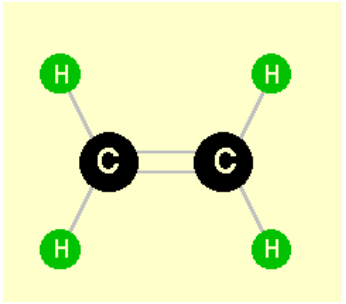

کیا پلیمر طاها

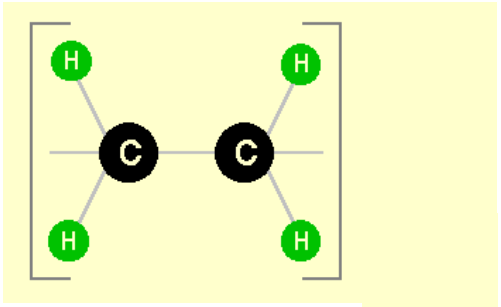
The first ones

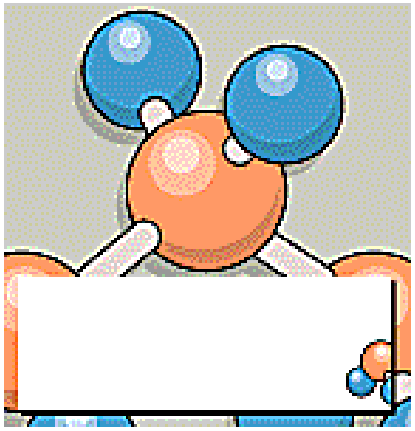
- **First industrial polymer**
  - natural rubber or elastic gum or polyisoprene
  - used to make containers, shoes, balls etc
- **First semi-synthetic polymer**
  - cellulose nitrate or celluloid
  - by John Hyatt to make billard ball, 1865
- **First synthetic polymer – first plastic**
  - bakelite or phenolic
  - by Leo Baekeland - the father of plastics, 1907
- **Invention of thermoplastics**
  - most of them invented bw 1930s – 1950s
  - PA, PE, PP, PVC, PS, PMMA, ABS, PET

Polymer = ?

- Polymers are chain molecules.
- They are built up from simple units called ***monomer.***
- E.g. polyethylene is built from ethylene units :







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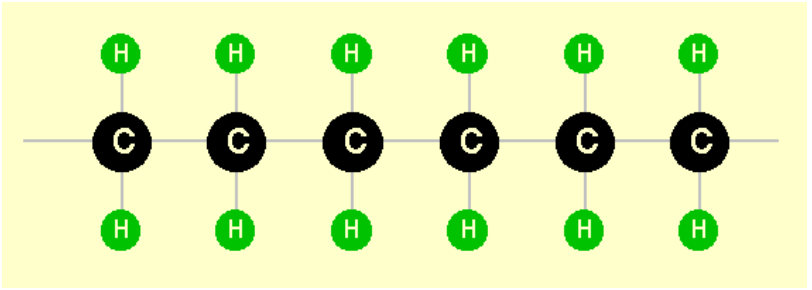
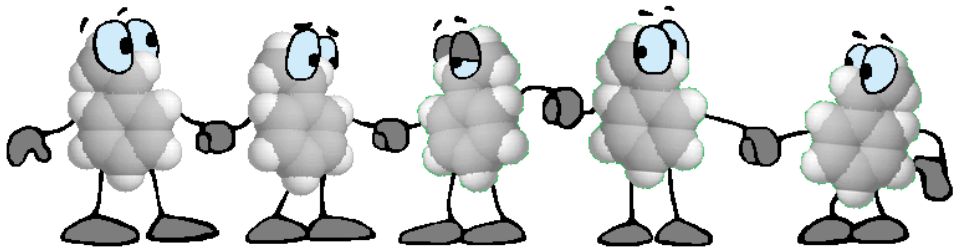


Plastics

Advantages & Properties;

