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Cubic growth of natural diamond

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Natural diamond grows by at least three different modes: (a) Faceted growth on {111} planes giving octahedra; (b) Fibrous growth in <111> directions giving cubes, or other shapes (such as spherulitic ballas); (c) Cuboid growth on crinkly surfaces approximating to {100}, which also produces cubes [1]. Combinations may also occur: growth by (a) followed by (b) gives coated stones [2], and (a) and (c) growth modes may occur together to give combined morphologies. Twinning of (a) gives spinel-type contact twins (called macles) [3] and twinning of (b) gives fluorite-type interpenetrant cubes [4]. Subsequent dissolution may greatly modify the morphology: for example, octahedral diamonds grown by mode (a) may turn into rounded rhombic dodecahedra [5].

The principal non-destructive techniques for studying diamond morphology are X-ray topography, scanning electron microscopy and cathodoluminescence microscopy, supported by various forms of spectroscopy.

Here we report a study of a fourth mode of growth: namely, (d) faceted growth on {100} planes. Flat cube facets are a common occurrence for *synthetic* diamonds grown by high-pressure high-temperature techniques, especially at the lower range of temperatures at which diamonds are formed. Although cube facets have been seen on natural diamonds before [6], they are so rare that some have denied that they are a genuine growth form. It is true that they have been seen only on small diamonds (< 1 mm). Their absence from larger diamonds may simply be the result of their growth rate being sufficiently large, compared with the growth rate for octahedral facets, that they grow out. Of the ten specimens studied, which all came from the Premier Mine, South Africa, and which showed more than one cube facet, some were sharp-edged truncated octahedra, while others were twins.

We also report a new finding: a diamond which has grown by fibrous mode (b), followed by octahedral growth (a). This succession of events (the reverse of that giving rise to coated diamonds) underlines the necessity to re-examine the geological conditions for which fibrous growth can occur.

[1] M Moore and A R Lang, *Phil. Mag.* 26 (1972) 1313-1325.

[2] W G Machado, M Moore and G S Woods, *J. Crystal Growth* 71 (1985) 718-727.

[3] A Yacoot, M Moore and W G Machado, *J. Applied Cryst.* 31 (1998) 767-776.

[4] W G Machado, M Moore and A Yacoot, *J. Applied Cryst.* 31 (1998) 777-782.

[5] M Moore and A R Lang, *J. Crystal Growth* 26 (1974) 133-139.

[6] S Tolansky, *Diamond Conference*, Oxford, 1970, Paper 26. (Unpublished.)

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Intercalation of sulphonates in the lamellar structure of Zn-Al-NO₃⁻ layered double hydroxides precursor phases

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Layered double hydroxides (LDH) with the formula $[Zn_2 Al(OH)_2]^+ [A \cdot nH_2O]^-$ are mixed metal-metal-hydroxysalts (MMH). The crystal structure is based on different chemical and structural alternated layers. Negative charged interlayers with reversible exchangeable anions, additional cations and water molecules occur alternating to the positive charged brucite-like mainlayers [1]. The members of the Hydrotalcite-group are characterized by the ability of permanent interlayer-anion-exchange, which is recently used by industry (building-materials, catalyst [3]) and pharmacy. Through the incorporation of large organic compounds in the interlayer, the lamellar structure of hydrotalcite expands, depending on the size and the position of the host molecules. Substitution of organic anions was performed by indirect anion-exchange. The LDH precursor phases with the formula $[Zn_2 Al(OH)_2]^+ [NO_3 \cdot 1.9H_2O]^-$ were synthesized using the coprecipitation method [2] at pH 7.0 and 45°C under constant inert atmosphere to prevent the contamination with CO₂, which is fixed predominantly in the interlayer and complicates an anion exchange. Sulphonic acid sodium salts of different chain size were added in excess and altered for 3-7 days and 60°C. The synthetic products were analyzed by in situ X-ray diffraction measurements, using a PANalytical system with X'Celerator detector and silicon as an internal standart, thermal analysis (TG), infrared absorption spectra, SEM and chemical analysis. The synthesized LDHs contain generally of well crystallized thin leaf-like crystals with pseudohexagonal shape. SEM image analysis display stacking of disordered distributed crystals. Structural refinement of samples (94% rel. Hum.) display an increase of the c'-lattice parameter of the LDH from 31Å for the methane sulphonate up to c' = 84Å for hexadecane-sulphonate guest anion by constant size of the a'-lattice parameter. The space group changes with increasing chain length of the host molecules from 'R' to 'P' bragg lattice. The amount of interlayer water molecules is half times larger than in the NO₃⁻ bearing precursor phases. Different temperature stages can be observed: a) lost of adsorption water (<313K), b) desorption of interlayer water molecules (323-423K), dehydroxylation (473-543K) and d) decomposition (>543K). High-temperature analysis in a temperature interval between 323-423K show after remobilization of the interlayer water molecules the formation of a stable hydration stage.

[1] Bish, D.L. (1980), Anion-exchange in takovite: applications to other hydroxide minerals. - *Bull. Minéral.*, 103: 170-175.

[2] Cavani, F., Trifiro, F. and Vaccari, A. (1991), Hydrotalcite-type anionic clays: Preparation, properties and applications. - *Catalysis Today*, 11: 173-301.

[3] Basile, F. and Vaccari, A. (2001), Applications of Hydrotalcite-type Anionic Clays (LDH) in Catalysis.- Rives, V.: Layered Double Hydroxides: Present and Future. - Nova: 285.