سلوك ميكانيكي / ثالث بوليمر
المحاضرة الاولى

1

- The effect of structure on mechanical properties:-

- polymers include materials such as plastics and rubbers and are used in a wide range of applications such as: home appliances, paints, car tyres, toys, foams for packaging.

- polymerisation is the process by which smaller units are joined together to create these larger chains.

- The degree of polymerisation of the polymer chain is the number of subunits (mers) used to form the chain.

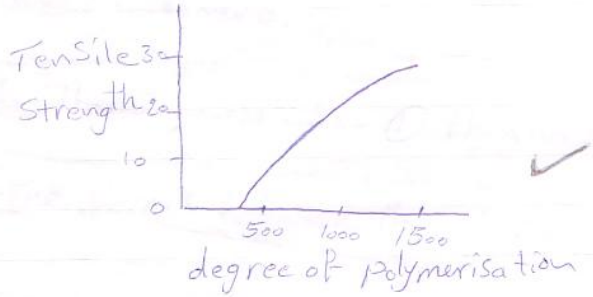
~~Any~~ Any sample of polymer will contain individual chains of different lengths, the degree of polymerisation n not being constant, The value quoted for the degree of ~~polymerisation~~ polymerisation and molecular mass of Any polymer is an average.

The properties are affected by chain length, there is a

سلوك ميكانيكي / شاك
المحاضرة الاولى

2

range of properties depending on the average size of ~~molecul~~ molecular chain in the sample of polymer.



~~Effect~~ " effect of degree of polymerisation on strength "

Classification of polymers:-
polymers can be classified into thermoplastics, thermosets, and elastomers.

1. Thermoplastics:- ① they have linear or branched chains ② the forces between the chains are due to the Van der Waals bonding, So the individual chain molecules are distinct and capable of being separated ③ the linear chains have no side branches or ionic or covalent cross links with other chains and can move readily past each other (slipping over each other), breaking and remaking Van der Waals bonds ④ the branched chains have a reduction in the ease with which the chains can move past each other and the material is more rigid ⑤ with the application of heat, the material softens and when the heat is removed the material hardens ⑥ thermoplastics are less stiff and less strong than thermosets ⑦ offer the possibility of being heated and then pressed into the required shapes.

4

2. Thermosets: ① have ionic or covalent cross-links ② ~~the~~ there is stronger cohesion between the polymer chains gives highly cross linked structure ~~and so a very st~~ ③ thermosets have a very rigid and stiff material ④ heat causes the material to char and decompose with no softening ⑤ the bonds linking the chains are strong (ionic or covalent cross links) and not easily broken, so the chains cannot slide over one another ⑥ cannot be manipulated. ⑦ the process of shaping of thermosetting polymers can be limited to the case where the product is formed by the chemicals being mixed together in a mould so that the cross linked chains are produced while the material is in the mould, other than possibly some machining ~~are~~ is likely to occur.

- Molecular structure :-

There is freedom for the chain to twist about any C-C bond and so the chain is flexible ~~(Note: The forces between the chains are due to the weak Vander Waals bonding.)~~

The structural changes ~~used~~ could be used to make a polymer ~~polypropylene~~ material consisting of linear chains of $-CH_2-$ groups a stiffer material :-

1. ~~ppd~~ polypropylene (pp) differs from polyethylene (PE) only to the extent that alternative carbon atoms have one of their hydrogen atoms replaced by CH_3 groups. This replacement can take a number of forms (atactic, isotactic, syndiotactic). Commercial pp is predominantly isotactic with small amounts of other forms present. PP is more rigid and stronger than PE in its linear form.

2. poly vinylchloride (PVC) :- has a linear chain differing from PE only to the extent that bulky atoms (chlorine atoms) replace some hydrogen atoms on the chain. Commercial PVC is largely atactic.

Because of this structure, PVC is a rigid and relatively hard material when used without a plasticiser.

3. If we put knobs or branches onto a - CH_2 - chain is to make the chain stiffer by incorporating blocks in the backbone of the chain. An example of such polymer is polyethylene terephthalate (PET). This incorporates a six - carbon (benzene) ring to the backbone. This ring structure will not twist like the C-C bond and so the chain is stiffer. PET is widely used for the plastic bottles used for drinks.

4. Another way of changing the chain structure is to combine two or more mers to give a copolymer. Ethylene and vinyl acetate can be combined to give a copolymer (EVA). Its basic structure is linear chain with short branches. the properties of copolymer depending on the relative proportion of the two constituents. Increasing the vinylacetate component increases the flexibility of the product ~~while~~ where

large amounts of vinyl acetate giving a polymer with properties more like those of a rubber than a thermoplastic.

5. Another way of modifying the properties of a polymer is to blend two or more polymers. Polystyrene (PS) has been mixed with rubbers to produce high impact polystyrene (HIPS). This overcomes the problem of brittleness that occurs with polystyrene alone.

مختصر لما سبق ذكره

∴ The stiffness can be increased by replacing some of the hydrogen atoms by bulky atoms or groups of atoms, introducing side branches to the chain, replacing some of the carbon atoms by groups of atoms, or introducing cross-links between polymer chains.