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Topographical Studies of Ferro-Electric domains in Glycine Potassium Sulphate (GPS) Crystals

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ABSTRACT

Grown solution of glycine potassium sulphate (GPS) crystals were subjected for topographical studies. Cleavage face of ferroelectric glycine potassium sulphate has been chemically and thermally etched. Rows of equally spaced pits have been observed. It is noted that the geometry of line do not change but they are different with different intensity. Faint line has perfect crystallographic orientation are the Ferro-electric domain wall. Domain wall do not penetrate through the body of the crystals. There is no co-ordination between domain and dislocation interaction. Geometry does not Geometry do not change beyond transition temperature support domain dislocation interaction.

Keywords: Organic compound, Topographical study, GPS crystals.

INTRODUCTION

Studies on topography of cleavage face is carried out to get knowledge about propagation of cleavage line and to detect the presence of other features like domains etc. Relation of domain by selective technique has been reported by Meleshina [1] in TGS crystal. Studies on Ferro-electric domain can be carried out by observing them very carefully under metallurgical microscope as reported by Hosokawa [2] and Chaudhari and Krishnakumar [3] under polarizing microscope as reported by Ingle and Deshmukh [4], Ingle and Bangre [5], Bhide and Bapat [6] and Deshmukh and Ingle [7] Etching technique is also used for their studies and to study their interaction with dislocation as reported by Kulkarni and Chaudhari [8] and Toyada [9, 10]. Difference in the etching characteristics of the domain pointed out by Ingle and Mishra [11] and is attributed to the etching of head and tail of domain [12, 13] respectively. Here it may be noted that the domains are formed to minimize the mechanical stresses developed during growth of the crystal when the crystal is grown. Thus it is seen that the very little work is reported on domain formation in organic ferroelectrics crystals. An attempt is made to study the ferroelectric domain in GPS crystal which is presented in this section.

MATERIALS AND METHODS

Experimental details:
Glycine K_2SO_4 crystal were grown from saturated solution by talking A-R grade Glycine and potassium sulphate in distilled water by slow evaporation technique. The solution was warm upto the temperature of 318^0K, filtered it and kept undisturbed at room temperature. The good transparent crystals of assorted size obtain within 6 to 7 weeks.

The etching technique is widely used to reveal the sites of edge dislocation and also to study the ferroelectric domains. The sample under study is dipped for known period in a beaker containing the suitable chemical agent [etchant]. The crystal samples are then dried with good quality filter paper. Care is taken to prevent impurities on the surface since well defined etch pits may not be observed in such a case. The etched and dried crystal face is mounted on glass plate using sand clay and then it is examined under a metallurgical "METZER" universal trinocular metallurgical research microscope [METZ-780] "METAPHOT" used for the topographical and dislocation studies on crystals.

RESULTS AND DISCUSSION

Fig. 1[a] and Fig. 1[b] represent the matched cleavage face of GPS crystal. In this figure, considerable correspondence of cleavage steps is observed. It is noted that the cleavage topography is not smooth. It is noted that (a) some cleavage steps such as X, Y are running quite strength, (b) Cleavage steps marked by A, B, C are curved one, (c) Curve and density packed thick steps are observed in the region marked by R, (d) the left out cleavage steps [C, D] have the usual nature , (e) careful observation of the P, Q lines differ in density having perfect crystallographic orientation parallel to [001] than the cleavage steps above which resembles with structure of domain, (f) P, Q lines have the correspondence on matched faces.

