

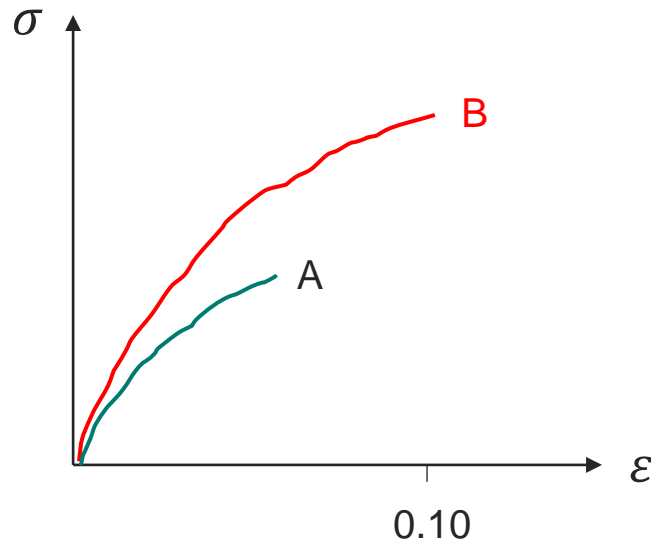
Transverse failure initiation – a dilatational stress controlled failure event in the glassy polymer matrix

Leif Asp, Professor, Materials and Computational Mechanics, 2022-09-14

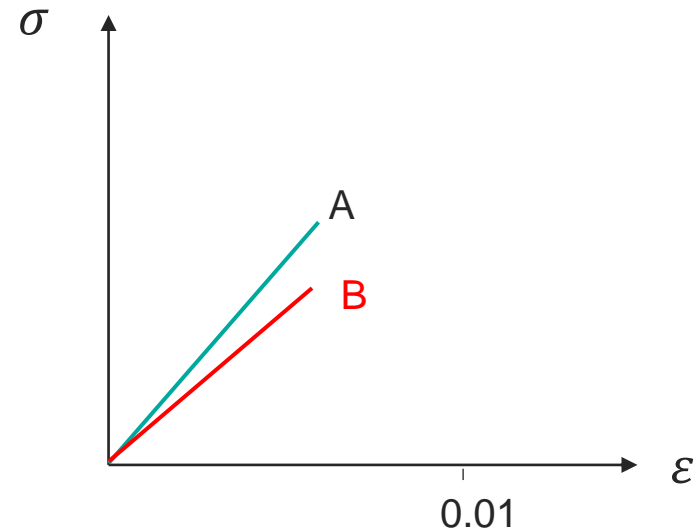
Uniaxial tension of glassy polymers and transverse composites



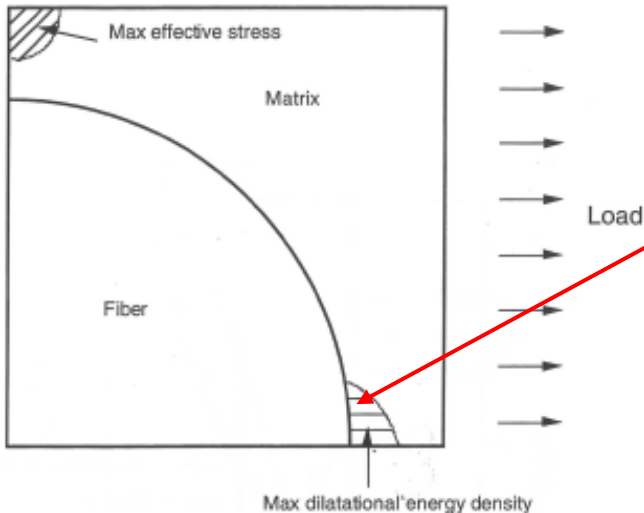
Glassy polymers



Transverse composite



Tensile strength controlled by 3D-stress state



Typical stress state: $\sigma_1 \approx \frac{\sigma_2}{2} \approx \frac{\sigma_3}{2}$, *all stresses* > 0

