ATEM-EELS study of diamond-like phases in the B-C-N system

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Diamond is the hardest known material but its technical use as abrasive tool is limited by the finite thermal stability. On the other hand, cubic BN is thermally more stable and resistant to oxidation but is less hard than diamond. It is thus desirable to synthesize ternary diamond-like B-C-N phases that may combine the best properties of both materials.

To synthesize such B-C-N phases we have used static (multi-anvil, diamond anvil cell) and dynamic (shock) high-pressure techniques pressurizing nano-powdered graphite-like $(BN)_{0.5}C_{0.5}$ to 30 GPa at temperatures up to 3500 K [2]. The structures, compositions and properties were subsequently studied by analytical transmission electron microscopy, electron energy loss spectroscopy, and X-ray powder diffraction.

Analyses of recovered materials reveal the formation of nanocrystalline diamond-like B-C-N compounds of variable composition ranging from BC_2N to BC_8N. B, C and N are homogeneously distributed in nanocrystals; superstructures with ordered arrays of C and BN have not been observed. The lattice constant a is a linear function of the composition. The variation in chemical compositions indicates however that there is no complete solid solution between diamond and cubic BN. Due to supersaturation of diamond in the BN component all ternary diamond-like B-C-N phases tend to decompose at high temperature into an diamond + cubic BC assemblage.

References

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Ordering of the Al cation distribution in the octahedral sheets related to the ordering of Al in the tetrahedral sheets of phlogopite studied by {^{1}H} ^{29}Si CPMAS NMR spectroscopy

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Our research project is part of the ORION-project (Ordering of Ions in Minerals) in the EuroMinScI programme of the ESF which aims the elucidation of ionic ordering in three exemplary systems by combining experimental investigations and theoretical calculations. One of the systems to be investigated is phlogopite, a trioctahedral 2:1 layer silicate.

Previous NMR solid state experiments of phlogopites indicated a non-statistical distribution of cations and anions in the octahedral sheets: F prefers sites coordinated by three Mg, whereas OH prefers sites with Al as next-nearest-neighbors (Fechtelkord *et al*. 2003). Further investigations will be carried out on phlogopites with various Al-contents and synthesized at different temperatures. In addition to that, cross-polarization (CP) experiments will be performed to clarify, whether the degree of ordering in the octahedral sheets is related to that in the tetrahedral layers.

The CP experiment is a double resonance experiment which allows the transfer of magnetization from a nucleus with a strong magnetic polarization due to its high natural abundance and high magnetogyric ratio, such as ^{1}H, on a nucleus with a low spectral resolution such as ^{29}Si via heteronuclear dipolar interaction. The increase of magnetization is a function of the cross polarization time, the number of proton spins, and the distance of these spins, r_{IS}, to the ^{29}Si nucleus. Thus, direct neighborhoods of protons in the octahedral sheets to Si environments in the tetrahedral sheets can be correlated in one- and two dimensional CPMAS NMR experiments. Moreover, information on the position of Al in both sheets can be achieved indirectly.

Our first experiments clearly indicate a direct neighborhood of aluminum in the tetrahedral sheets to aluminum in the octahedral sheets and, thus, a relationship between the ordering of ions in both sheets.

References

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