ENGINEERING CHEMISTRY

Department of Science and Humanities

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Functional materials-Polymers

Class content:

- ***Structure –property relationship***
  - ***Crystallinity***
  - ***Tensile strength***
  - ***Elasticity***
  - ***Chemical resistance***
  - ***Plastic deformation***

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Structure - property relationship of polymers

- Polymers are **extremely versatile** when it comes to their properties
- Some are hard while others are soft and flexible
- Some are insoluble and resistant to heat while others are soluble and fusible
- Properties of polymers are **influenced by their structure**

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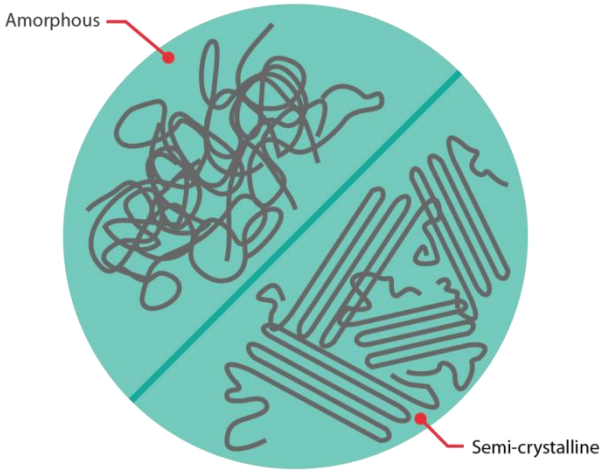
Crystallinity :

- The degree of cystallinity of a polymer depends on its **structure and configuration**
- Polymers contain both **crystalline and amorphous** regions
- Crystalline regions occur when polymer chains are arranged in an orderly fashion parallel and close to each other



https://coventivecomposites.com/explainers/types-of-polymer-matrix/

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Structure:

- Polymers made up of linear chains **without bulky pendant groups** are more crystalline

  e.g., Polyethylene(PE) is more crystalline then polyvinylacetate

- Polymers containing **polar groups** are more crystalline
- A close packing between polymeric chains because of strong secondary forces like dipole–dipole interactions or hydrogen bonding imparts a high degree of crystallinity

  e.g., PVC is more crystalline than PE

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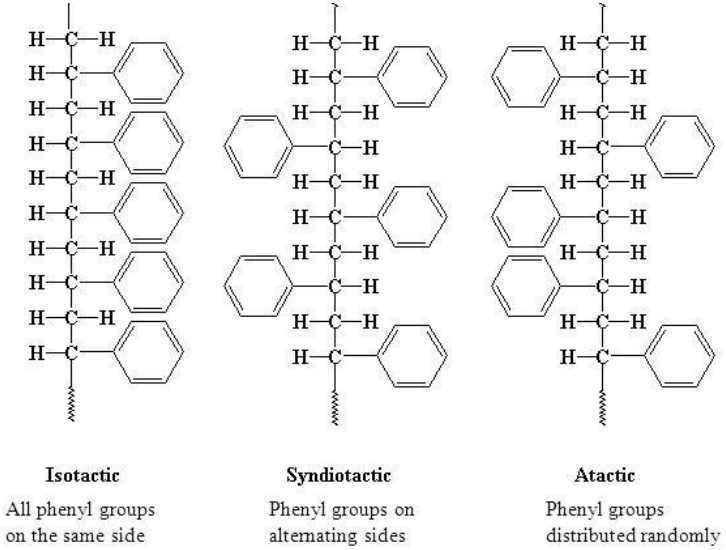
Configuration:

- Crystallinity also depends on the **stereoregularity** of the polymer
- Based on stereoregularity polymers are classified as **isotactic, syndiotactic and atactic**
- Isotactic polymers are found to be **most crystalline** while atactic are found to be **least crystalline**



Source:https://slideplayer.com/slide/5759919/

- High crystallinity leads to sharper melting point, greater rigidity, strength and density

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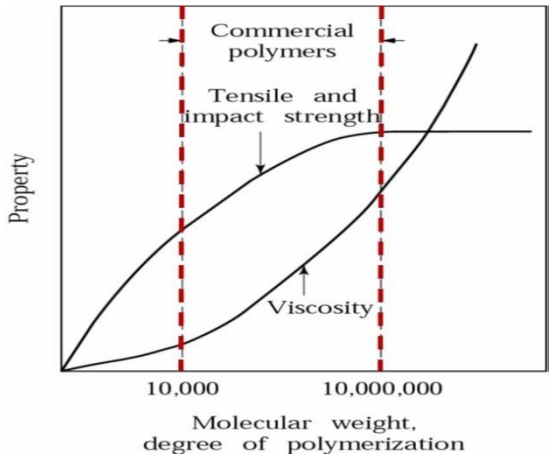
Tensile strength:

