A B S T R A C T

The Thesis has been divided into four parts. In part one a brief account of the existing information about diamond is given. The various experimental techniques applied in the present investigation are briefly described in part two.

The third part deals with the optical, the electron optical and interferometric studies made on the microstructures of diamond surfaces.

In chapter III of part three the previous work done on the microstructures of diamond surfaces is described. The work done on the different faces of diamonds has been described in different chapters.

The optical studies made on the microstructures of the natural faces of diamonds obtained from Panna Mines, India, have been described in Chapter IV. The trigons, the block pattern and the ring cracks have been observed to exist simultaneously on the natural faces of a large number of crystals. From the observations made, it is conjectured, that the Panna diamonds might have been subjected to dissolution in nature and therefore the trigons observed on these faces along with the block pattern and the ring cracks might have been formed due

to dissolution. The conjecture is further supported by the observations made on the octahedral faces of some octahedra from South Africa, where the micro-disc patterns and the trigons are observed on the same face. On the natural face of one Panna crystal, rows of broken trigons have been found and exactly similar pattern has been produced in the laboratory by etching the octahedral face of calcium fluoride in nitric acid solution. The implications are discussed.

In the Chapter V is described the studies made on the octahedral cleavages of diamond. Diamond dodecahedra obtained from the Panna Mines have been cleaved along octahedral planes and matched cleavage pairs have been obtained. In one crystal it is observed that some part of the cleavage obtained from this crystal had some triangular features while the remaining part of the cleavage had the usual cleavage lines on it. It is shown that the triangular features are the depressions and have identically the same characteristics as those of trigons observed on the natural (111) faces of diamond. The microstructures on the curved faces of this diamond have been fully studied and from this study it is concluded that the diamond must have been

subjected to the dissolution process in nature. The mechanism of the origin of the triangular pattern on the cleavage faces has been explained and the implications are discussed.

The investigations on the dodecahedral diamonds have been described in Chapter VI. Some forty small rounded diamond dodecahedra, purchased from Scott Williams Mineral Company, Inc., U.S.A., have been studied by optical and light profile microscopy and observations made on some unusual microstructures have been described. The microstructures consist of equilateral and elongated triangular elevations on all the faces of a crystal except in a small region on one face where triangular depressions are observed. It is conjectured that the triangular elevations may have been formed due to a dissolution process in nature. By etching octahedral cleavages in the atmosphere of oxygen at different pressures, microstructures similar to those observed on the natural faces have been produced (Chapter XI). The implications are described.

The electron optical studies of the trigons observed on the octahedral faces of diamonds are given in Chapter VIII. Here the trigons have been studied in

transmission electron microscopy by preparing single stage carbon replicas. Trigons within the trigons and the basal extensions associated with them have been critically analysed. Studies have also been made on isosceles and scalene trigons and the trigons having eccentric point--bottoms. From these studies, it is conjectured that the trigons are the result of the dissolution process and not the growth process.

The observation giving the evidence of slip and screw dislocations in diamond is described in Chapter VIII. Rectilinear lines initiating from edges of an octahedron and propagating in <110> direction on octahedral faces and terminating within the respective faces have been observed. Step heights have been determined at different places all along these lines using multiple beam interferometry and it is observed that the step height at a point is proportional to its distance from the point at which the slip terminates on the face. It is thus conjectured that the lines terminating on the face may be slip lines. The angle between the two slipped regions is found to be of the order of 10^{-4} radians. The stress producing the slip as calculated from the magnitude of the slip step comes out

to be about 3.21×10^9 dynes/cm^2., which is much less than the stress required to produce a crack on (111) faces which is 1.4×10^{11} dynes/cm^2.

In the fourth part, the optical and interferometric studies made on the etch patterns produced on the different faces of diamonds are described. In Chapter IX is given the existing information on dissolution of single crystals in general and for diamond in particular is given in Chapter X of this part.

The studies made on the fast etching of diamond surfaces have been described in Chapter XI. Diamond octahedral cleavages have been subjected to fast etching. Appreciable etching is produced within a few seconds. The etch patterns on (111) faces consist of the triangular etch pits. It is observed that the triangular etch pits have rectilinear sides and sharp corners and their orientation is the same as the orientation of trigons on the natural octahedral faces. It has been shown that the triangular etch pattern produced in these experiments completely resembles the trigons. It is therefore, conjectured that the natural trigons might have been formed

due to dissolution of the crystals in nature.

A study on the etching of octahedral cleavages in oxygen at various temperatures and pressures has also been made. It is observed for the first time that at a particular temperature and pressure etching produces triangular hillocks on (111) faces instead of normal triangular etch pits. The etch hillocks have been studied by light profile microscopy. The effect of etching the faces in a melt of potassium nitrate has also been examined.

Fast etching of the polished (100) faces has also been carried out and is described.

The micro-disc patterns on (110) and (111) cleavage faces of diamonds produced by fast etching is described in Chapter XII. These surfaces have been rapidly etched by subjecting them to a high temperature in an atmosphere of oxygen. The high temperatures were produced by burning carbon in a bomb calorimeter at a pressure of 25 atmospheres. Appreciable etching is produced in a few seconds. It is observed that the etch pattern on (110) faces consists of the usual boat shaped pits and elevated micro-discs. Micro-discs are also produced on (111) cleavage surfaces of diamond. The formation of micro-discs

is discussed.

The studies on the etch rates of the different faces of natural diamond have been described in Chapter XIII. The rate of etching of the (100) cubic, (110) dodecahedral, and (111) octahedral faces of diamond has been studied. For this purpose, on an octahedral diamond (100) and (110) faces were obtained by polishing. Thus all the three faces on the same diamond were subjected to etching in the melt of KNO_3 at 580° C. It is observed that the rates of etching of these faces differ. The octahedral face etches faster than the cubic face and the cubic face etches faster than the dodecahedral face. The implications of the findings have been discussed in the light of the observations on the microstructures, made by different workers on these faces.

Comparative studies on the rates of etching octahedral cleavage faces obtained from Panna and South African diamond mines have been made. It is observed that Panna cleavages etch at a faster rate as compared to the South African diamond cleavages.

In Chapter XIV is described the optical and interferometric studies made on the cleavages of boarts

and their etch patterns. The critical observations made have been described and the implications are discussed.