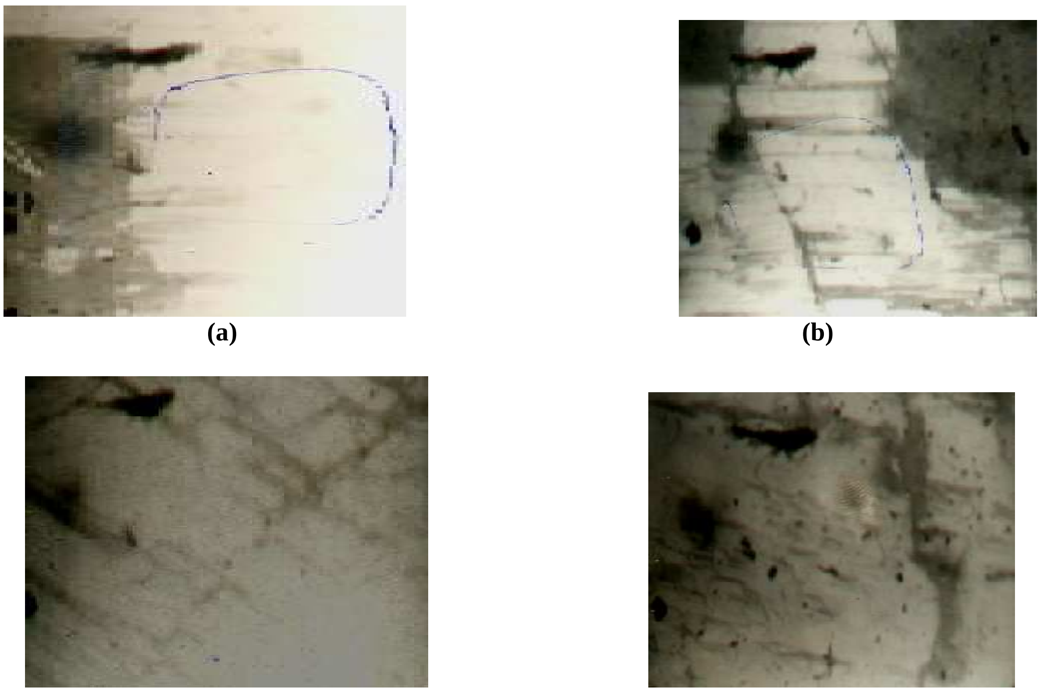
1(b)

1(b)

Fig. 1(a) and 1(b) Topography of matched cleavage face.

Fig. 2 Cleavage topography of crystal

More details of such lines are observed in Fig. [2]. The lines marked by an arrow are bend at one and gives rise to the resembling structure of wedges formation of domain as reported by Ingle[12] in $KnBO_4$ crystal. It may be noted that such lines also observed on fracture face identical lines such as P, Q of Fig. [1] having different thickness and intensity shown the correspondence on matched faces as seen in Fig. 3[a] and 3[b].



(a) **(b)**

(c) **(d)**

Fig. 3(a) Intensity correspondence on match face, 3(b) Partial topography of etching characteristics of line, 3(c) Resulting etch pattern on corresponding region after slight etching by etchant and 3(d) Photomicrograph of dislocation etch pit

In order to study the etching characteristics of such lines, the face partially topographically represented in Fig. 3[b]is slightly etched in dislocation etchant [GAA] and resulting etched pattern of corresponding region shown in Fig. 3[c]. It is noted that the dislocation of usual cleavage steps is much faster than that of these line. Further it is also noted that the very faint lines disappeared on slight etching. Few lines maintain their crystallographic orientation but their thickness changes on heavy etching. The complete structure disappears and dislocation etch pits are formed as observed in Fig. 3[d]. However, sometimes these lines do not show any change on etching as shown in Fig. [4]. Therefore an attempt has been made to study these lines on opposite faces of thin flakes of different thicknesses. It is also noted that these lines do not show the correspondence on opposite faces of thin flakes. However, the evidence of wedge P, Q observed on one face and the cleavage steps A, B on opposite face as shown in Fig. [5], which is transition photograph of a thin flakes having thickness of about 160 micron. The crystal faces having these lines subjected to thermal etching shown in Fig. [6] represents the structure of such line along with the thermal etch pits. It is noted that the geometry of these line do not change but different in different intensity.


Fig. 4


Fig. 5


Fig. 6

Fig. 4 Line does not show any change on etching,
Fig. 5 Transmission photomicrograph of thin flage having thickness about 160 micron and
Fig. 6 Structure of line along with thermal etch pits.

CONCLUSION

From the topographical studies on cleavage faces it is observed that (a) faint line having perfect crystallographic orientation are the ferroelectric domain walls as supported by evidence of formation of wedge. (b) Domain walls show the correspondence on matched faces but washed out after heavy etching and does not show the correspondence on opposite faces of thin flage suggest that these domain walls do not penetrate through the body of the crystal. (c) No dislocation etch pits are observed domain walls or the region between two domains; it is very difficult to say that there is no co-ordination number between the domain and dislocation interaction. (d) When the crystals are heated beyond the transition temperature, there geometry do not change which support the conclusion regarding domain dislocation interaction.

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