5. Mechanical Properties of polymers

Mechanical properties

The mechanical properties are related with the behaviors of polymers against deforming external forces such as twisting, stretching, stress, and compressing.

The deformation term corresponds to the observed change in the size (shape) of polymers under load. While the solid materials are deformed by changing their shapes, the liquids flow.

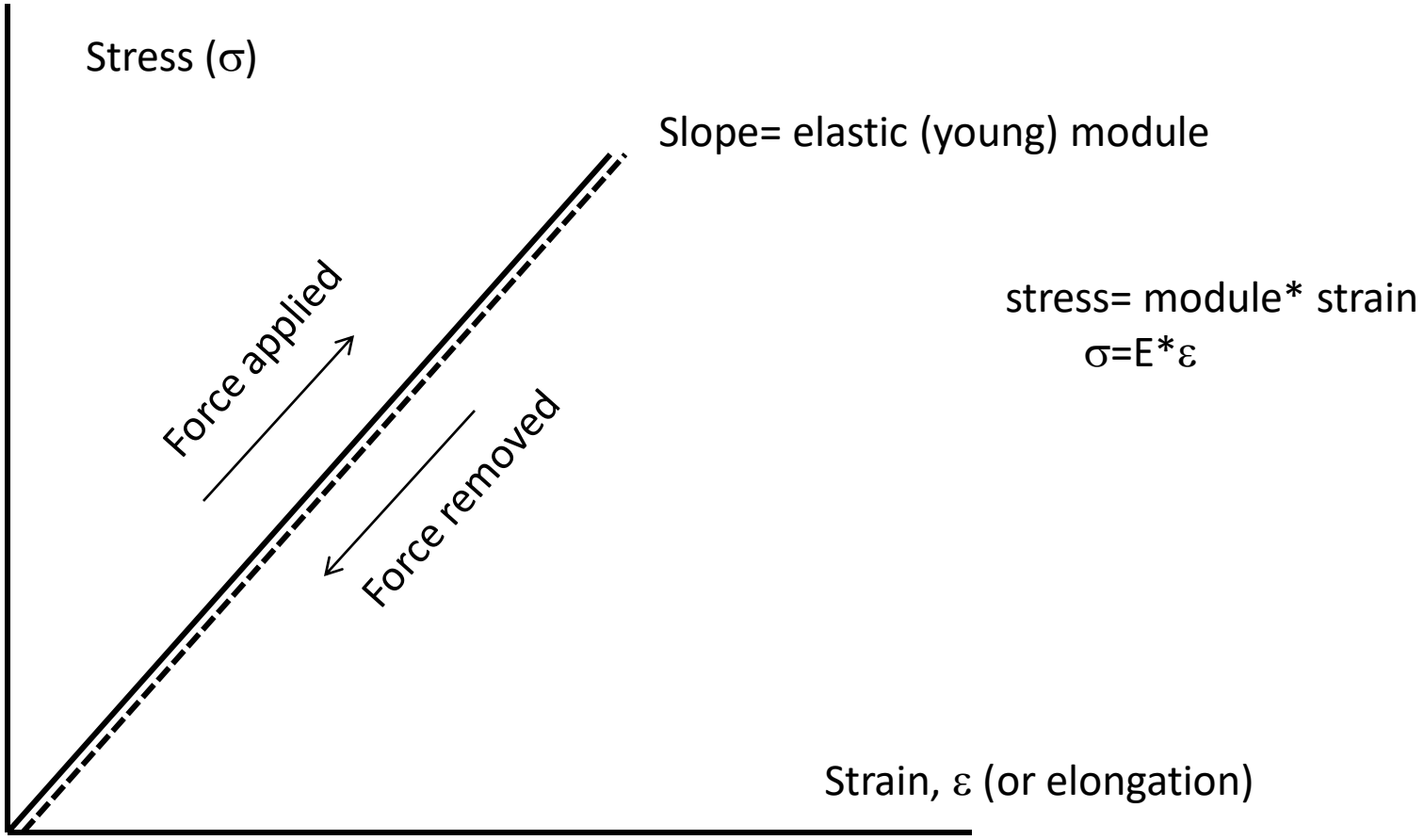
The beneficial information related to the mechanical properties of polymers can be obtained from the stress-strain (load-deformation) curves. In this graphs, an increasing force is applied to the polymers and the elongation amounts per unit length of a polymer is plotted.

