

HACKTEX VIRTUAL TRAINING MATERIALS

ADVANCED TEXTILES MANUFACTURING INDUSTRY

Learning unit 2: Raw materials and products for functional and smart textiles

Lesson 1

Raw materials for functional (passive) textiles

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RAW MATERIALS FOR FUNCTIONAL (PASSIVE) TEXTILES

LU2.1



Contents

- Electrically conductive materials for textile applications
 - Conductive fibres
 - Conductive coatings, printing pastes and inks
- Light conductive fibres
 - Optical fibers
- Photocatalytic materials

ELECTRICALLY CONDUCTIVE MATERIALS FOR TEXTILE APPLICATIONS



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CONDUCTIVE FIBRES



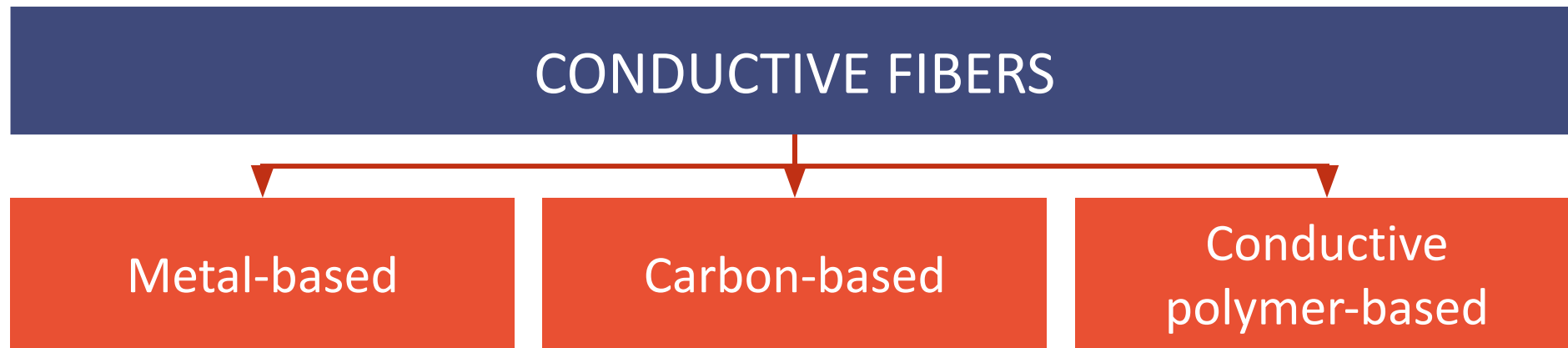
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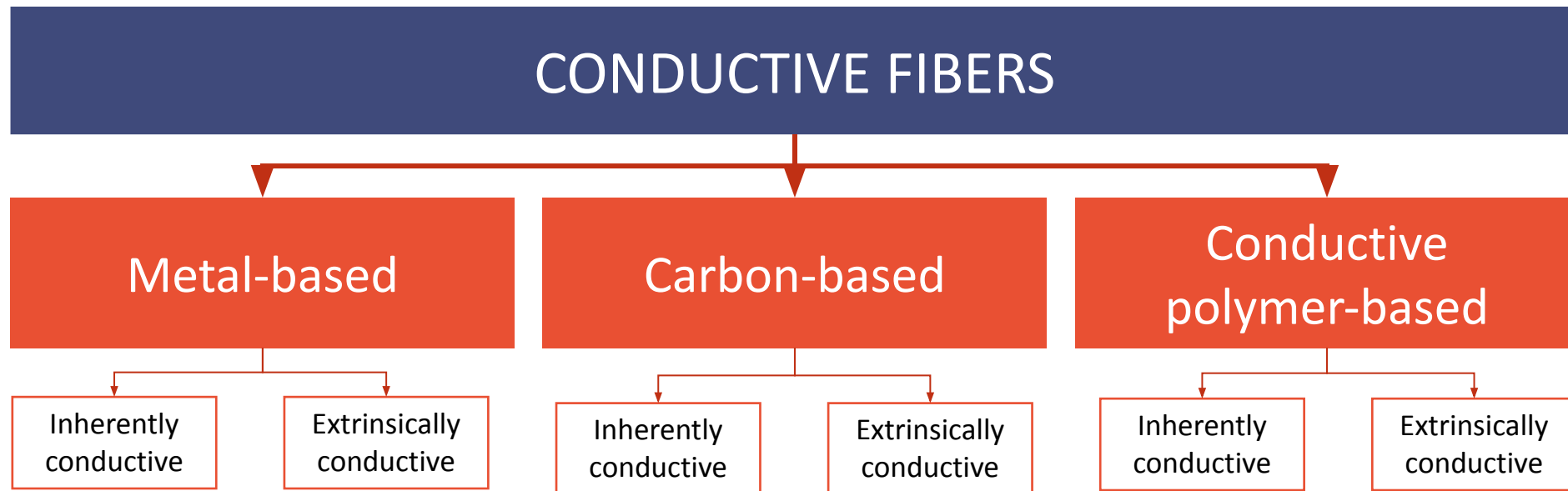
Classification of conductive fibres

