Fluids in fibrous diamonds – Insights from optical spectroscopy

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The first evidences for presence of water and CO_2 in fibrous diamonds were given by Chrenko et al. (1967) and by Klyuev et al.(1972). However, until the paper by Navon et al., (1988) these observations did not attract much attention of geoscientists. The majority of studies of microscopic inclusions in diamonds aimed to the microprobe chemical analyses of fluids and minerals in them. In this work we present results of our spectroscopic investigations of the microinclusions and of fluids in diamonds.

Thin plates (0.3-0.5 mm) cut from fibrous diamonds from different localities (Brasil, Canada, Yakutia) were investigated using IR and Raman spectrometers. Spectra from the whole samples as well as from different growth zones (with diaphragms) were acquired at ambient conditions. The studied samples contain relatively high concentration of nitrogen defects in the diamond lattice: 500-1500 at.ppm of nitrogen, mostly as A-defects (nitrogen pair). Beside this, the following groups of IR peaks were found: silicates and phosphates (500-1000 cm^{-1}), carbonates (~1450 cm^{-1}), CO_2 (2350 cm^{-1}) HOH band (~1650 cm^{-1}) and broad OH band (2900-4500 cm^{-1}) with a complicated structure.

In many cases HOH band is non-symmetric and decomposition of the HOH and OH bands was performed. The HOH band could be decomposed into two and sometimes three components. Position of one of the components is similar to the position of the HOH band in liquid water (1640 cm^{-1}), whereas the second one is shifted to higher wavelength (~1680 cm^{-1}) and could be explained as vibration of water molecule, perturbed by a cation. This observation shows that there are at least two types of water-containing microinclusions: some of them contain solution of cations which can strongly modify the hydrogen bonding of the water molecule, whereas more abundant inclusions are filled with solutions, leaving HOH vibrations largely intact.

Infra-red spectra of fibrous diamonds often show rather complex structure of OH band. It is clear that one observes overlapping of features related to liquid water and solutions as well as OH groups in the structure of trapped minerals. Results of the decomposition of the band and inferences from it will be presented.

All the diamonds with microinclusions shows strong rise of the IR extinction (absorption plus scattering) at large wavenumbers. The exact behavior of the extinction curve depends on many factors and the size distribution of the scattering objects (inclusions in our case) plays a very important role. Modeling of the size distribution of microinclusions will be presented in the talk.

Chondritic meteorites and X-wind

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We review the theory of X-winds in young forming stars as applied to the formation of the refractory inclusions and chondrules that are found in chondritic meteorites. In particular, we discuss the successes and failures of the model with respect to issues like flash heating, size sorting, remnant magnetization, complementarity between chondrules and matrix, presolar grains, loss of moderate volatiles, and short-lived radioactivities. We also consider predictions of the model that distinguish it from competeting ideas. Finally, we speculate on the importance of the process of chondrule formation for current ideas concerning planetesimal formation in the terrestrial-planet region of the primitive solar nebula.