Most of the solid materials can return to their initial size after the removal of low loading .

If a material can return to its original sizes after the removal of the force>>>>>>>> **reversible (elastic) deformation**

The liquids flow under force and flowing is a permanent deformation>>>>>> >>>>>>>> **irreversible (viscous deformation)**

Ideal elastic deformation



If the young module of a material is high, then it is suggested that the material is resistive to the deformation in terms of elongation

Viscoelastic deformation

- liquids>>>>>>> viscose materials that display irreversible deformation under stress load.
- Solids>>>>>>> show elastic behavior when low stress is applied and can return to thier originial state after the removal of the load.

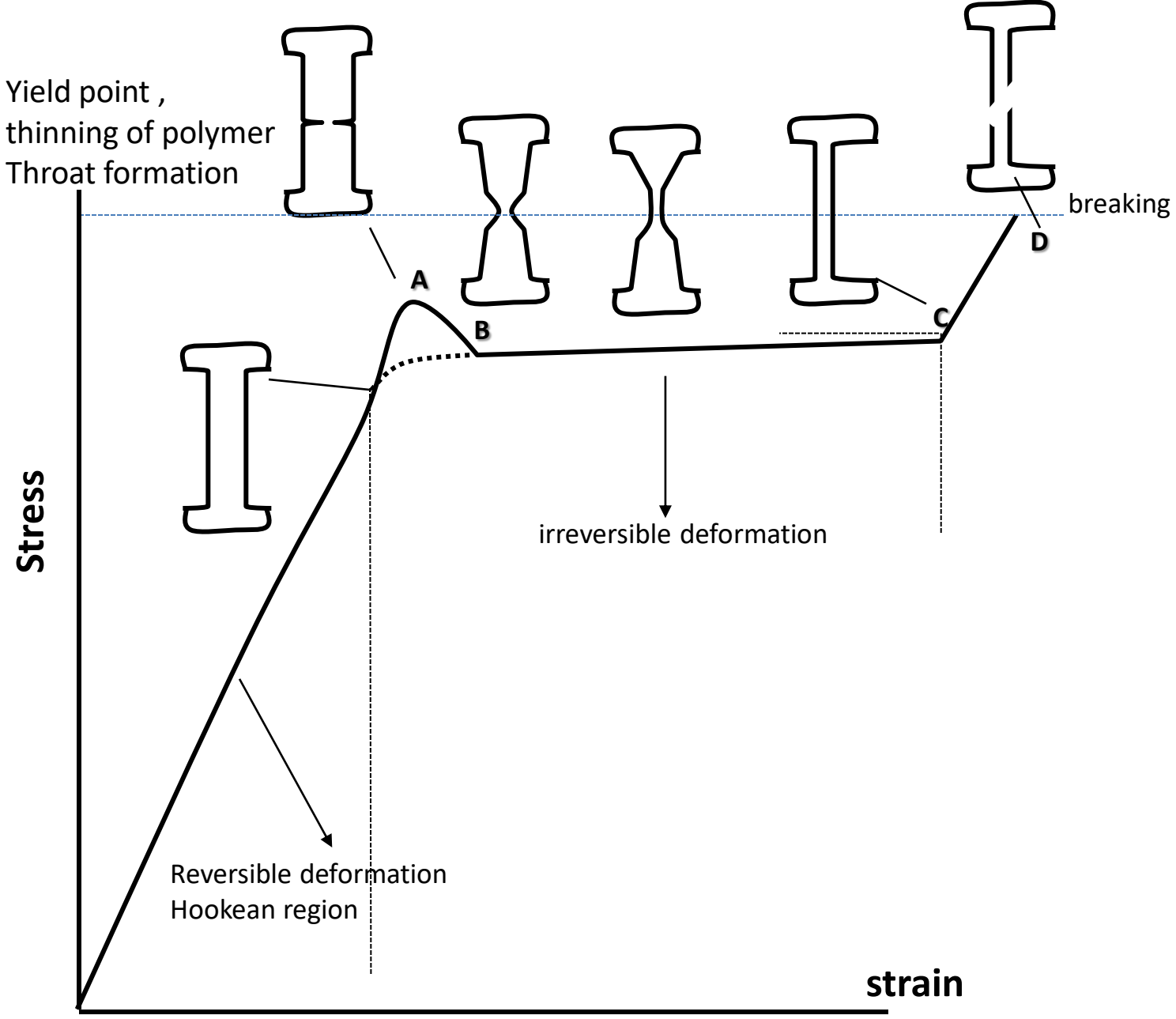
- If a material shows the mechanical behavior between liquids and solids>>>>> ***viscoelastic deformation***
- Most of the ***polymers*** show viscoelastic deformation.

