Electron diffraction and EELS study of carbon allotropes in impact diamonds

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Impact diamonds are formed by a rapid solid-state transformation of mainly sp^2 bonded carbon (graphite or coal) under very high pressure (up to 50 GPa) on the nanosecond timescale accompanied by high temperature (up to 4000K). The impact diamond grains, which size can reach few millimeters are nano-polycrystalline and besides diamond and graphite they may contain onion-like carbon and amorphous carbon as well.

Impact diamond grains originating from one of the largest known impact craters Popigai (Russia) were studied by TEM, focusing on the nanostructure and the textural relationship of the different carbon allotropes. Our aim is to reconstruct the conditions of impact diamond formation based on nanustructural features, and in parallel, to correlate impact diamonds with synthetic HPHT diamonds produced from different precursor materials from the nanostructural and physical (thermodynamic stability, hardness) point of view.

Based on morphology tabular-layered and massive-irregular shaped grains can be distinguished. The latter ones are characterized by an inhomogeneous nanostructure (Figure 1). The size of the nanodiamond grains varies within 20-100 nm with twin thickness 1 nm-20 nm however larger twin-free single crystals and co-oriented diamond and graphite growth with disordered stacking also occur. The nanodiamond crystals are embedded in a native amorphous carbon matrix.

The present talk focuses on the interpretation of SAED and EELS data obtained from the amorphous and crystalline components of the impact grains (Figure 2). Moreover the possibility of distinction of hexagonal diamond from graphite and cubic diamond will be discussed through the example of the impact diamond.

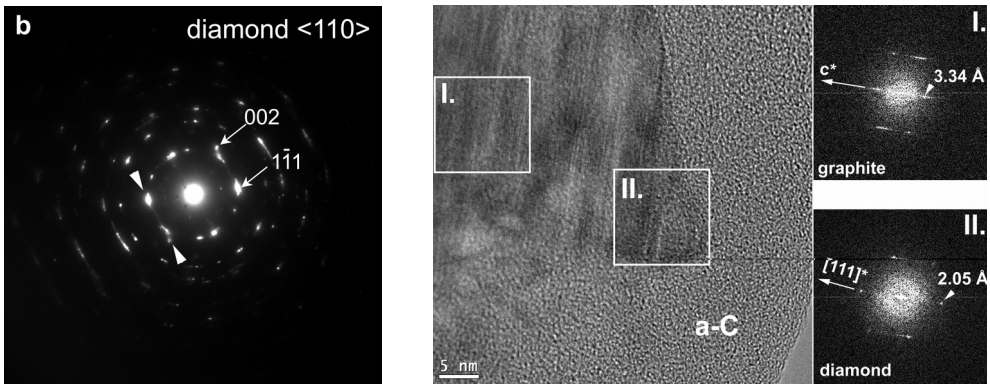

Figure 1: SAED obtained from an area of 250 nm diameter (a) and a HRTEM image from co-oriented graphite-diamond embedded in native amorphous carbon matrix

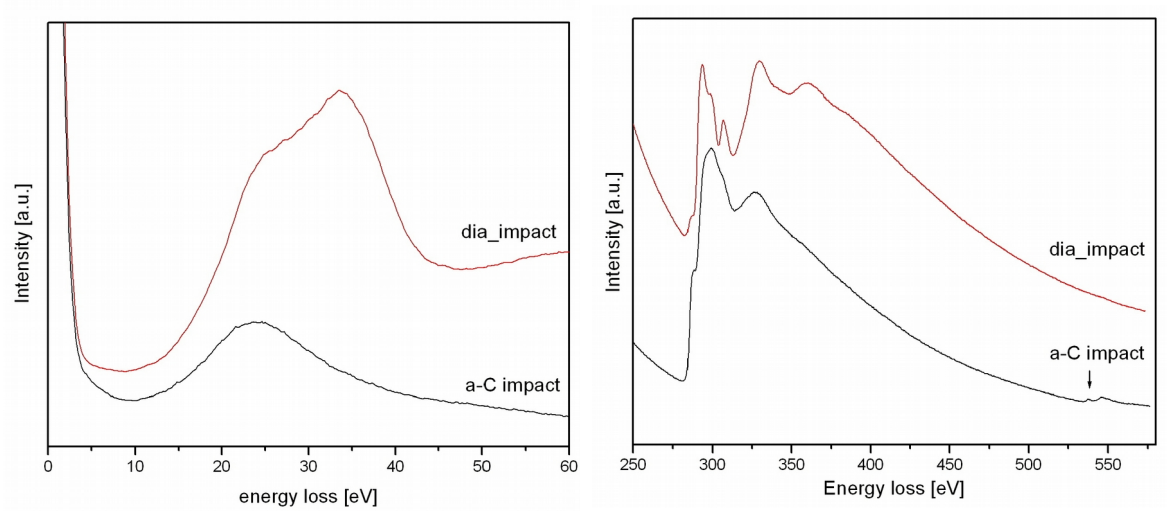

Figure 2: EELS spectrum of the amorphous and crystalline component of impact diamond.