AQA GCSE

Design and Technology 8552

Modern materials

Unit 2
Energy, materials, systems and devices

PG ONLINE

3

Objectives

- Be able to recognise a range of modern materials
- Describe developments made through the invention of new or improved processes involving modern materials
- Explain how modern materials can be used to alter functionality

Modern materials

- New and improved materials are constantly being discovered and developed
- Modern materials can help to solve:
  - design issues
  - technical constraints
  - environmental issues
- Which non-stick modern material is used to coat some kitchen equipment?

What is a modern material?

- Modern materials are new inventions or one that has been relatively recently discovered
- A material or element may also be used or combined in a way that is different from its normal function
  - It might be blended, coated, alloyed or treated to improve its functional or aesthetic properties
  - Which modern security features do many new bank notes have?

Biodegradable polymers

- Biodegradable polymers are made from vegetable starches, often corn-starch
- Common varieties include:
  - Polylactic acid (PLA) commonly used in 3D printing filament
  - Polyhydroxybutyrate (PHB) under the trade name Biopol™
  - Polycaprolactone (PCL) known as Polymorph
- Why might some biodegradable polymers struggle to decompose in a landfill site?

Did you know…?

- The Saltwater Brewery (Florida USA) used wheat and barley remnants from brewing their beer to make 100% biodegradable, compostable and edible six-pack rings
  - Discuss which other commonly thrown away plastic products could benefit from being made from such a modern material

Polymorph and Coolmorph™

- Polycaprolactone (PCL) is a low temperature, hand-mouldable polymer
- Polymorph fuses at 62°C, although Coolmorph™ bonds together at just 42°C making it easier to use
  - They are both biodegradable, non-toxic and can be coloured
  - They are ideal for modelling as they can be shaped using only hand pressure
  - They can be reused and remoulded multiple times
- How could PCL be used to make repairs to household items?

Flexible MDF

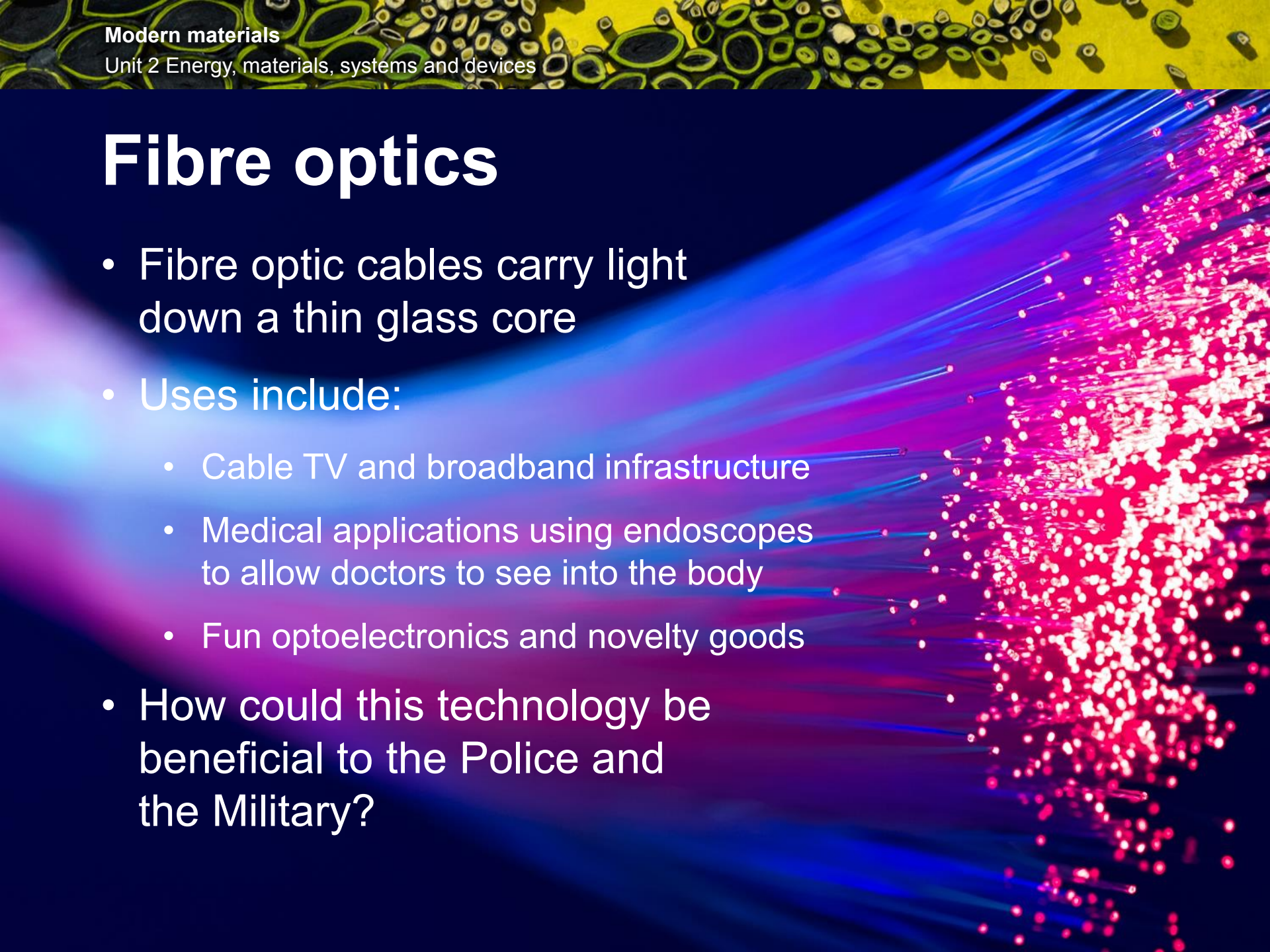
- Flexible MDF allows for the creation of natural curves
- It is commonly used in the design of shop fittings and bespoke commercial projects
  - Routed or machined grooves enable the material to bend
  - Name an alternative flexible timber-based material?

