INTRODUCTION

The resistance of any material to indentation involves both the elastic and plastic properties. In metals, the hardness based on plastic straining is described as resistance to dislocation motion [3]. Many investigators have performed studies on microhardness of single crystals and metals, however, only a limited work has been carried out on microhardness of polymers. The wide use of polymers as engineering and technological material is mainly due to their high strength and large recoverable deformation. The internal structure and fashion of linkages between molecules in polymers can be studied by knowledge of deformation phenomena in polymers. Deformation in polymers is produced by slip between loosely bonded molecules. The amount of deformation produced depends upon the magnitude of the stress and the rate at which it is applied. For small values of stress, deformation produced is instantaneous and elastic and the material recovers immediately on the removal of stress. The deformation produced as a result of uncoiling of chains from their natural configurations is recovered on removal of the applied stress. This recovery depends on time and on the individual bonds reaching the required activation energy on account of thermal agitations. On the other hand, the deformation produced by chain-chain slipping is non-recoverable and persists even after removal of the stress.

MECHANISM OF MICROHARDNESS

The deformation in crystalline solids occur by well defined mechanism such as slip or twinning whereas for plastics it involves the relative movement of molecules. Since the molecules can be very large and occur in long chains, this would be a highly complex process. The micro hardness studies on polymers are very limited [1]. Being a complex elastic-plastic parameters, the hardness of polymer involves reversible and irreversible contributions to deformation. The Vicker's method is suitable for polymeric materials as the diagonal length of the indentation is not affected by the recovery of the material after the removal of load. Mason et al have studied the dependence of hardness on load and have proposed two types of load dependent hardness. They investigated the influence of different microstructures and micro hardness near the glass transition temperature[2].

\[ H_v = \frac{2Lsin\theta/2}{d^2} \text{ or } H_v = \frac{K_L}{d^2} \]  

(1)

*Corresponding author: Shalini Patil
Department of Physics, Government Autonomous Post Graduate College, Chhindwara, Madhyapradesh, India
Where $K$ is a constant, $L$ is the magnitude and $d$ is the diagonal size of the specimen.

According to the theory proposed by Schultz and Hanemann $L$ is given by [8]

$$L = a \cdot d^n$$

(2)

Where $a$ and $n$ are constants.

Hence

$$H_V = K \frac{ad^n}{d^2} = Ka d^{n-2} = cd^{n-2}$$

(3)

Where $c = K.a = constant$

Experimentally Vickers hardness number ($H_V$) is measured by using the relation,

$$H_V = 1.854 \frac{L}{d^2} (kg/mm^2)$$

Where $L$ is load in kg and $d$ is the diameter of indentation.

An investigation of the spectral dependence on the microhardness of polycarbonate provided additional information regarding the photoplastic effect.

RESULT AND DISCUSSION

The increase in $H_V$ as the load increases can be explained on the basis of strain hardening phenomenon in polymers. The strain hardening phenomena in polymers can also be explained on the basis of spectrum of micromodes of deformation in the polymer chain. For low loads, value of $H_V$ is maximum for different wavelengths. At higher frequency and at a low loads this effect is more pronounced.

Generally, as for other mechanical properties, microhardness undergoes both transient and permanent changes as a result of absorption of energy in the form of radiation. Microhardness seems to be especially suited in monitoring the surface phenomenon of radiation induced effect on polymers because it investigates only the surface of the materials.

CONCLUSION

The higher value of $H_V$ for the irradiated specimens as compared to the non-irradiated specimens may be attributed to the radiational crosslinking in polycarbonate. The application of indentation techniques to polymers is a relatively new approach. The results exist which show the relationships between macroscopic mechanical properties measured from microhardness indentations. In this connection, microhardness measurements have been correlated with tensile studies and mechanical strength.

References


How to cite this article:
DOI: http://dx.doi.org/10.24327/ijrsr.2020.1012.4937

******