CONDUCTIVE FIBERS

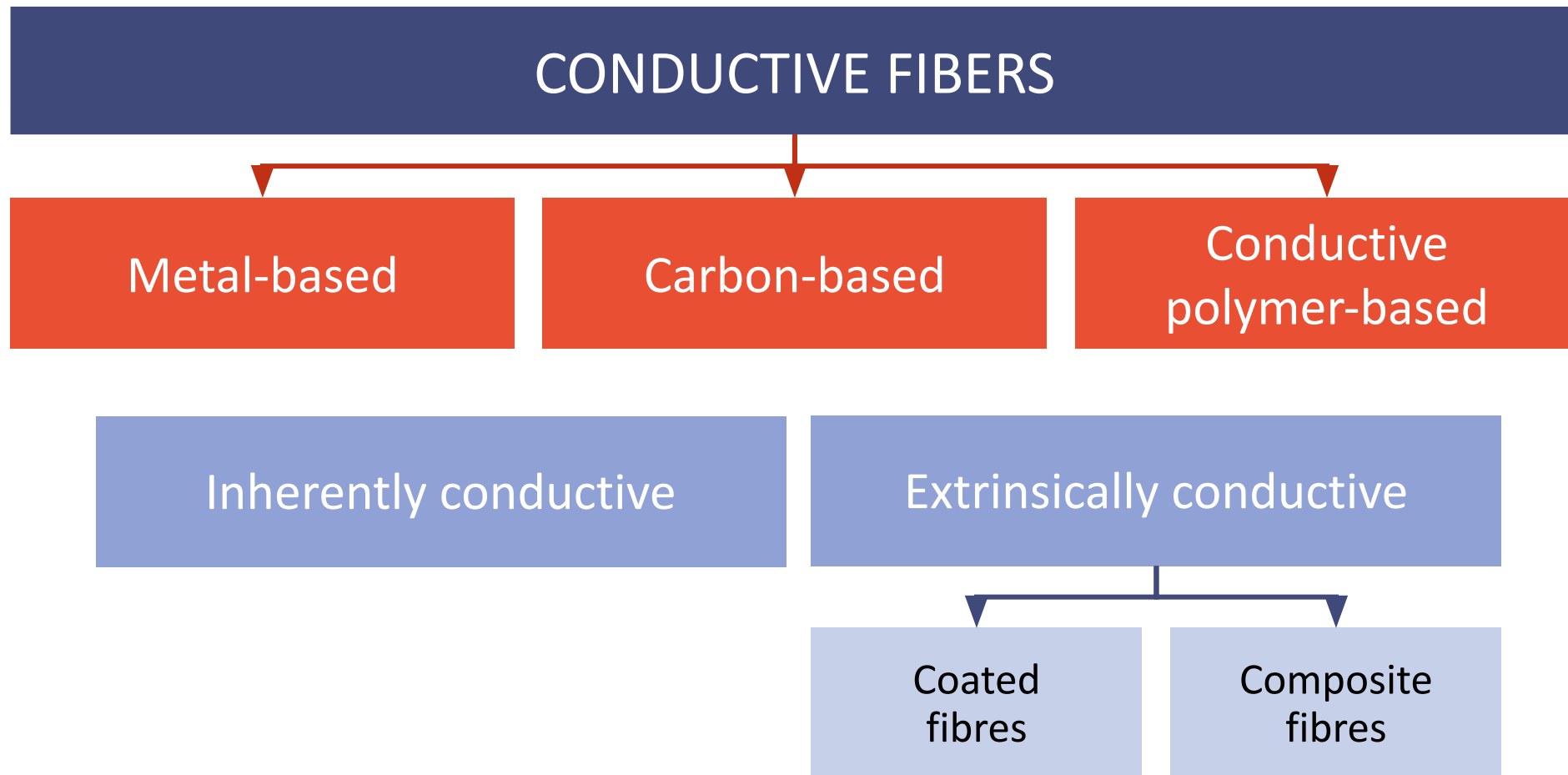
Classification of conductive fibres



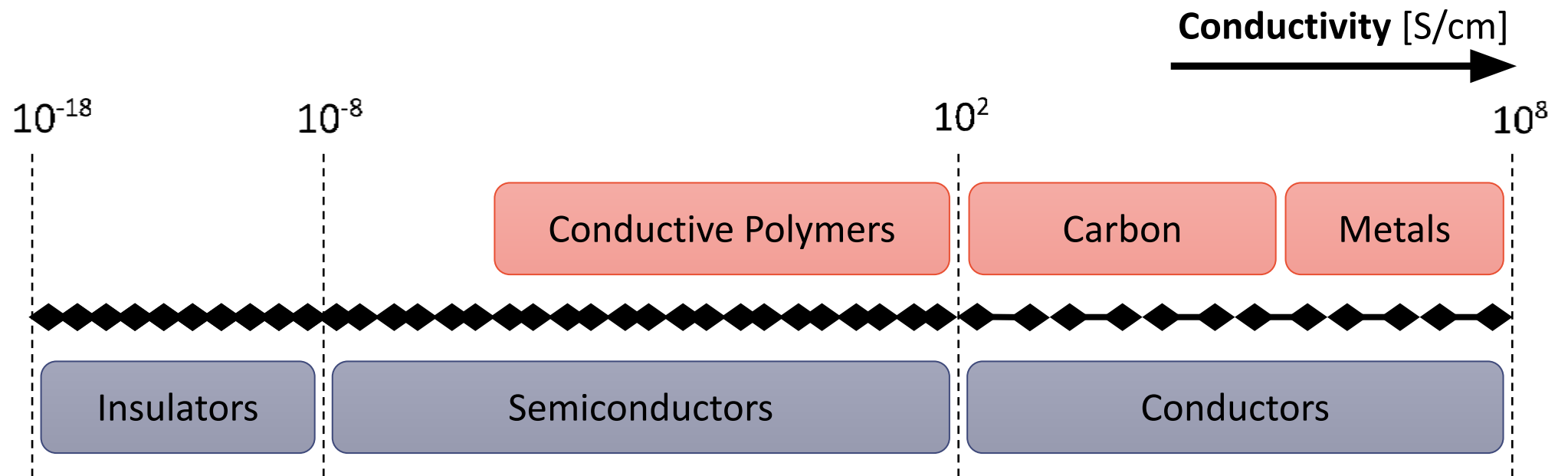
Classification of conductive fibres



Classification of conductive fibres



Conductivity



Metal-based fibres

Intrinsically conductive

Extrinsically conductive

Metal-based fibres

Intrinsically conductive

Metallic fibres

- **Stainless steel fibres**
 - $\sim 10^6$ S/cm
 - 7.9 g/cm³
 - T_m : 1380 °C
 - 8 μ m - 22 μ m