The viscoelastic behaviors of the polymer melts and solid polymers depend on:

* inter-molecular interactions,

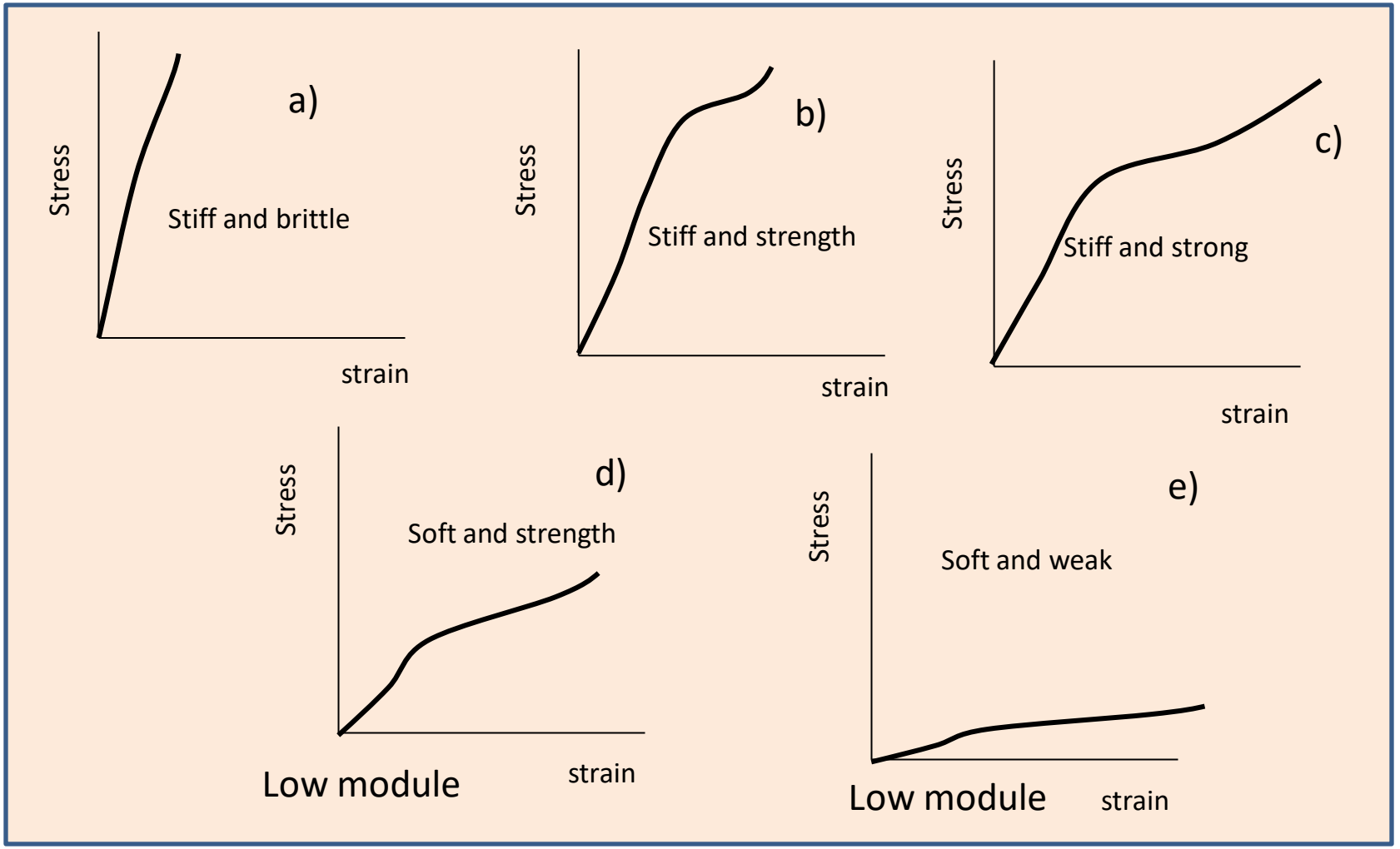
*cristallinity,

* chain rigidity.

