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We have studied the internal structure and defect-impurity centres of small diamonds (less than 1 mm) in which signs of change in growth mechanism were recognized (from normal to layer-by-layer). "Re-faceted" diamonds were selected from the collection of crystals of the Aikhal pipe (Yakutia). The crystals were cut into flat-parallel plates of 50-100 μm in thickness. The internal structure was investigated by X-ray and luminescence topography. The composition of impurity defects and distribution of impurities were characterized using FTIR-spectroscopy.

The "re-faceted" crystals clearly exhibit an inner zone of cubic habit, with a fibrous structure and submicron inclusions in it. The cuboid surfaces are made up of abundant octahedral apexes, which evidences a change in the growth mechanism from normal to layer-by-layer one. Such a multi-head and step-like surface is gradually re-faceted into a closed octahedral form (Figure 1). The different degrees of re-faceting are responsible for the variety of habits of such diamonds.

The "Re-faceted" diamonds are characterized by a non-uniform distribution of impurities. Within the cubic inner zones the content of nitrogen is high (more than 1700 ppm). Predominance of B1-type defects in this zone suggests a high degree of aggregation of nitrogen centres (60-63% B1), which is uncommon to fibrous cuboids from the deposits of different genetic types [Shatsky et al., 1999]. A high degree of aggregation is also reflected in the presence of the peak of platelets with a high integral intensity. The saturation of cubic zone with micro-inclusions is reflected in the adsorption related to the presence of carbonates (1430 and 878-881 cm^{-1}) and H_2O molecules (3420 and 1630 cm^{-1}) [Navon et al., 1988]. An exiting feature of this zones is an extremely high intensity of the peak (3107 cm^{-1}) (17-55 cm^{-1}), which is accompanied by additional lines 1405, 2786, and 3227 cm^{-1}. An abnormally high intensity of this peak adsorption, attributed to the adsorption of structurally connected molecules C_2H_2 [Sobolev, 1988], in a cubic zone saturated with micro-inclusions and containing B1- and B2-type defects might be due to localization of hydrogen on the surface of micro-inclusions and voidities [Sobolev, 1988]. It is interesting that in the peripheral zone that contains no micro-inclusions of water and carbonates the intensity of peak 3107 cm^{-1} is no more than 5 cm^{-1}. The outer zone does not exhibit variations in the content and degree of nitrogen aggregation. It is worth noting that in "Re-faceted" crystals nitrogen content decreases when passing from normal to layer-by-layer mechanism (Table 1). The degree of aggregation in various zones either does not change or slightly decreases. The values of time/temperature occurrence of "Re-faceted" crystals in the mantle, determined by the second order kinetic equation, suggest that the peripheral zone is an older generation rather than the central one. This fact fits well the experimental data on different activation energies of the transition of nitrogen centres for cubic and octahedral crystals [Taylor et al., 1995].

The studies of "Re-faceted" diamonds suggest their long-term occurrence under mantle conditions. The fibrous growth of cuboids at the initial stage favours the capture of mineral-forming medium represented by water-carbonate fluid. Re-faceting of cubic crystals into an octahedron with a change of growth mechanism suggests that diamonds crystallized in a closed system under conditions of decreasing supersaturation.

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Figure 1: Idealized scheme of re-faceting of natural diamonds from cuboid to octahedron. Table 1. Main impurity distribution in "re-shaped" diamonds (representative samples).

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