Extrinsically conductive

Metal-based fibres

Intrinsically conductive

Metallic fibres

- **Stainless steel fibres**
 - $\sim 10^6$ S/cm
 - 7.9 g/cm³
 - T_m : 1380 °C
 - 8 μ m - 22 μ m

Extrinsically conductive

Metal coatings

Cu, Ag, Ni, Al, Au, Mg, Ti

- **Silver coated fibres**
 - Polyamide-based
 - Antibacterial properties
 - $\sim 10^3$ S/cm

Metal salts coating

Copper sulphide (Cu₂S)

- **Copper sulphide coated fibres**
 - Polyamide-based or polyester-based
 - $\sim 10^5$ S/cm

Carbon-based fibres

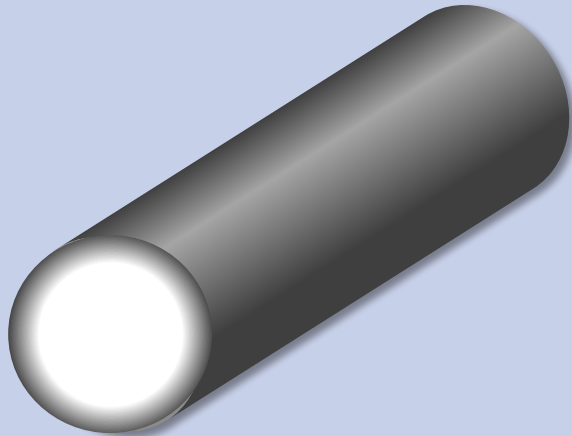
Coated fibres

Composite fibres

Carbon-based fibres

Coated fibres