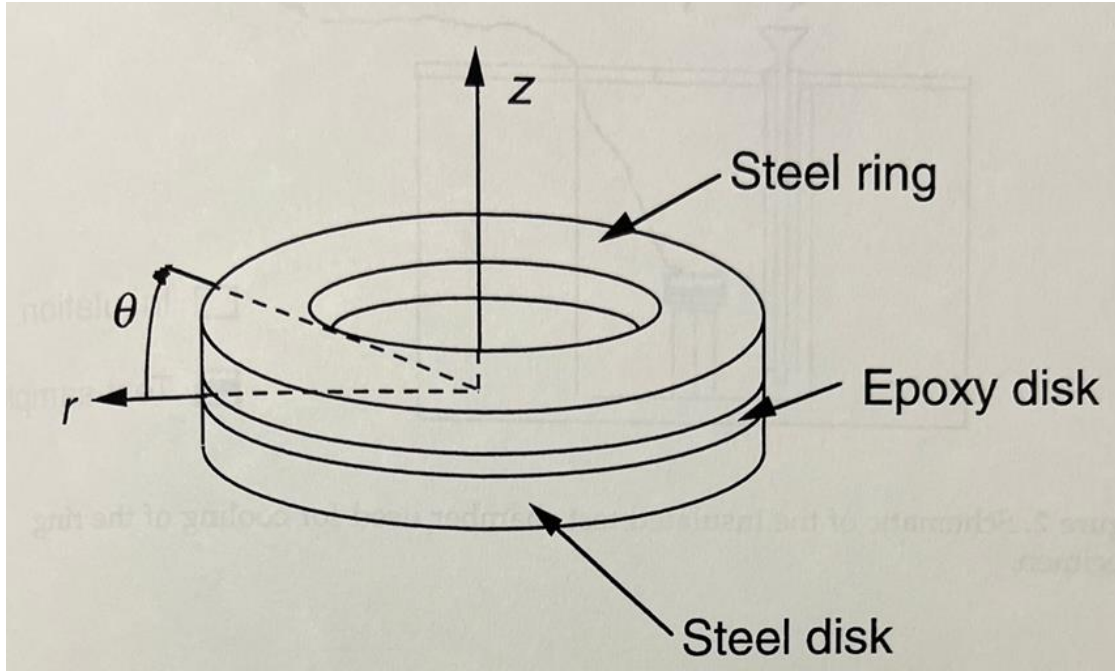
Dilatational energy density:

$$U_v = \frac{1-2\nu}{6E} (\sigma_1^2 + \sigma_2^2 + \sigma_3^2)$$

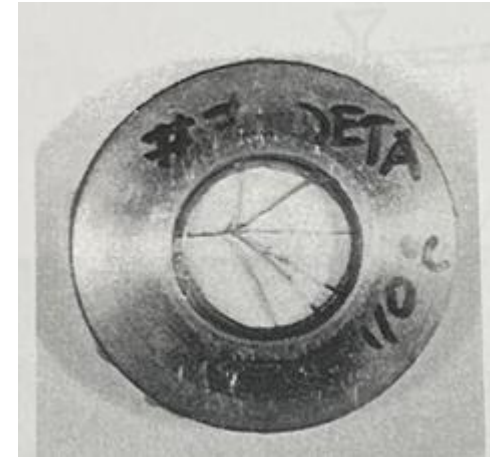
(only valid when $\sigma_1 + \sigma_2 + \sigma_3 > 0$)