•The **amount of stress** a polymer can take before undergoing permanent deformation

•Tensile strength depends on :

- **Molecular mass** - low molecular mass polymers are soft and gummy, high molecular mass polymers are tough and heat resistant
- By increasing molecular mass the **tensile strength increases** to a certain extent and then becomes constant
- **Melt viscosity** initially shows gradual increase then increases steeply with high molecular weight



Source:https://polymerinnovationblog.com/polymer-composites-part-2-introduction-polymer-resins/

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- Tensile strength increases when polymer has **polar groups**

- Force of attraction between chains prevents polymer chains from **slipping against each other**
  e.g., PVC, Nylon

- **Cross linking** in a polymer also increases its tensile strength

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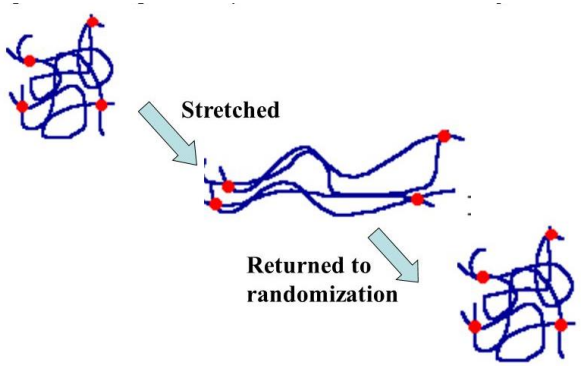
Elasticity :

- The property of a polymer by which it **deforms on applying force and regains original shape on release of force** is called elasticity

•Elastomers have **long coiled and entangled chains** which straighten and orient themselves on stretching. When stress is removed they go back to coiled form



Source:https://slideplayer.com/slide/8755303/

•For a polymer to show elasticity the individual chains **should not break** on prolonged stretching

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- Presence of **polar groups** in the polymer chain results in strong secondary force of attraction between the chains making them **stiff and inflexible**

- **Non polar groups** have weak van der Waal's attraction between them and hence they are **more elastic**

- Presence of **bulky, aromatic and cyclic groups** in the polymer **decreases** the elasticity of the polymer

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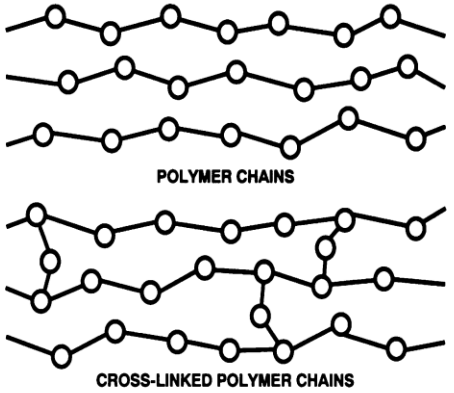
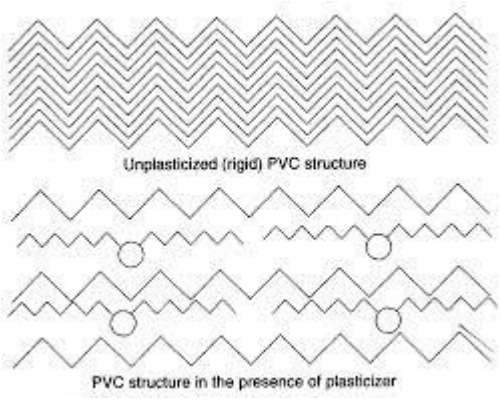
- In elastic materials such as natural rubber, elasticity can be improved by **introducing cross linking** at suitable molecular positions like in vulcanisation



Source:https://revision4gcses.wordpress.com/science/chemistry-2/polymers/

- In non-elastic materials, elasticity is achieved by using **plasticisers** , for example (Ph_3PO_4), which enter between the polymer chains and make a hard polymer more flexible



Source:https://www.diva-portal.org/smash/get/diva2:1312811/FULLTEXT01.pdf

THANK YOU

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