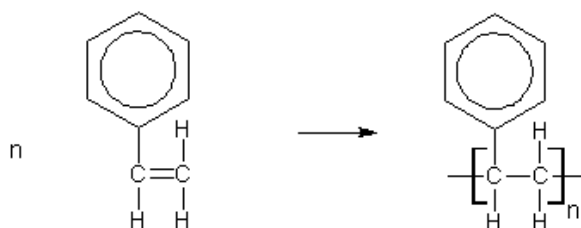


Topic 11 – Polymerisation Revision Notes

1) Addition polymers

- The monomer is an alkene which has a π bond
- The π bond breaks and is used to join many monomers into a long chain
- The polymer has single bonds along its backbone
- Addition polymers are not biodegradable
- The monomers come from crude oil which is a non-renewable resource

Example – poly(phenylethene), commonly called polystyrene, whose monomer is phenylethene

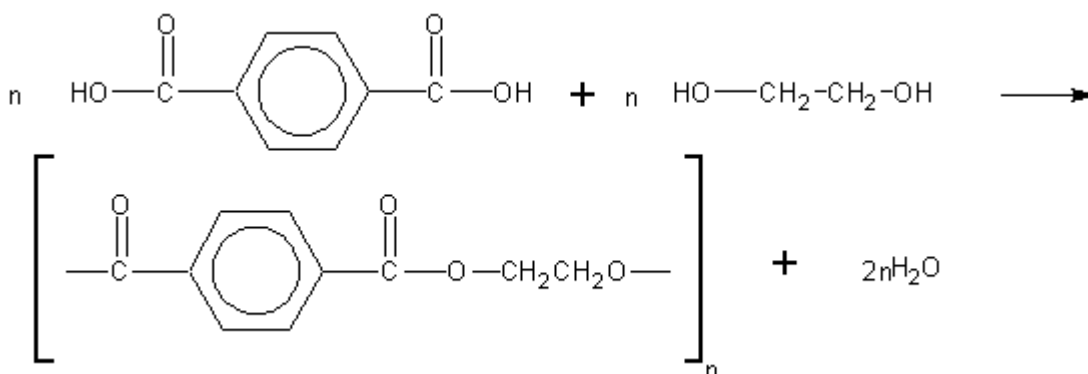


2) Condensation polymers

- The monomer has a functional group at each end
- The functional groups react to form a link; the reaction also produces a small molecule, such as water
- The links in condensation polymers (ester, amide and peptide) can be hydrolysed by heating with dilute acid or alkali

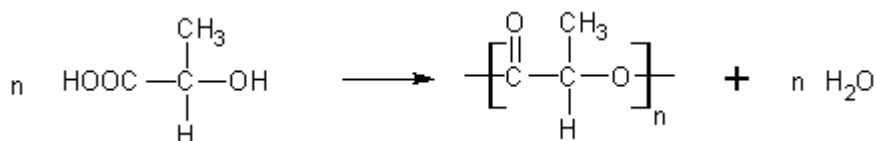
a) Polyesters

- The monomers are a di-carboxylic acid and a diol
- An ester link is formed between an acid group and an alcohol group with a water molecule eliminated
- **Example 1: Terylene** whose monomers are benzene-1,4-dicarboxylic acid and ethane-1,2-diol



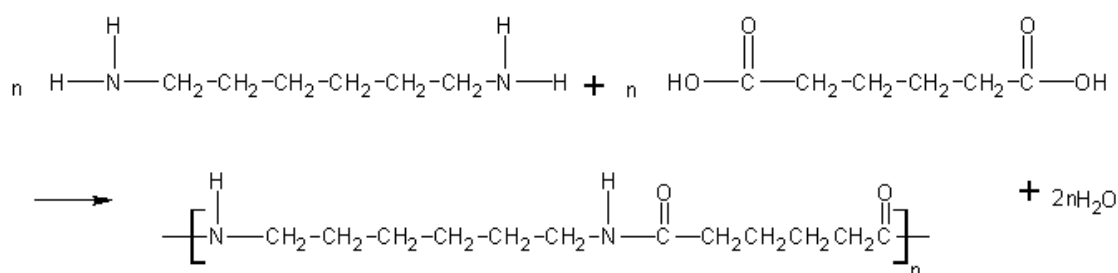
- Polyesters are used as fibres in clothing e.g. poly-cotton shirts

