
Polymers in everyday things – contact lenses

(Background information)

Polymers are a part of everyday life and examples can be found almost anywhere. Many people think of polymers simply as plastics used for packaging, in household objects and for making fibres, but this is just the tip of the iceberg.

Polymers are used in all sorts of applications you might not have thought much about before, for example in modern contact lenses.

What is a contact lens?

A contact lens is a prescription medical device manufactured from high-grade plastic polymers. The contact lens rests on the front surface of the eye (the cornea) and works just like eyeglasses – it bends light rays so that images are properly focused on the retina (at the back of the eye).

Contact lenses can be worn by people with eye disorders as an alternative to glasses.

The history of contact lenses

The first contact lenses were made from glass shells filled with jelly. Early contact lenses were uncomfortable and often very unhealthy for the eye. Until 1930 there was no alternative to using glass for making contact lenses – no other suitable material was available.

In the 1930s suitable polymers were discovered and by 1950 the first polymer contact lenses were being made.

Research into new types of polymers has now provided three types of material that can be used to make different kinds of contact lenses. These are called hard (created in the early 1960s), soft (created in the early 1970s) and gas-permeable (created in the late 1970s) lenses.

What properties are desirable in polymers for contact lenses?

Polymers are the most suitable materials available now for contact lenses to be made from.

The properties of an ideal polymer for contact lenses include:

- Transparent
- Some flexibility
- Low density
- Tough
- Unreactive to chemicals on the eye surface
- Easy to manufacture
- Made from a raw material that is available in abundance
- Easy to mould
- Refractive index suitable for bending light rays
- Hydrophilic ('water-loving')
- Lets oxygen gas pass through to the eye surface
- Produces lenses that are easy to insert, remove, clean and store.

Scientists first developed materials that had some of these properties. Continual research work produced polymers that were more and more suited to the application.

What polymers are used to make contact lenses?

The first polymer contact lenses became commonly available in the early 1960s and were made from a polymer called poly(methylmethacrylate) (PMMA). Lenses made of PMMA are called hard lenses.

PMMA is still used in Plexiglas® and Lucite®, as well as for things like aquariums and ice hockey rink barriers.

PMMA lenses are hard, rigid and not very comfortable; it sometimes takes users many weeks to get used to them. The lenses do not allow oxygen to pass directly to the cornea, which can be damaging to the eye. Users have to put a wetting solution in their eyes before putting the lenses in. Hard lenses are not very popular anymore, even though they give good clarity of vision and are very durable – they can last for years.

The first soft contact lenses were introduced in 1971. These were made from a polymer called polyacrylamide. This polymer is different from PMMA because it contains nitrogen atoms in its structure (PMMA does not contain nitrogen). Polyacrylamide is similar to the polymers used to make acrylic fibres for fabrics. When the polyacrylamide chains are cross-linked, the material absorbs water. Substances such as this are called hydrophilic ('water-loving').

This property makes polyacrylamide a useful material for producing contact lenses. Between 38% and 79% of a soft contact lens is water. This water keeps the lens soft and flexible. However, the high water content also makes the lens more fragile and reduces clarity of vision.

Soft lenses are cheaper than hard lenses and this has added to their popularity. In fact, some soft lenses can be used for one day and then discarded.

In 1979, the first rigid gas-permeable lenses (also known as RGPs) became available. These lenses are made from a combination of PMMA, silicones and fluoropolymers. This combination allows oxygen to pass directly through the lens to the eye, which makes the lens more comfortable for the wearer. It may only take three hours to get used to wearing this kind of lens. The rigidity of RGPs can also make vision clearer than with soft lenses. RGPs are better suited to correcting astigmatism and for bifocal needs than the other kinds of lenses. The disadvantages of RGPs include their high cost and some inflexibility in the lens.

The future of contact lenses

People are now starting to buy contact lenses for fun, choosing coloured or designer contact lenses. As contact lenses become more popular, the companies that make them will be able to spend more money on research into the different types of materials that could be used to make better or cheaper lenses in the future.

Polymers in everyday things – contact lenses

1. Suggest why people may wish to wear contact lenses instead of glasses.

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2. Suggest why some people who wear glasses do not wish to wear contact lenses.

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3. Write down two properties of glass that made it suitable for use in the contact lenses made before 1950.

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4. Suggest why research scientists looked for alternative materials to glass for use in contact lenses.

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5. Why could polymers not be used in contact lenses before 1930?

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6. Explain the meaning of the word 'transparent.'

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7. Suggest why the ideal material for a contact lens should:

a. Have a low density

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b. Be unreactive

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c. Be easy to manufacture.

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8. What is the name of the monomer that polymerises to form poly(methylmethacrylate)?

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9. PMMA is still used for aquariums but not in contact lenses. Explain these facts.

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10. Users of PMMA contact lenses had to apply a wetting solution to their eyes before putting the lenses in. Why is this not necessary with polyacrylamide lenses?

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11. How does cross-linking affect the properties of polyacrylamide?

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12. Why is the absorption of water by the material used to make contact lenses an advantage for the users of the lenses?

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13. What type of contact lens is made from PMMA only?

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14. What halogen element is found in fluoropolymers?

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15. Which element of Group 4 of the Periodic Table is found in silicones?

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16. Each of the three types of polymer used in contact lenses has advantages and disadvantages. Copy and complete the table below to summarise these strengths and weaknesses. Give as many points as you can for each kind of lens.

	Advantages	Disadvantages
Soft lenses (polyacrylamide)		
Hard lenses (PMMA)		
Rigid gas-permeable lenses		

17. Continued research into materials by chemists and materials scientists is important. Name two other areas, in addition to contact lenses, where this is important.

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