Members' Paper

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A STUDY OF THE RELATION BETWEEN APPLIED STRAIN AND STRUCTURE IN ELASTOMERS

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Introduction

Elastomers form a significant proportion of materials used in everyday life. They are used in footware, cables and hoses, belts and tyres, engineering components, automobiles, biomedicine, et cetara. Their strength, deformability, fracture toughness are created through the interconnection of polymer chains selected so as to produce the desired mechanical behaviour. It is essential to know how the structure of the elastomer olumchanges as a function of applied stress, so as to select the best polymeric mix for the desired mechanical properties. One class of elastomers are those based on the poly-urethanes. The samples used in this study were manufactured by DJ Martin, University of Technology, Sydney[1].

Experiment

The experiments were undertaken at BL20B using the sagittal focussing monochromator[1] and beam dimensions typically 35 x 35 μm2… The mono-chromator was tuned to 1.739 A and the detuned to eliminate harmonics. A tensometer based on a linear slide and a dc motor encoder was devised to be mounted on the theta-axis of the vacuum diffractometer [2].The samples were mounted strain- free normal to the incident beam and 303 mm from an imaging plate which was mounted in a new imaging plate changer [3]. See Figure 1.

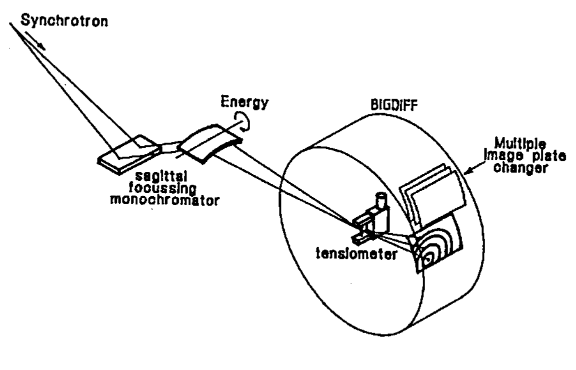

Figure 1: Experimental configuration

An imaging plate was moved into position, and a 2 min exposure taken. The plate was then changed, a known strain applied to the elastomer, and another exposure taken. Up to ten diffraction patterns can be acquired before it was necessary to break the vacuum in the diffractometer.

Discussion and Results

Figure 2 shows part of a sequence taken with one of the elastomers. In Figure 2a the zero-strain diffraction pattern indicates that the elastomer is highly crystalline, and quite highly oriented. As stress is gradually applied the long range order is gradually lost, and the outermost Debye rings become diffuse at about 80% strain.

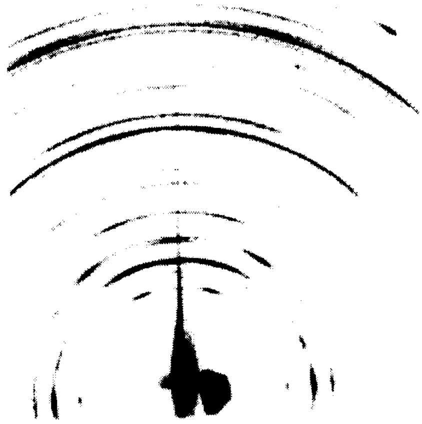

Figure 2 : Diffraction patterns from stressed elastomers
(a) Diffraction Pattern with 0% strain

The loss of order is gradual, and at 320% strain (Figure 2b) all order has been lost in the elastomer. On relaxing the stress the diffraction patterns retrace the path they followed on loading, but the strain is different, and the sample now has acquired a permanent set.

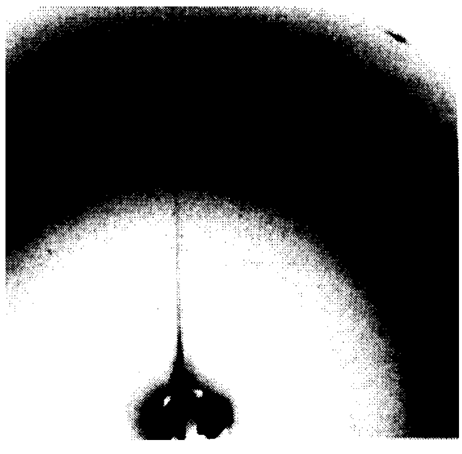

Figure 2 : Diffraction patterns from stressed elastomers
(b) Fully loaded .. 320% strain

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We have demonstrated a new technique for examining the relation between structure and strain in elastomeric materials. The progression of the structural change from an ordered to a disordered state is the opposite to that commonly encountered in polymer systems.

References

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[3] RJ Mills (1995) BSc Honours Thesis, University College UNSW

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