- **Example 2: Poly(lactic acid)** whose monomer is lactic acid (2-hydroxypropanoic acid)

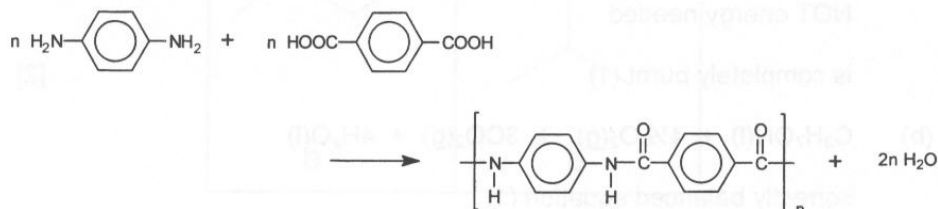


b) Polyamides

- The monomers are a di-carboxylic acid and a diamine
- An amide link is formed between an acid group and an amine group
- **Example 1: Nylon-6,6** whose monomers are hexane-1,6-dicarboxylic acid and 1,6-diaminohexane



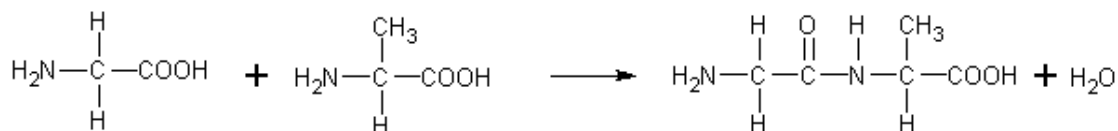
- **Example 2: Kevlar** whose monomers are benzene-1,4-dicarboxylic acid and benzene-1,4-diamine



- Polyamides are used as fibres in clothing e.g. Kevlar is used in bullet-proof vests and in extreme sports equipment
- Hydrogen bonds form between polyamide chains from the H in -NH to the O in C=O
- Polyamide chains are regular because they are made from one or two monomers
- Polyamides contain the same link as polypeptides/proteins but polyamides are synthetic (man-made) and polypeptides/proteins occur naturally

c) Polypeptides and proteins

- The monomers are amino acids
- A peptide link is formed between the acid group of one amino acid and the amine group of another amino acid e.g. glycine and alanine forming a dipeptide



- Hydrogen bonds form between polypeptide and protein chains from the H in -NH to the O in C=O
- Polypeptide and protein chains are irregular because they are made from many different monomers
- Polypeptides and proteins will have chiral centres (unless they are formed solely from glycine)

3) Going from polymer to monomer

- Identify the type of link. If there is no ester or amide link it's an addition polymer
- For a polyester, put in the -OH 's on the acid groups and the H's on the alcohol groups
- For a polyamide, put in the -OH 's on the acid groups and the H's on the amine groups
- For an addition polymer, identify the repeating unit and put in the double bond

4) Hydrolysis and degradable polymers

- Acid hydrolysis of a polyester produces an alcohol and a carboxylic acid
- Base hydrolysis of a polyester produces an alcohol and a carboxylate salt
- Acid hydrolysis of a polyamide produces an amine and a carboxylic acid
- Base hydrolysis of a polyamide produces an amine and a carboxylate salt
- Chemists have helped to minimise environmental waste by developing degradable polymers similar to poly(lactic acid). This can be used to make packaging, waste sacks, disposable eating utensils and internal stitches. All of these products will degrade over time
- Condensation polymers may be photodegradable as the C=O bond absorbs radiation
- Condensation polymers may be hydrolysed at the ester or amide link
- Another advantage of degradable polymers is that the monomer is made from renewable resources