

Nano-crystalline osbornite from Carbonados: Spectroscopic studies

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Carbonado has been recognised as a polycrystalline aggregate of diamond since 1840 and was mined as a placer mineral in Sincoro County in Brazil. Carbonado has been recovered only from alluvial deposits in Brazil and the Central African Republic (CAR). The origin of the unusual type of polycrystalline diamond is not yet understood. In order to understand the origin of this exotic diamond aggregates, we have carried out powder-X-ray diffraction, Nuclear Magnetic Resonance and FT-IR, and TEM studies on the carbonados from Brazil as well as CAR. While our data on the chemical and trace elements analyses agree with the earlier data, there is a minor difference in the observation of presence minor minerals. We have identified few grains of osbornite (TiN) with 50 to 100 nm size, and presence of lonsdaleite- a high – pressure polymorph of diamond. The presence of these two minerals has been independently and unambiguously confirmed by XRD. The NMR spectrum also show a shock-induced broadening of the diamond line centred at 34.8 ppm which is more than the chemical shift 34.5ppm of pure diamond crystal. Our observation of presence of osbornite in carbonado shows the possible extraterrestrial origin of carbonado, as this mineral is known to exist only in enstatite chondrites and achondrites.

Incorporation of guest-molecules into natural zeolite mordenite

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Microporous materials such as zeolites are more and more applied for the design of advanced nano-materials, e.g. miniaturized electronic devices. They are also a group of minerals with geologic and environmental importance. Despite kinetic and spectroscopic studies of guest incorporation, little is known about the exact positions, geometrical arrangement and disorder phenomena of encapsulated guest-compounds.

Large synthetic mordenite single-crystals of good quality and suitable morphology were used for incorporation of semiconductor material (selenium) and organic dye molecules (thionin blue ($C_{12}H_9N_3S^+$), methylene blue ($C_{16}H_{18}N_3S^+$)). Single-crystal X-ray diffraction experiments were performed with a conventional in-house X-ray source as well as using synchrotron radiation at the Swiss Norwegian Beamline at ESRF, France. Complementary methods such as polarization and fluorescence microscopy were applied to analyze the orientation of the dye molecule transition dipole-moment.

Guest-molecule arrangement in all three guest-host systems is highly influenced by electrostatic interaction with the mordenite framework and the present extraframework occupants (Na^+ , H_2O). Elemental Se in mordenite builds chains, which show a highly variable geometrical arrangement and differ clearly from the regular chain geometry as occurring in elemental, trigonal selenium. The dye molecules show distinct occupational disorder along the channel axis and prefer an inclined arrangement within the channel cross-section resulting in short CH...O and NH...O contacts to the framework.

References

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