Assessment of a craze initiation criterion

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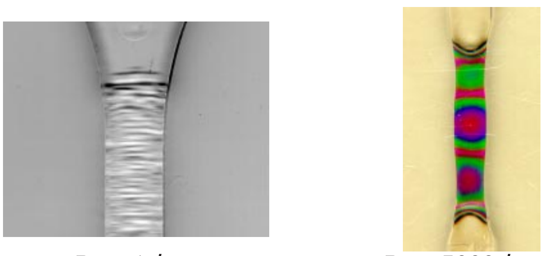
Introduction

Macroscopic plastic deformation in glassy polymers (like polystyrene and polycarbonate) is determined by microscopic localisation phenomena (i.e. necking, crazing). Whether necking or crazing occurs, is strongly dependent on the amount of softening and strain hardening [1, 2]. In tension:

- Polystyrene (PS) → brittle (crazing)
- Polycarbonate (PC) → tough (necking)

However, under superimposed pressure PS is tough.



$P_0 = 1$ *bar* $P_0 = 5000$ *bar*

fig. 1 *PS in tension under superimposed pressure*

Thus hydrostatic stress plays an important role in craze initiation [3, 4].

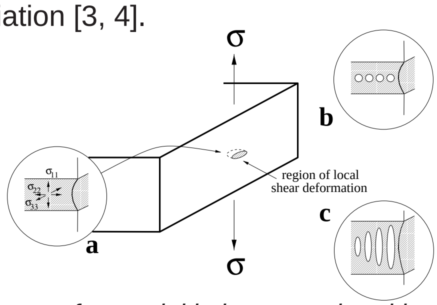


fig. 2 *Process of craze initiation, postulated by Kramer [3]*

Objective

Assessment of a craze initiation criterion.

Strategy

Experimental setup

By indentation of a PS plate under plane strain conditions [4], a craze can be formed in a neat and reproducible way (fig. 3).

Numerical simulation

Using FEM, employing the compressible Leonov model [1, 2], strains and stresses can be evaluated.

Experimental validation

A polariscope, visualising principal stress direction (isoclinics) and difference (isochromatics), can be used as a validation tool.

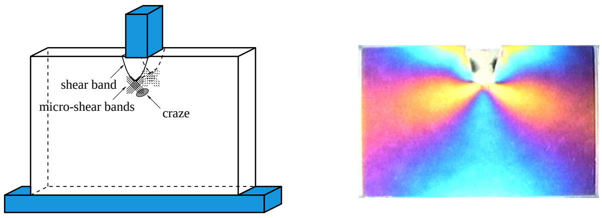
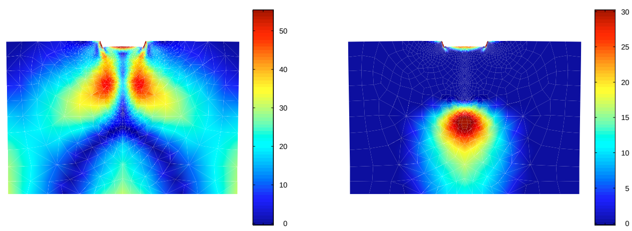


fig. 3 *Experimental setup and validation*

Next a criterion, for instance hydrostatic stress, will be checked in the simulation.

Preliminary results

A preliminary study is done resulting in an image of a deformed sample between cross-polarisers (fig. 3) and a FE simulation giving the first principal stress difference (fig. 4).



princ. stress difference *hydrostatic stress*

fig. 4 *FE simulation*

Concluding remarks

In the near future, $\frac{\lambda}{4}$ plates will be used in the experimental setup. Next experiment and simulation can be compared as isoclinics and isochromatics can than be discriminated.

References:

[1] Tervoort, T.A.: *Constitutive modelling of polymer glasses: finite, nonlinear viscoelastic behaviour of polycarbonate, PhD thesis, Eindhoven University of Technology, 1996.*

[2] Smit, R.J.M.: *Toughness of heterogeneous polymeric systems, PhD thesis, Eindhoven University of Technology, 1998.*

[3] Kramer, E.J.: *Crazing in polymers. In H.H. Kausch, editor, Adv. in Polymer Sci. vol. 52/53, p1-56.* (Springer-Verlag, 1983).

[4] Narisawa, I., Ishikawa, M., Ogawa, H.: *Fracture and crazing in the indenting of glassy polystyrene and styrene-acrylonitrile copolymer, Phil. Mag. A, vol. 41, no. 3, p331-351, 1980.*