Titanium

- Although a chemical element, titanium is commonly alloyed with other metals
  - It is relatively lightweight, tough and stiff with low density
  - It has excellent corrosion resistance making it very versatile
  - Titanium does not react with the human body, making it ideal for medical applications
- Where might a metal with these properties be useful?

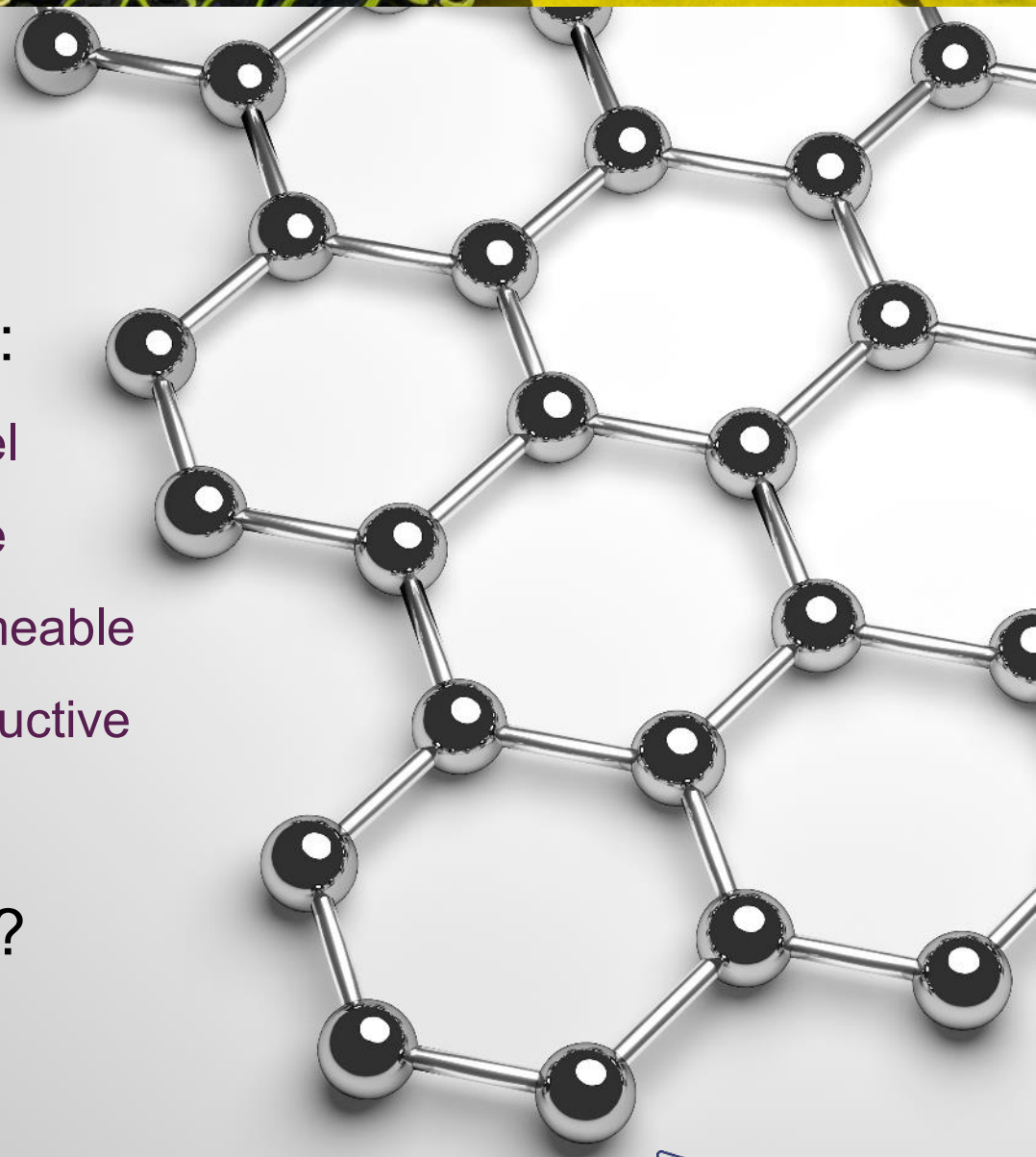
Fibre optics

- Fibre optic cables carry light down a thin glass core
- Uses include:
  - Cable TV and broadband infrastructure
  - Medical applications using endoscopes to allow doctors to see into the body
  - Fun optoelectronics and novelty goods
- How could this technology be beneficial to the Police and the Military?



