Microhardnes Studies on Oxodized and Pure Carbazole Single Crystal Cleavages

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Abstract

Microhardness studies have been carried out to study the effect of impurities on hardness in term of the deformation behavior. The present communication compares the variation of microhardness with load of pure and oxidized carbazole single crystals. Plot is observer that there are four humps for the pure carbazole crystal around 20 gm, 40 gm, 60 gm, and 80 gm.

Whereas in the case of oxidized carbazole a small humps around 50 gm and three other prominent humps at 60 gm, 75 gm and 90 mg are observed. These humps are due to cause of slip on the different crystallography planes and the shift in the humps postions is due to the impurities hindering the slip is taking place at law loads.

Introduction

It is a well known fact that the physical and chemical properties of materials are effected by the addition of impurities enter the lattice. The addition of impurities changes the activeness of the slip systems.

The present communication compares the absolute hardness of carbozole and oxidized carbazole.

Oxidized carbazole is molecular organic solid, characterized by low lattice energies. The purpose of undertaking this study was to investigate the various slip systems that become operative in the organic molecular solid oxidized carbazole due to plastic deformation by microindentation. A carl zeiss NU2 Universal research Microscope was used for microindentation studies. Vicker s pyramidal indenter was used for mocrohardness indentation studies (fig. 1).

At microscopic level, modes of deformation include the formation of slip lines, slip bands, folds and cell structure leads to nanostructure. At microscopic level, modes of deformation involve, generation, motion, multiplication, interaction of dislocations and defects.

Applying point loads in studies (a) occurrence of plastic deformation (b) indentification of slip systems and twinning planes and (c) dynamic behavior of dislocation in crystals Single crystals of carbazole and oxidized carbazole where grown by Bridgman method using material that has been column chromatographed, twice vacuum sublimed and zone refined (sherwood 1969). Trasparent single crystals were obtained which exhibited good cleavage.

Optically flat cleavages were indented using a Carl zeiss Nu2 Universal Research Microscope. Indents were made using a pyramidal diamond indenter. The loads (P) varied from 10g to 100 g. A number of indents were made at each laod and at random on the surface. The mean diagonal length was used in calculating the Vicker s Hardness (H) using the formula.

$$H = 1.854 \times P/d^2$$

were 'P' is the applied load in kilograms and 'd' the mean diagonal length in millimeters (Tabore 1951, Mott 1956). The indentation time of 10 s was kept constant. The specimen size was far larger than the indents made, so as to eliminate the boundary effects on the results. The distance between the indents was kept four to five times the largest size of the indentation mark. The thickness of the specimen was such that the indenter did not sense the lower surface. A number of specimens were studied.

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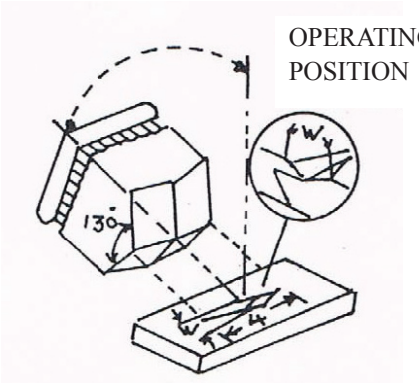
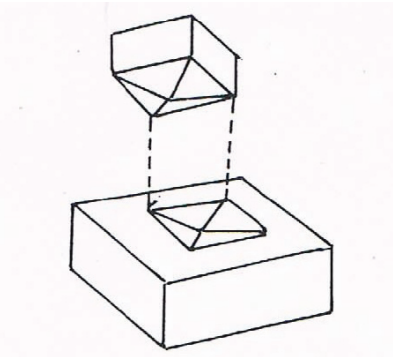


Details of the knoop indenter together with its impression



Details of the diamond pyramid indenter together with its impression

Fig. 1.

Microindentation studies on impure carbazole cristals

The studies on impure carbazole were done on crystals that had oxidized during the process of growth, the tubes having cracked.

Figure II is plot of variation of hardness with load on the (010) cleavage plane of oxidized single crystals. It is observed that no prominent peaks are there but humps appear at 50g, 60g, 75g and 90g load which are very close in comparison to what one observes in the case of pure carbazole. The hardness value are 7.85 Kg/mm^2, 9.05 Kg/mm^2, 8.7 Kg/mm^2 and 8.45 Kg/mm^2 respectively. The increase in hardness in due to the impurities seggregating along the dislocation lines.

Carbazole crystallizes in the orthorhombic structure with space group Pnma and 4 molecules per unit cell. The lattice parameters are a = 7.77° A, b=19.18° A and c = 5.72° A with $\alpha = \beta = \gamma = 90°$. The crystals are transparent and cleave perfectly on the (010) planes (Robertson 1953). Fig. III shows the arrangement of molecules in the unit cell.

