

that of diamond. Nickel and cobalt containing limited amounts of carbon both possess structures which almost perfectly match that of diamond. These phases, consequently, are easily accommodated within diamond as dispersed but systematically oriented inclusions (Lonsdale *et al.*, 1959, and Kohn and Eckart, in this issue of *Am. Mineral*). The carbide forming systems studied thus far have not been found to possess structurally compatible coexisting phases.

The concentration of epitaxially included matter has been observed to be roughly inversely proportional to the temperature at crystallization. In addition, the concentration appears to influence both the pattern of growth as well as the resultant habit. The following sequential correlation has been observed:

(a) At minimum pressures and temperatures, cube morphology invariably prevails. The impurity level is so high they are rendered completely opaque to visible radiation and they are structurally weak. Not only is the content of epitaxial inclusion high, but random inclusion of other coexisting phases also is marked. The latter frequently appears to function as nucleation surfaces around which diamond crystallization commences. This type of diamond is so impure that it is questionable as to whether such specimens can properly be considered chemically as diamond. Crystal growth is observed to proceed either as a random propagation of lamellae parallel to and upon (100), or as spirals terraced parallel to the cube edges. The occurrence of spirals has been reported earlier by Bovenkerk (1961, and Tolansky and Sunagawa (1959 and 1960).

(b) At higher pressures and temperatures, a diminished content of "structural" impurity is observed. Crystals may transmit somewhat in the visible region, and the development of octahedral faces become apparent at the corners of the cube. Growth appears to continue parallel to (100), but lamellae now are systematic; the direction of propagation being approximately normal to the cube edges.

(c) At higher levels of pressure and temperature, diamond of corresponding higher chemical purity are realized. Relatively transparent cube-octahedral, and sometimes cubo-octahedral-dodecahedral, forms are found. The trace of growth layers on (100) are observed to run parallel to the edges of octahedral planes. The latter is considered indicative of normal (111) diamond growth free of influence from the chemical environment which was observed at lower pressures and temperatures.

(d) At relatively high pressures and temperatures within the diamond forming region, the octahedral habit predominates (Fig. 9), and the clarity and purity of the crystals are accordingly greater. Growth is observed to propagate upon and parallel to (111), in directions normal to (111) edges. The observations described above are illustrated by the correspondingly designated sections of Fig. 11.

Although the content of epitaxially included matter is approximately inversely proportional to the temperature at crystallization, both its chemical composition and crystal structure remain relatively stable. The formula for that of nickel has been suggested as Ni_xC , with x greater than four (Lonsdale *et al.*, 1959). A similar formula is applicable to the "structural inclusion" observed with the cobalt-carbon system. In view of the fact that the proposed mechanism of direct chemical solution of carbon

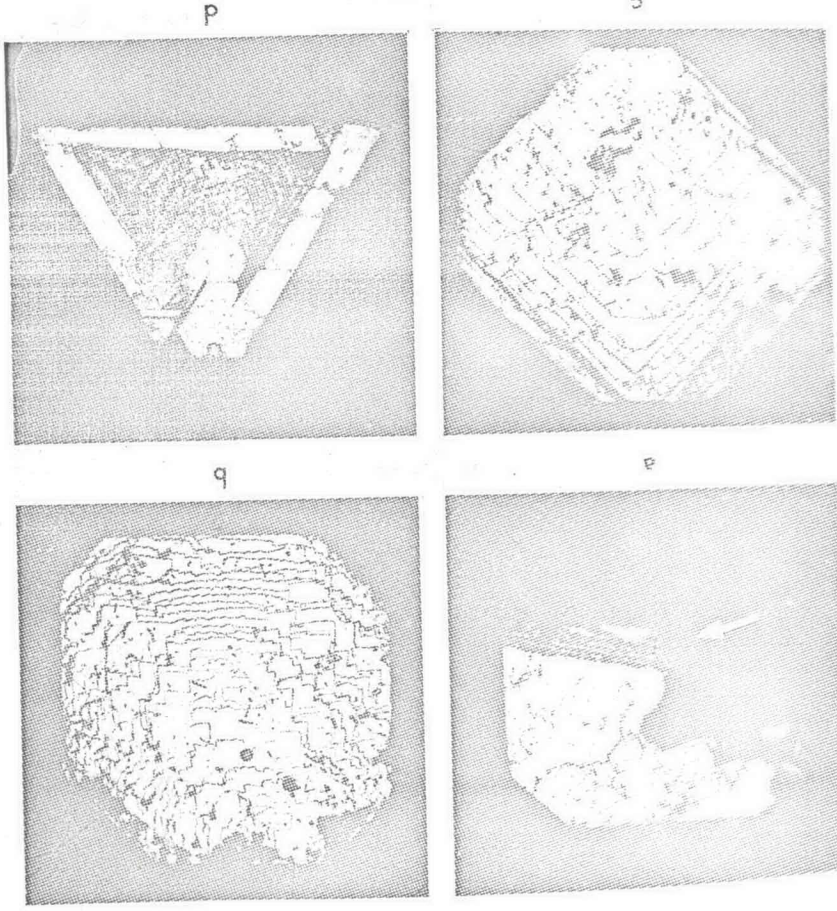


Fig. 11. (a) an example of surface texture commonly observed on highly impure, but well formed diamond cubes. The exposed lower right section of the crystal (see arrow) illustrates the occurrence of lamellar growth parallel to (100). (b) a somewhat impure cube with noticeable (111) development at the corners shows an example of growth on (100) with the direction of propagation approximately parallel to [100]. (c) the face of a relatively pure cube-octahedron exhibiting growth propagation on (100) in directions essentially normal to the edges of (111). (d) the surface of a diamond octahedron exhibiting growth on and parallel to (111) with directions of propagation normal to the faces of the face.

followed by precipitation and recrystallization is based upon the study of residual reaction products, the possibility that phases present during diamond crystallization may provide a catalytic interaction cannot be experimentally ruled out. The observed range of structural compatibility of