Strength of glassy polymers under dilatational stress

- A way to measure transverse failure initiation



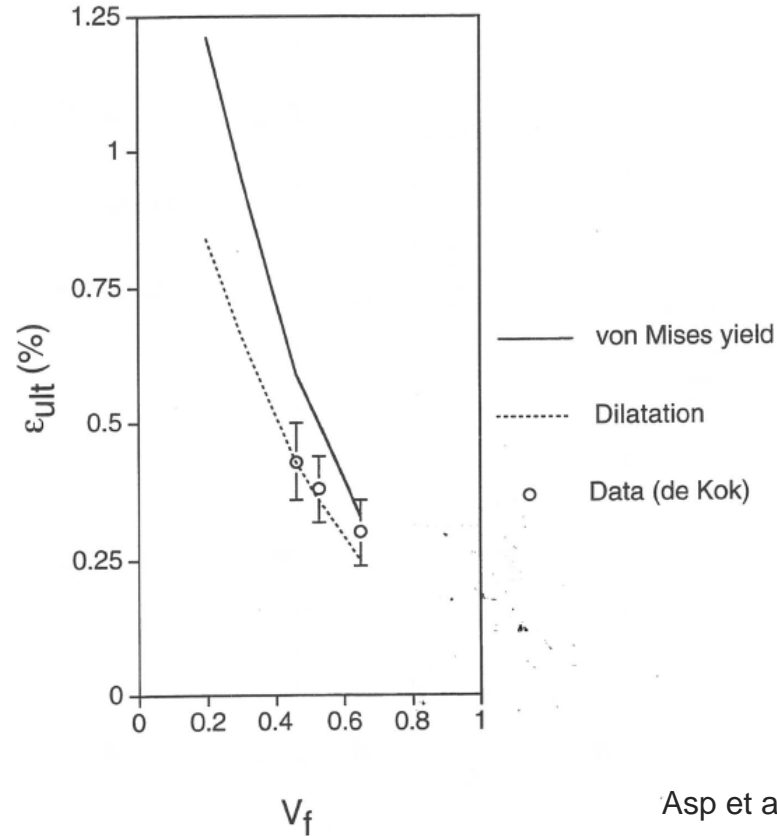
$$\Delta T \approx -200 \text{ } ^\circ\text{C}$$



$$\sigma_r = \sigma_\theta$$

Asp and Berglund. *Exp. Mech.* 1997.

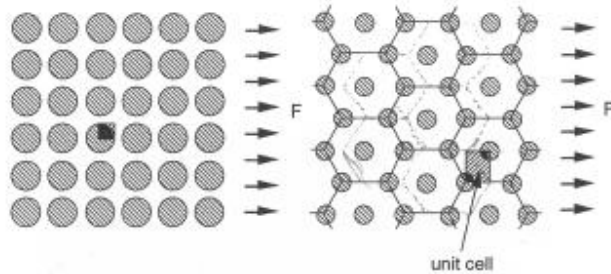
Prediction of tensile strength





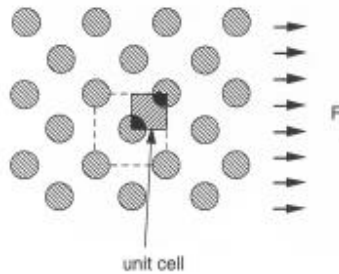
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Transverse strength: 3D stress state

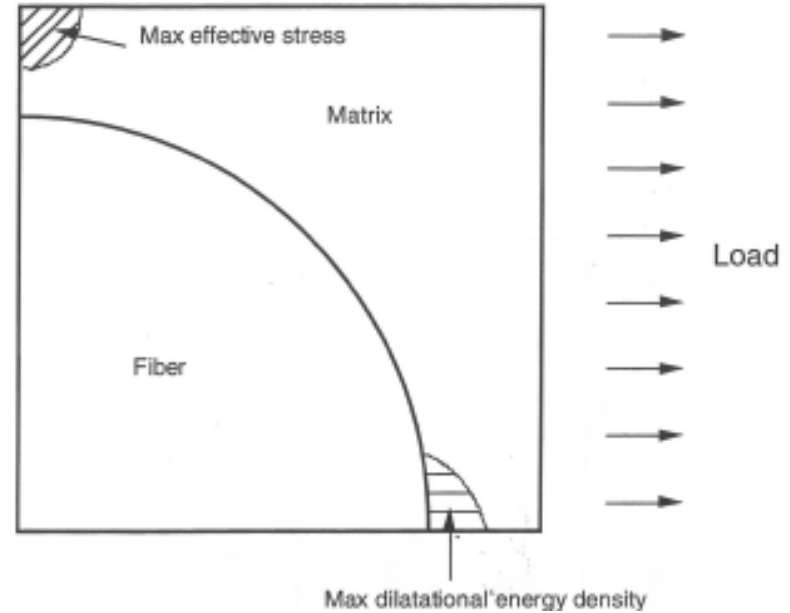


a) Square array

b) Hexagonal Array



c) Square-diagonal array





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