How thin?

- Imagine a material one atom thick that is:
  - 200x tougher than steel
  - stretchable and flexible
  - transparent yet impermeable
  - highly electrically conductive
- What could this be?
- How might it be used?



Graphene

- Graphene was accidentally discovered in 2004
  - Research into the uses of graphene is currently active in many areas including: flexible electronics, biomedicine, energy storage and composite materials
  - Scientists are very optimistic about its future applications

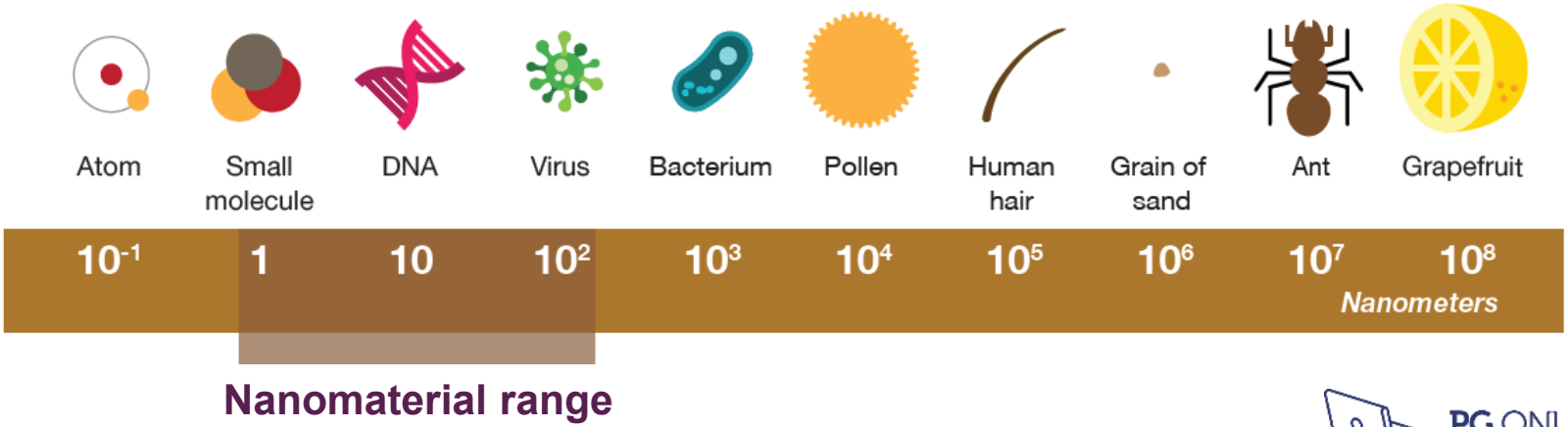
- How could flexible electronics benefit the consumer?
- How could lighter and tougher materials assist the elderly or disabled?

