lateral size of the *mPc*'s.

Another striking example for the existence of mosaic blocks in single crystal mats is found in the degradation experiments with fuming HNO_3 [4]. Within experimental error the lamellar thickness remains constant during the degradation. If chain obliquity and equation (3) would really play a dominant role the lateral sizes also should stay constant. This again is not the case. The lateral sizes of the *mPc*'s are drastically diminished as the acid interpenetrates the mosaic blocks from the grain-boundaries.

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Plastic fracture of polystyrene

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INTRODUCTION

Previous work has shown that a number of common thermoplastic materials undergo ductile fracture in the manner first described by Cornes and Haward for PVC.[1] These include cellulose acetate[2], polycarbonate, poly(ether sulphone) and poly(methyl methacrylate)[3], the last three at elevated temperatures. Ductile fracture in these cases results from the growth by tearing of one or more diamond shaped cavities generally initiated at the surface of yielded material from crazes if present or, generally, from other surface defects. A fast running crack then develops as the stress on the remaining cross-section reaches some critical value resulting in the formation of characteristic fracture surfaces. Cornes *et al.*[4], have referred to this process as 'plastic fracture' so as to distinguish it from a conventional 'brittle' type craze to crack mechanism.

Recent work with polystyrene has indicated that under suitable conditions of testing this material, like those cited above, will also show plastic fracture.

EXPERIMENTAL

The material used was a pure extruded sheet supplied by the Shell Chemical Company and having a glass transition temperature of 100°C. Standard dumbbell test-pieces were prepared and tested using a floor mounted Instron equipped with an environmental chamber for work at elevated temperatures. Electron microscopy was carried out using a Cambridge Instruments S4 'stereoscan' using an accelerating voltage of not more than 10 kV. All specimens were prepared for observation by covering with an ~100 Å gold film to prevent both charging up and damage under the applied electron beam.

RESULTS

Tensile behaviour

At strain rates of less than $2.5 \times 10^{-4}\ sec^{-1}$ and temperatures above 80°C necking and post yield deformation occurred. At temperatures above 90°–95°C no distinct yield point was evident and the material was considered to be no longer in the glassy state.

Scanning electron microscopy

Figure 1 shows a number of surface

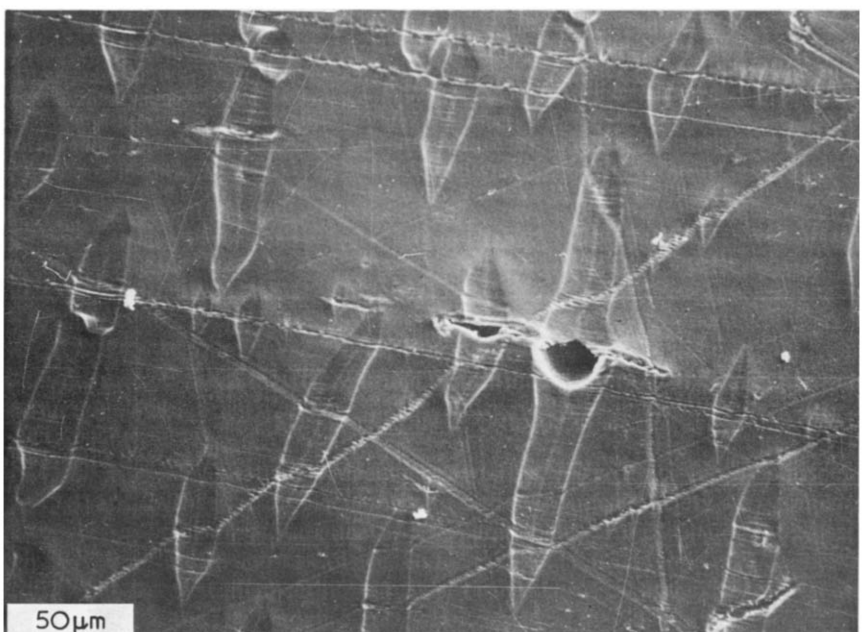

Figure 1 Scanning electron micrograph showing widened crazes in bulk yielded polystyrene

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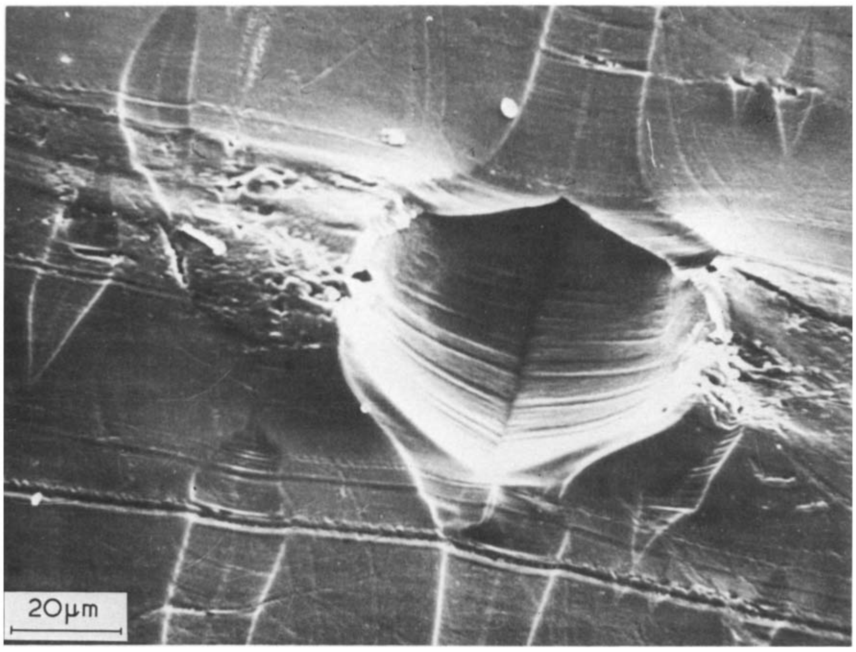

Figure 2 The characteristic structure of a diamond cavity in polystyrene

'ruts' distributed in the surface of yielded material taken from a polystyrene test-piece deformed at a strain rate of 10^{-4} sec^{-1} at 85°C. The parallel alignment of the 'ruts' and general distribution indicate that they are in fact 'widened' crazes. It is interesting to note that the extent to which these crazes have deformed is illustrated by the change in direction of the large scratch travelling from the bottom left to top right in the micrograph. Running from top to bottom down the centre of each widened craze is a faint line which may well define the original prenecking craze.

A diamond shaped cavity, a fundamental feature of the plastic fracture mechanism, can clearly be seen growing in the centre of the largest craze. In this instance it appears that the cavity was initiated from the intersection of the large transverse scratch with the mother craze. This type of initiation has been clearly demonstrated in poly(methyl methacrylate)[4]. It appears however that scratch–craze interactions need not necessarily lead to diamond cavities as illustrated by the rest of the micrograph.

Figure 2 shows a much higher magnification view of a diamond cavity growing from within a deformed craze. In this the morphology of the cavity surface can be clearly seen and shown to resemble that of similar cavities in PVC.

CONCLUSIONS

Under most tensile testing conditions polystyrene shows brittle behaviour below its T_g. However by selecting very low strain rates and temperatures approaching T_g necking and post yield elongation can occur. Under these conditions it has been shown that polystyrene can show plastic fracture.

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