A B S T R A C T

ABSTRACT

The results of optical studies of growth, cleavage and etch features on some crystal surfaces with special references to Calcite are reported in this thesis. The thesis is divided into three parts.

In the part I (chapter 1), a brief historical review of the studies on growth, cleavage and etch phenomena is given as a general introduction.

All the experimental techniques used in the course of this work are described in part II (chapter 2). The techniques employed for optical studies were (i) Multiple-Beam-Interferometry, (ii) Phase Contrast Microscopy, and (iii) Light Profile Microscopy. The special techniques applied for growth of crystals or other etching techniques are described in chapters on relevant crystals. In part III are incorporated the detailed studies on mica and calcite surfaces and the conclusions arrived at from these studies.

In the chapter 3 on study of mica are described the optical and interferometric studies of cleavage and etch phenomena on mica. The cleavage is effected by inserting a fine pointed needle in a direction parallel to the cleavage plane of mica crystal. Both the surfaces obtained on cleaving

were examined and the counterparts were matched for comparison. The matching was exact. These surfaces were then subjected to etching. Hydrofluoric acid (liquid and vapour) and fused alkalies (sodium and potassium hydroxides at different temperatures)were used as etchants. Action of hydrofluoric acid gives rise to parallelogram shaped etch pits with their shorter diagonal parallel to the stronger ray of the percussion figure whereas with the fused alkalies, the shape is isoscales triangles with curved sides and their medians to the bases of the triangles parallel to the b-pinacoidal direction. It was observed that the effect of etching was distributed in two ways.:-(i) General etching of the surface covered by very small pits and (ii) individual isolated larger etch pits. The pit concentrations are found to vary from 10^3 per sq.mm. to over 10^7 per sq.mm., and small regions are found quite free from imperfections. There is also a remarkable degree of coincidence and matching of the etch patterns on the two faces obtained on cleaving. There was nearly one-to-one correspondence between centres of the isolated pits and the cleavage ledges displaced sideways due to the solution process and this produced a displacement of etch patterns. Etching at a temperature (about 150°C) lower than the fusing point of alkalies showed sharp triangular etch pits in contrast to the usual cuvelinear triangular etch pits obtained by fused

alkalies at their melting point. Evidence is collected to show the origin of etch pits to be at impurity centres giving rise to lattice distortion, surrounding the impurity in mica. crystals.

In chapter 4, the study of natural and synthetic Calcite is described. Calcite was grown in the laboratory by different methods and observations on growth surfaces are reported. Since Soda nitre is isostructural with Calcite a study of the growth of these crystals was also undertaken for the purpose of comparison.

The study of the rhombohedral cleavage faces of crystals natural Calcite (obtained from different localities) was carried out by cleaving the crystal by a number of methods:- (i) By the usual method of cleaving i.e. by giving sharp blow with a hammer on a razer blade kept in contact with the crystal. (2) By allowing a polished steel ball of known dimensions to fall from a measured height on to the crystals. (3) By passing a very high electric spark through the crystal. (4) By immersing half the crystal in a solution of hydrochloric acid and then taking out and very gently tapping on the line of demarcation made by the action of solution on the crystal. (5) By compressing the crystal between two firm supports. This study shows that so far

as matching of the two counterparts is concerned, it is exact, but in addition to this observation, freshly cleaved surfaces of Calcite from certain regions (Pawagarh and Broach, Gujarat) showed two sets of cleavage lines parallel to the crystal edges and are identified as revealing cleavage directions (and suggesting a mosaic structure) and the second set of lines, equally inclined to the edges, run parallel to the longer diagonal of the surface. The study has shown that some crystals from certain regions exhibit the mosaic block structure whereas for others it is difficult to predict from such a study. This conclusion is supported by the study of etch pattern on the freshly cleaved surfaces of Calcite.

On the cleavage faces of Calcite, the etch patterns produced by several etchants including inorganic acids (e.g. HCl, HNO_3, etc.), the organic optically active and optically inactive acids (e.g. Citric acid, tartaric acid, d-tartaric acid etc.), strong solutions of alkalies (NaOH & KOH) and salts (NH_4Cl, fused $NaNO_3$ etc.) are studied. The concentration and orientation of the pits, the movement of cleavage ledges and matching of the two etched counterparts are fully reported. A good deal of circumstantial evidence is gathered to determine the origin of etch pits. The evidence points to dislocations as the probable sites for etch pits.

In the chapter 5, a general conclusion is drawn on the above study.

In appendix, some preliminary study on the etching of fluorite is reported.