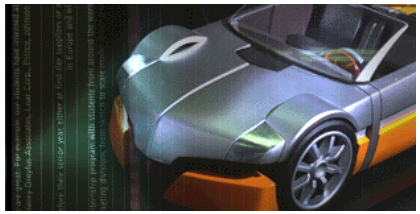
- ✓ High performance/density ratio
- ✓ Chemical resistance
- ✓ Impact strength & toughness
- ✓ Insulation (electricty, noise, and heat)
- ✓ Purity & Optical properties
- ✓ Ease of processability & giving shape
- ✓ Part consolidation & assembly
- ✓ No need for extra painting
- ✓ Low raw material & processing cost



Plastics

An industry example;

- ✓ **Automotive;**
  - **Reduced weight : 20 years ago 8% of cars by weight was plastic. Now it is 12%**
  - **Energy saving : 100kg of plastic can replace 200-300kg of other materials in car. This means 750 lt of petrol saving in 150.000km.**
  - **Environment : emmision of CO_2 is reduced by 10% in the last 10 years**
  - **Recycling**
  - **Safety & aesthetics : air bags, seat belts, insulators, acoustics & nice colors**
  - **Innovations : new products are developed continuously**



Plastics

Disadvantages;

- **Flammability**
- **Thermal performance**
- **Shrinkage & anisotropy**
- **Dimensional stability**
- **Aging with time**

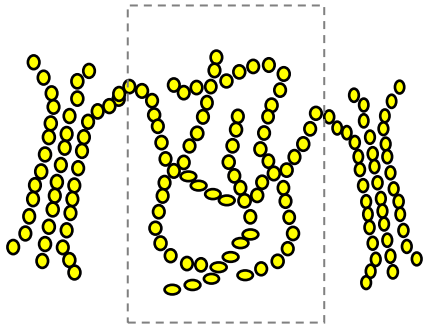
Classification of Polymers

1. Nature
   - natural, semi-synthetic, synthetic (plastic)
2. Chain structure
   - linear, branched, cross-linked
3. Monomer composition
   - homopolymer, copolymer, terpolymer
4. Polymerizarion mechanism
   - Condensation (step), addition (chain)
5. Chain configuration
   - conformation, configuration
6. Thermal behaviour
   - thermoplastic, thermoset, elastomer

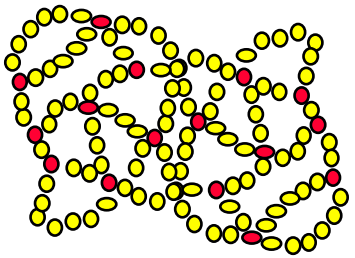
Classification

- ***Thermal Behaviour***

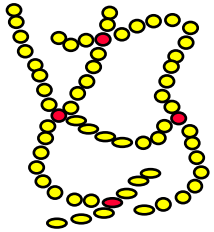
  - Thermoplastics (Amorphous & Semi-crystalline)*
    - *Softens & Flows when heated*
    - *Re-shapeable*
    - *Recyclable*



