

## Deformation and fracture of polymer systems

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## Research goal

Determining the influence of microscopic phenomena on macroscopic deformation behaviour of amorphous polymers.

## Stress-strain behaviour

Three stages that can be recognised in a stress strain curve of polymeric materials are (figure 1):

- Visco-elastic deformation till yielding point (A)
- Strain softening (A-B)
- Strain hardening (B-C), followed by fracture (in tension)

### Compression:

- PC, PS and PMMA have qualitative similar stress-strain curves. PS and PMMA have more softening

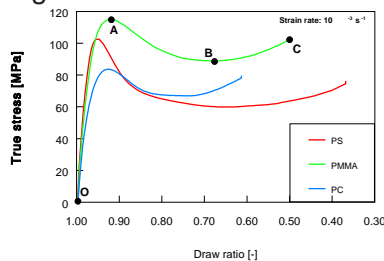


fig. 1 Compression

### Tension:

- PC deforms ductile
- PS and PMMA fracture brittle

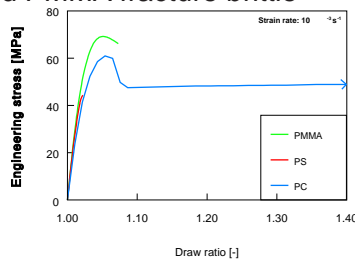


fig. 2 Tension

## Brittle-to-ductile transition

Decrease of softening, i.e. lowering the yield stress, reduces the localisation of plastic strain and increases the macroscopic plastic strain. This can be done by:

- Mechanical rejuvenation

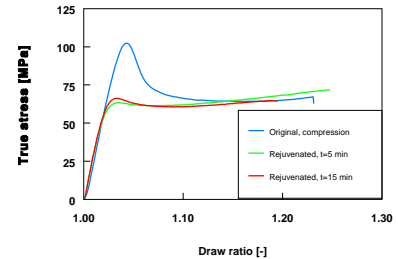


fig. 3 Influence of rolling on PS

Reduction of softening recovers in time (specimens tested after 5 and 15 minutes).

- Increase temperature

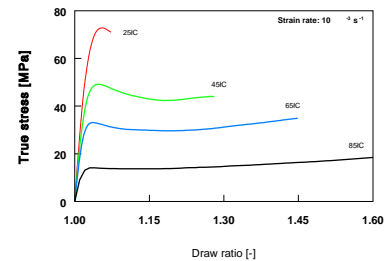


fig. 4 Temperature dependence of PMMA

- Application of plasticisers

## Conclusions

- Macroscopic deformation behaviour determined by localisation of plastic deformation
- Localisation of plastic strain dependent on softening and hardening
- Decrease of softening and increase of hardening increase macroscopic strain

## Future work

- Investigation of microscopic phenomena like craze initiation and propagation in PS
- Further investigation of brittle-to-ductile transition
- Experimental validation of finite element model