Condensation Polymerisation

A-Level Chemistry ▪ Topic 35

A-Level Chemistry

What we will cover

1. Condensation polymerisation
2. Addition vs condensation
3. Finding the monomers
4. Degradable polymers

nylon, a polyamide

1 Condensation

Condensation polymerisation

polyester: -C(=O)-OH + H-O- → -C(=O)-O- + H_2O

polyamide: -C(=O)-OH + H-N(H)- → -C(=O)-NH- + H_2O

every new ester or amide link loses a small molecule (condensation)

In **condensation polymerisation** 缩合聚合, monomers join and a small molecule is lost. Each monomer needs two reactive groups.

- **polyester** 聚酯 – ester links (diol + diacid)
- **polyamide** 聚酰胺 – amide links (diamine + diacid)

Addition vs condensation

addition polymerisation
- monomer has a **C=C**
- the double bond opens and the monomers join
- **nothing else** is lost

e.g. ethene → poly(ethene)

condensation polymerisation
- each monomer has **two** functional groups
- a **small molecule** (H_2O or HCl) is lost
- ester or amide links form

e.g. a polyester or polyamide

- **addition** 加成聚合 – a C=C opens, nothing lost
- **condensation** 缩合聚合 – two-group monomers join, a small molecule lost

Finding the monomers

polyester (ester links)

$\cdots$–CO–O–R–O–CO–R′–CO–O–$\cdots$

↓ break each link; add back –OH and –H

HO–R–OH + HOOC–R′–COOH

diol dicarboxylic acid

The **repeat unit** 重复单元 contains parts of both monomers.

> To find the **monomers** 单体, break the chain at each ester or amide link and add back −OH and −H to the cut ends.

Degradable polymers

- **poly(alkene)s** 聚烯烃 are inert (strong non-polar bonds) – hard to **biodegrade** 生物降解
- polyesters & polyamides are biodegradable – their links **hydrolyse** 水解

2 Recap

Worked example – which polymerisation?

A polymer is made from 1,6-diaminohexane and hexanedioyl dichloride. Name the link and say why it is biodegradable.

- Each monomer has two functional groups, and a small molecule (HCl) is lost each time ⇒ condensation.
- NH_2 + COCl gives a −CONH− **amide link** 酰胺键 ⇒ a polyamide (nylon-6,6).
- Amide links are polar and can be hydrolysed by water, acid or enzymes.
- So the chain breaks back to monomers ⇒ biodegradable, unlike poly(alkene).

Two functional groups + a small molecule lost ⇒ condensation. Addition polymers (all C–C) resist hydrolysis; polyesters and polyamides do not.

Topic 35 – key takeaways

1. **Condensation** — two-group monomers; a small molecule lost
2. **Links** — polyesters (ester) & polyamides (amide)
3. **Monomers** — break the links, add back −OH & −H
4. **Degradable** — condensation polymers hydrolyse & degrade

Check yourself

1. How many reactive groups does a condensation monomer need?
2. What link does a polyamide have?

3. What is lost in condensation but not addition?
4. Why do polyesters biodegrade?

Answers **1.** two **2.** an amide link **3.** a small molecule (water/HCl) **4.** their ester links hydrolyse