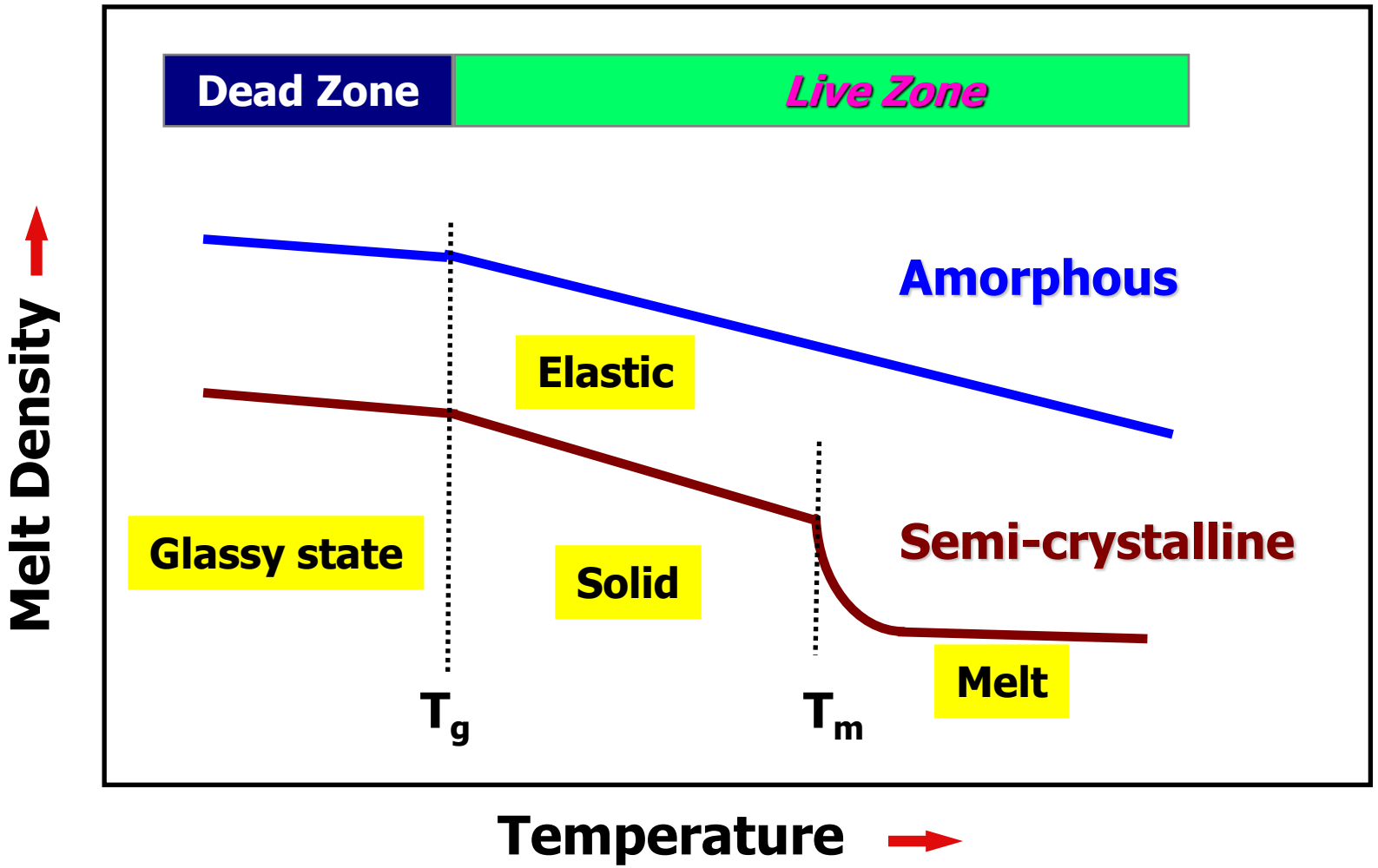
  - Thermosets
    - *X-linked chains (3D network)*
    - *Can not be melted*
    - *Can not be recycled*



  - Elastomers
    - *Low rate of 3D network*
    - *Elastic behavior*



Amorphous vs. Semi-crystalline



Amorphous vs. Semi-crystalline

	Amorphous	Semi-crystalline
Thermal Property	glass transition temperature (T_g)	glass transition temperature and melting temperature (T_m)
Max. Service Temperature	<Tg	Between T_g and T_m
Processing Temperature	T_g + 100-130°C	T_m + 20-50°C
Effect of Temperature on Viscosity	high	low
Optical Property	transparent	opaque
Dimensional Stability	good (low shrinkage)	fair (high shrinkage)
Anisotropy	low	high
Chemical Resistance	fair	good
Polymers	ABS, PS, PMMA, PC, PPO, PVC	PA, PP, PE, PBT, PET, POM

Characterization

- ***Molecular Weight (MW)***

  - **MW and MW distribution are very important in determining material properties & flow**
    - **Mechanical properties (better with higher MW)**
    - **Chemical properties (better with higher MW)**
    - **Rheology**
      - **High Flow (low MW) : good for injection molding**
      - **Low Flow (high MW) : good for extrusion**
  - **MW is not easy to determine with direct methods**
    - **GPC, sedimentation**

      but easy with in-direct methods like;
    - **Viscosity or MFI**

    MW ↗ => Viscosity ↗ & MFI ↘