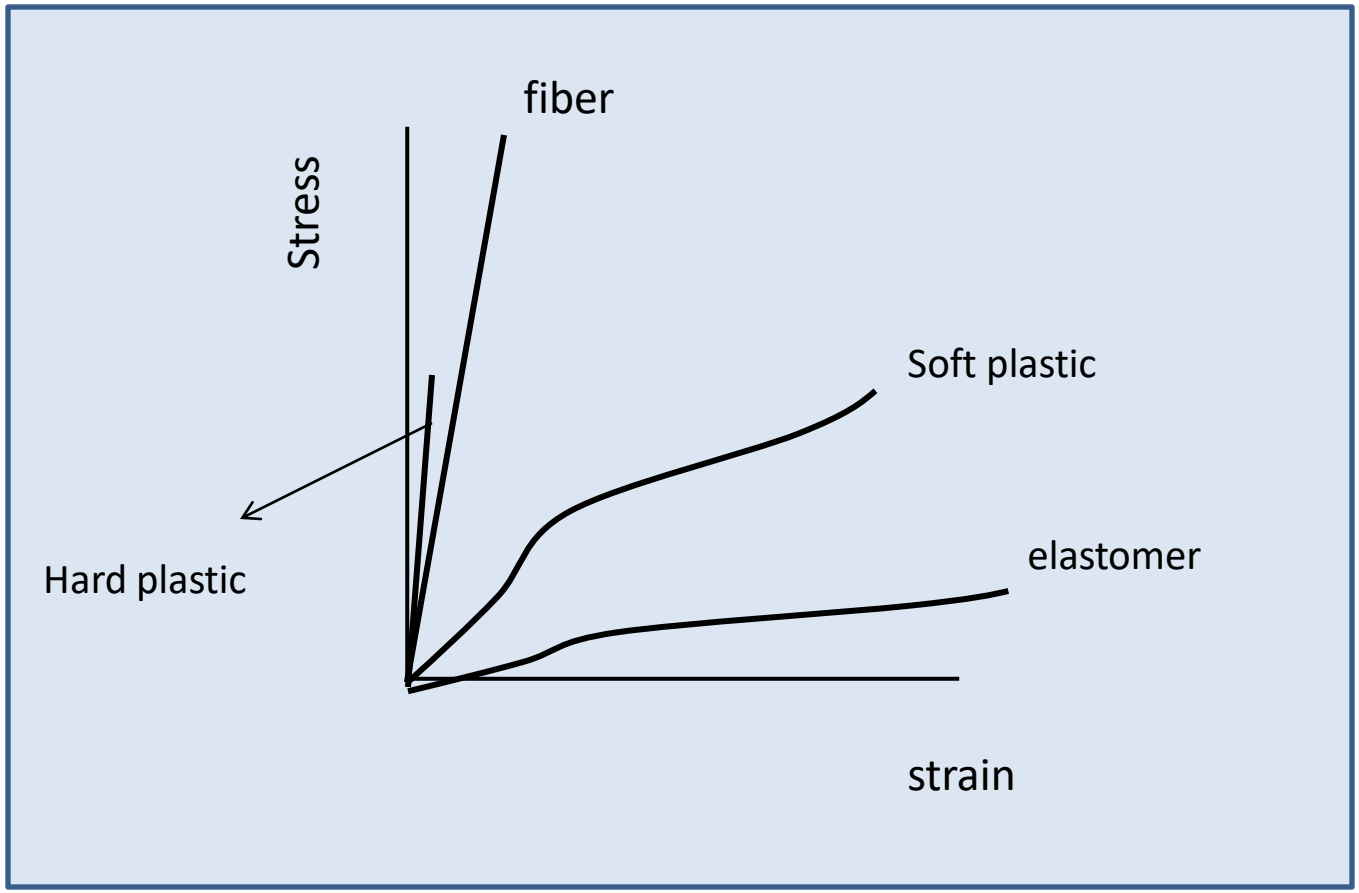


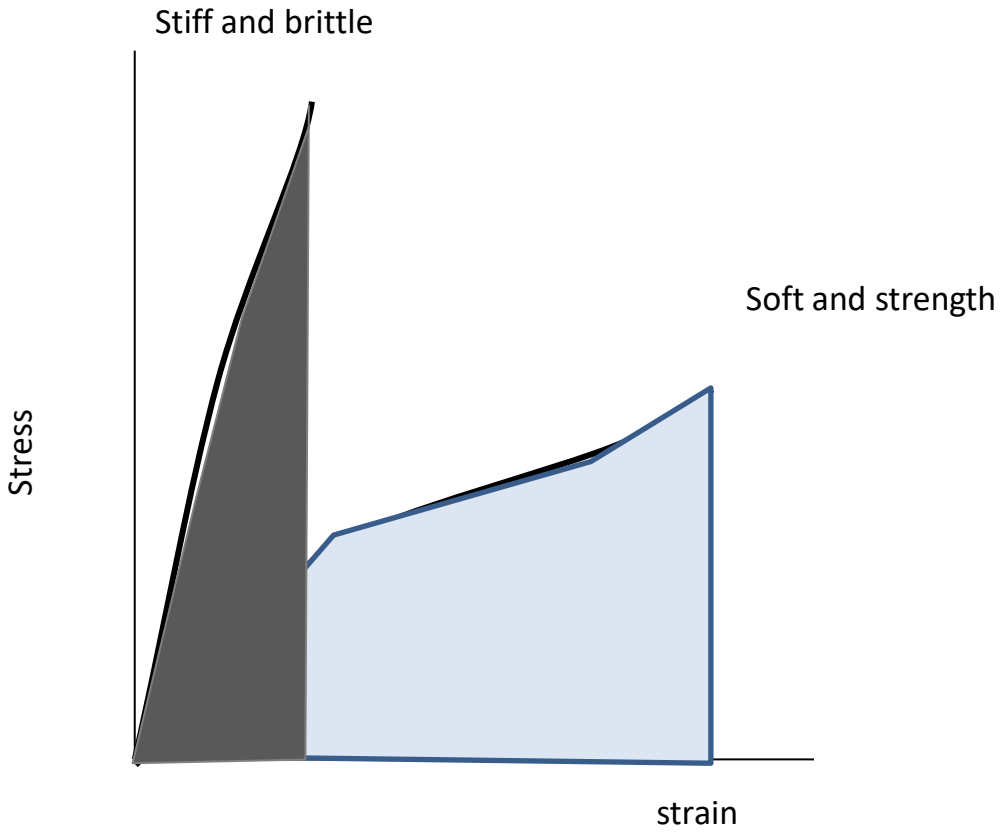
A stress-strain curve for a semi-crystalline polymer

High module Moderate module Moderate module



Some stress-strain curves of commercial polymers


fiber
Stress
Soft plastic
elastomer
Hard plastic
strain


Stiff and brittle
Soft and strength
Stress
strain

Elasticity

It is the ability of a material to reach its initial length when the applied force is removed on the polymer.

e.g.

100 cm…….> stress applied……..>110 cm…….>stress removed…..100 cm (100% elasticity)

100 cm…….> stress applied……..>110 cm…….>stress removed…..105 cm (50 % elasticity)