On observing the arrangement of molecules, it is seen that the (100) plane can slip along the [001] direction (001) plane can slip along the [100] direction and the (100) plane along the [010] direction. Also, the density of the molecules on the

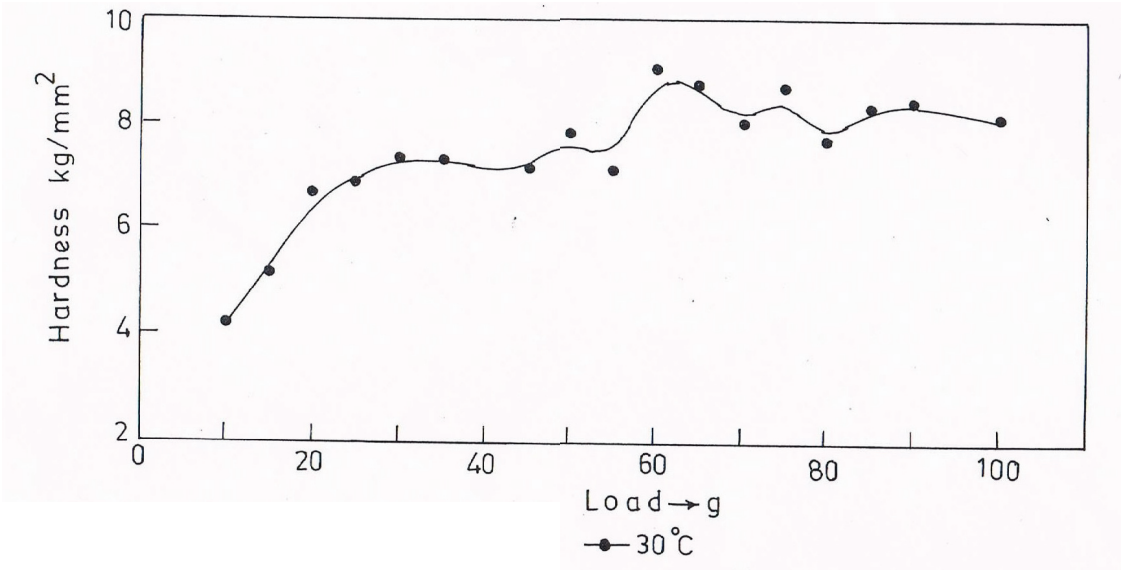


Fig. 2. Vickers indentation impure carbazole

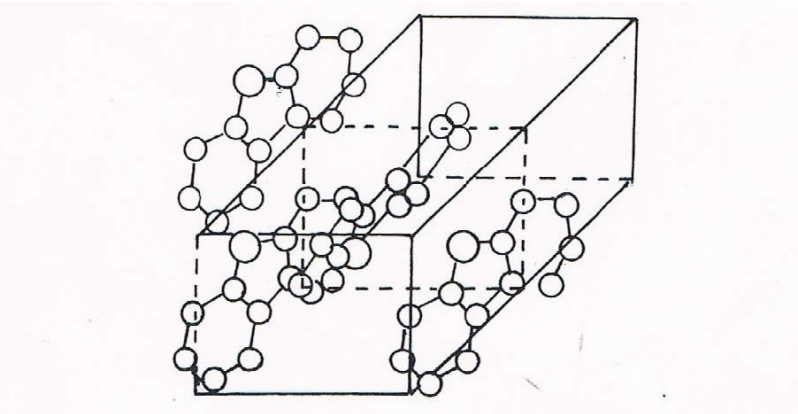


Fig. 3. Packing diagram of carbazole

different slip planes is the same. The slip along the [001] direction is energetically more probable because of the short repeat distance compared to the [100] direction. Thus the first and second peaks in the hardness varsus load curve are conjectured to be due to the generation of dislocations of the (100) [001] and (001) [100] types, respectively.

These are edge dislocations. Slip in the (100) and (001) planes in the [010] is probable also. These are screw dislocations. Slip in the (100) planes in more facile as the molecules on these planes do not experience intramolecular interactions as much as the (001) direction, slip to take place would require a larger stress. Thus he third peak in the headness versus load curve is due to dislocations of the (100) [0010] type which are screw in character. The hardness values also support these observations.

The fourth peak in the impure carbazole is attributed to dislocation of the type (100) [001].

Conclusions

1. The hardness versus load behavior in orthorhombic carbazole single crystals exhibits three peaks.

2. The first two peaks are due to dislocations of the (100) [100] and (001) [100] type which are edge in character.

3. The third peak is due to dislocations of the (100) [001] type and screw in character.

4. The hardness values of 3.8 Kg/mm^2 and 4.75 Kg/mm^2 support these observations.

5. The hardness variation with load in impure carbazole (oxidised) shows four humps which are very close to each other.

6. The hardness values for oxidised carbazole humps are very close to each other.

7. These observations suggest that the impurities have segreggated at dislocations.

8. Over and above the three types of dislocations observed in the pure carbazole, the fourth type of dislocation is (100) [011] which is edge in character.

References

1. Sherwood, J.N., Fractional Crystallization Vol. 2 Ed. Zief, 175, 1969

2. Tabor, D., The Hardness of Metals Clarendon Press, Oxford, 1951.

3. Mott, B.W., Microindentation Hardness Testing Butterworths Scientific Publ., London, 1956.

4. Robertson, J.M., Organic Crystals and Molecules Cornel University Press, N.Y. 216, 1953.

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