Liquid Crystal Display (LCD)

- LCDs come in monochrome and full colour versions
  - Screens can be very small and lightweight
  - Bespoke monochrome layouts can be achieved
  - They have very low power consumption
  - LCDs do not emit light, so they require back lighting
  - Colour versions use pixels
- Where might you find LCDs in use?

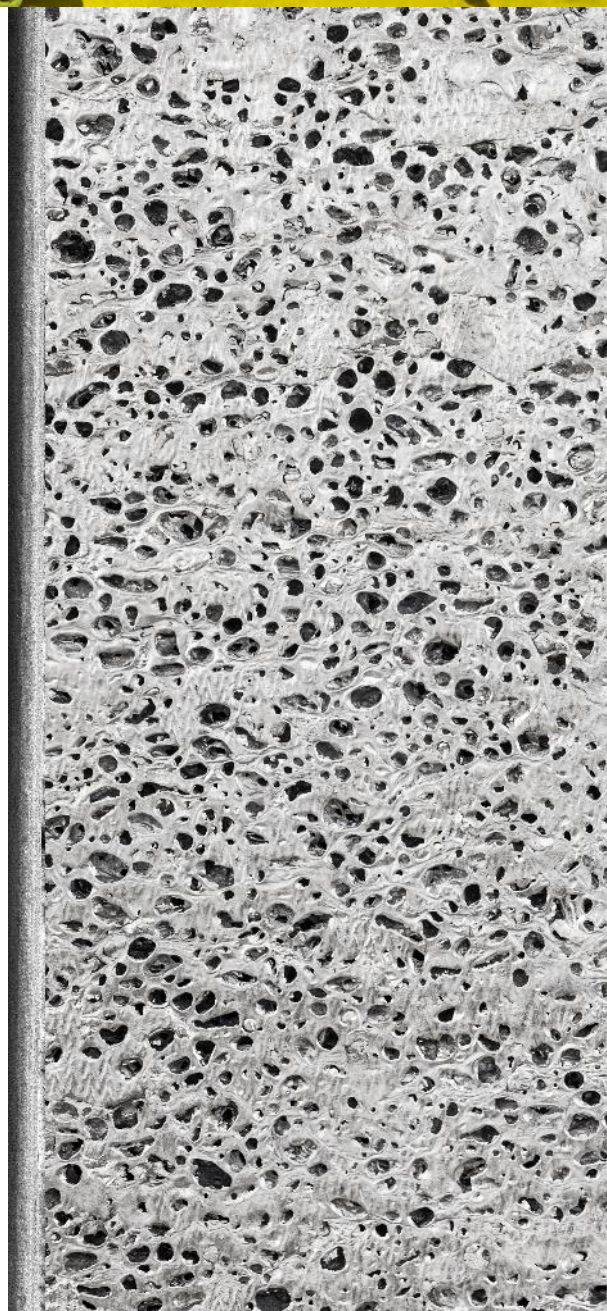
Nanomaterials

- Exactly how small are nanomaterials?
  - From the chart below, you can see a grain of sand is roughly one million times larger than a nanometre
  - Nanomaterials range from 1 to 1000 nanometres
- Nanomaterials benefit from their scale and increased surface area, but what do they actually do?



Metal foam

- Metal foams are very lightweight compared to solid metals
  - As little as 25% of the mass of the solid metal is used
  - The air pockets are made by injecting gas into liquid aluminium or titanium
  - They are 100% recyclable
- How might metal foams be beneficial to the aircraft and automotive industries?



Worksheet 3

- Complete the worksheet

Plenary

- Name **two** modern materials that can be shaped using heat
- Which modern materials are currently in a very early stage of development?
- Explain how biodegradable polymers reduce the amount of fossil fuel used in plastic manufacturing
- Which modern materials can be used to improve strength-to-weight ratios and performance in the automotive industry?

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