPa. This phase has the bulk modulus (K_0= 400 GPa) 10% smaller than that of diamond, but unfortunately became amorphous during a decompression to the ambient condition. Recently, I succeed to synthesize a new cubic carbon nitride with a diamond-like structure using tetracyanoethylene (C_6N_4) as a starting material. This result is the first data synthesizing a pure carbon nitride product recoverable to the ambient condition. This phase was only produced by “flash heating” (less than 1 sec) estimated at temperature above 5000 K at 53 GPa, and the further heating resulted in the decomposition to diamond. The hardness of this phase is estimated to be comparable to that of diamond due to the similar compression behavior under a non-hydrostatic condition. The determination of the C:N ratio is now tried by using TEM-EDS examination, on the day I will introduce a present report in detail.

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