

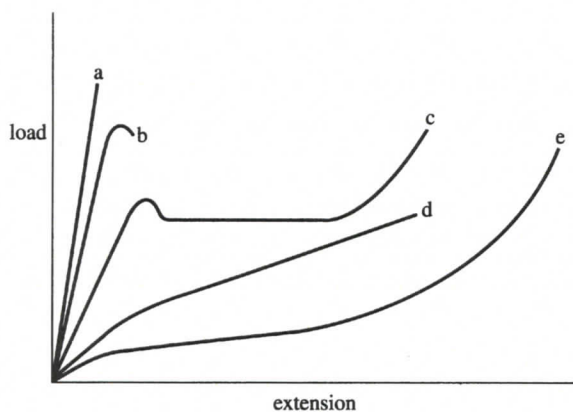
# Polymer Physics Exam, 28. 1. 2014

Tfy-125.4341 Polymer Physics

## Answer in 4 questions

1. (a) What is an entropic force? What gives rise to an entropic force in rubbers? (b) Real rubbers are usually not purely entropic, but a finite proportion of the restoring force originates from atomic bond twisting and stretching. How would you determine experimentally the relative contributions of entropic and energetic parts of the force?

2 a) Figure shows a Stress-Strain behavior of various polymers. Which curve describes best the behavior of 1) polystyrene, 2) polyethylene, 3) cross-linked polyisoprene?

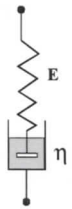


b) Define the terms: Young's modulus, tensile strength, chain entanglements, and glass-rubber transition.

3. Suppose that you want to mix polystyrene and polybutadiene at equal proportions in order to form a homogeneous phase at  $T = 25\text{ }^{\circ}\text{C}$ . What is the largest molecular weight that allows homogeneous mixing (when the same molecular weight is used for both polymers)? You can assume equal molecular weights for the repeat units (100 g/mol). The Flory-Huggings parameter at  $T = 25\text{ }^{\circ}\text{C}$  is  $\chi = 0.1$ .

#### 4. Viscoelastic properties

Suppose that materials viscoelastic properties can be modelled using Maxwell model, where the  $E = 10^9$  Pa and  $\eta = 10^{11}$  Pa·s. At the time  $t = 0$  s material is given the relative strain of  $\epsilon = 1\%$  and at the time  $t = 30$  s the relative strain is increased to  $\epsilon = 2\%$ . What is the stress at the time  $t = 100$  s.



Maxwell model

5. A new polymer was found to soften at  $50^\circ\text{C}$ . Several experiments were performed to determine if the softening was a glass transition or a melting point.

- In interpreting the results for each experiment separately, was it a glass transition? a melting transition? cannot be determined for sure? or was there some mistake in the experiment?
- What is your reasoning for each decision?

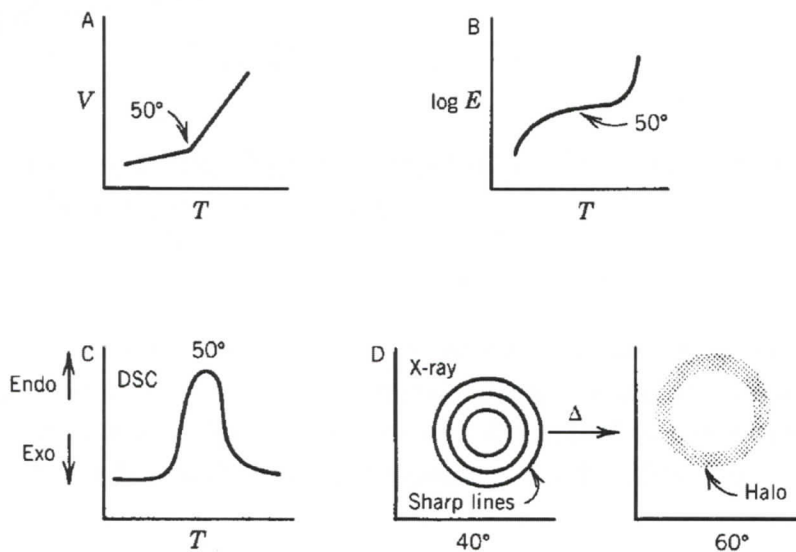


Figure P8.21 Laboratory studies of transitions.