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1/ Mechanical behavior of polymers by Stretching:-

What will happen if will you stretch the crystalline thermoplastic ?

when stress is applied, the first thing that begins to happen is that there is some movement of folded chains past each other.

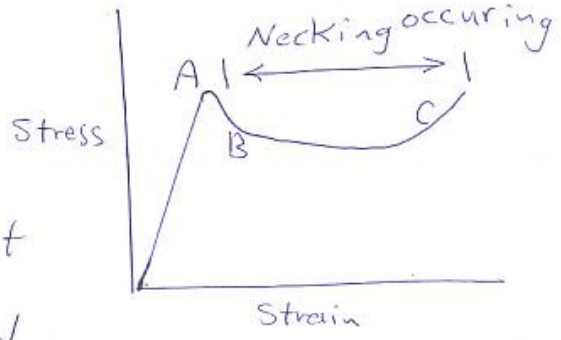

Fig.(2) stress-strain graph for a crystalline polymer Semi-

After point A, the polymer chains start to un fold to line up the chains along the direction of stretching; This is a start to exhibit necking where a section of the material suddenly shows a marked contraction in its cross-section (Fig. (3)).

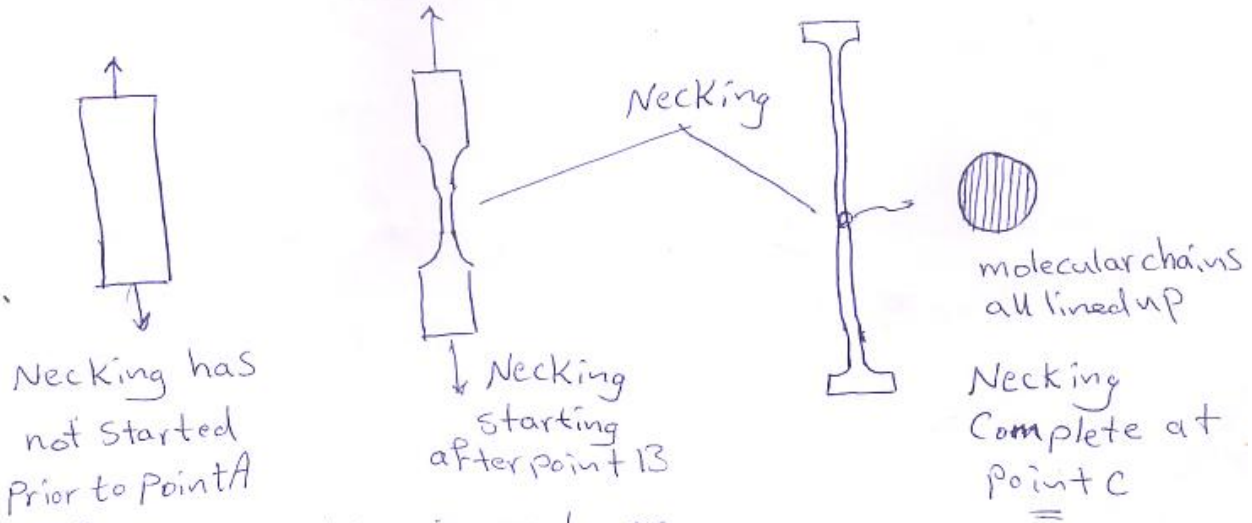

Fig.(3) Necking in a polymer

As the stress is increased, the necking spreads along the material with more and more chains unfolding. Finally, when the entire material is at the necked stage, all the chains have lined up, the material is cold drawn.

Cold drawn material has different properties with the undrawn material because the orientation of the molecular chains. The material is stiffer (has higher strength and tensile modulus).

For example, the tensile modulus of PE increases from (1-10) Gpa and the tensile strength from (30-200) Mpa while the percentage of elongation is reduced from a few hundred percent to less than 10%.

The previous behavior tends to occur if the material is stretched slowly and sufficient time elapses for the molecular chains to unfold (low strain rate). If a high strain rate is used, the material is likely

to break without the lined up of the chains.

Crystalline polymers can be hot formed and shaped at temperatures above the melting point or cold formed and shaped at temperatures between the glass transition Temp. and melting point.

What will happend if you stretch an amorphous polymer?

For an amorphous polymer, Below Tg the polymer is glass-like, stiff and Brittle (no chains or parts of chains can move). above Tg, the material behaves in a rubbery fashion (polymer is very flexible, has low elastic modulus, able to withstand large and recoverable strains) → here there is thermal energy sufficient to rotate the side groups on chains and the entire segments of the chain.

Amorphous polymers formed and shaped at temperatures

above Tg because they are in a Soft Condition

Elastomers are amorphous polymers exhibit rubbery behavior at room Temperature (above their glass transition temp.). by Cooling of rubber, it becomes brittle and shows glassy behavior (Such behavior needs to Cooling rubber by liquid nitrogen).

Most polymers become rubbery at Some temperature with the exception of havily Cross-linked thermosets which decompose before they reach Tg.

Note 1- Moisture is another variable of great importance in polymers such as nylon and poly Sulphones will change the relaxation behavior in a Similar manner to Temp.