- PES or PA **coated** with carbon particles

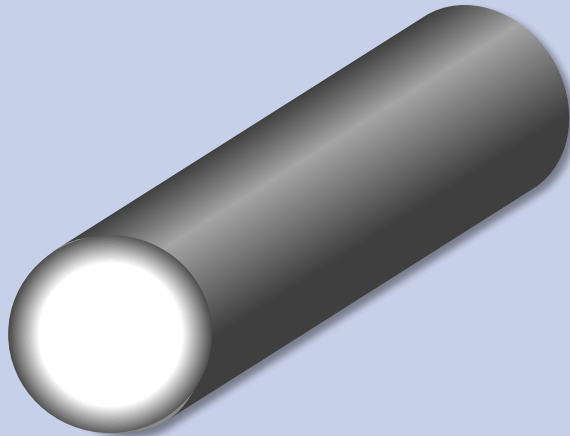


Composite fibres

Carbon-based fibres

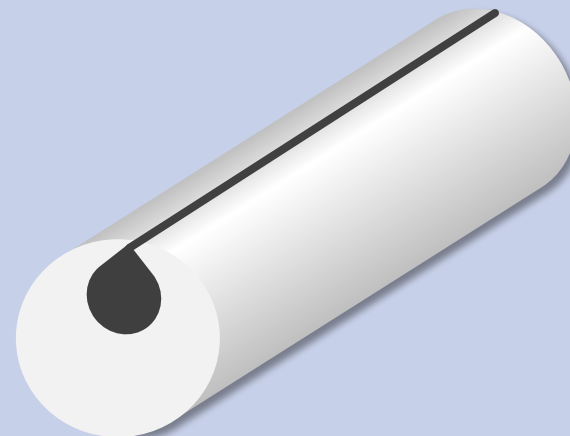
Coated fibres

- PES or PA **coated** with carbon particles



Composite fibres

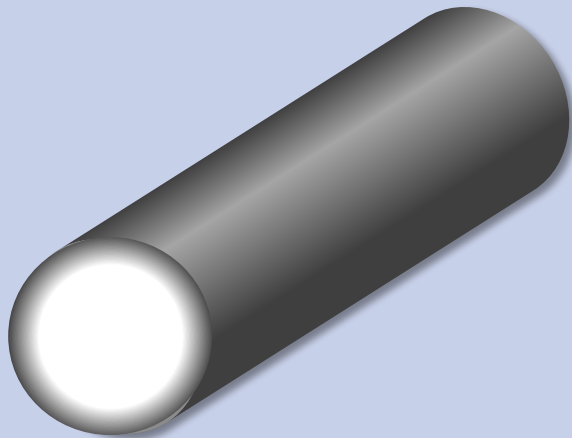
- PES or PA **mixed** with carbon particles



Carbon-based fibres

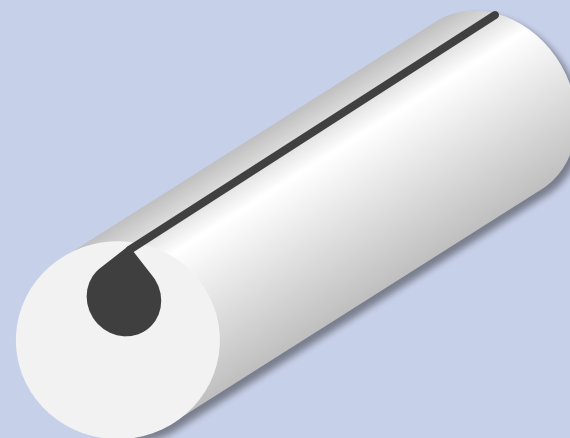
Coated fibres

- PES or PA **coated** with carbon particles



Composite fibres

- PES or PA **mixed** with carbon particles

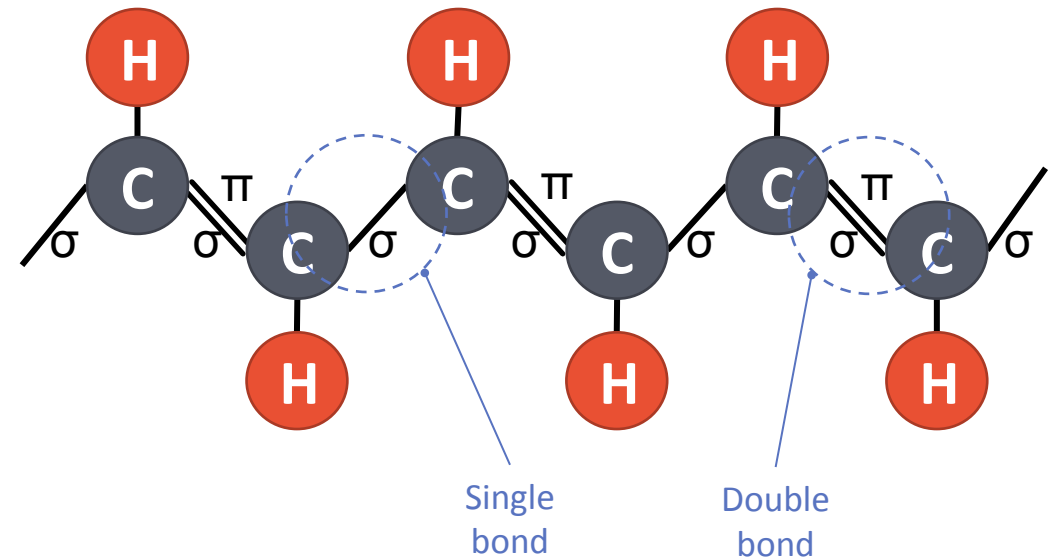


Carbon particles such as: carbon black (CA), carbon nanotubes (CNTs), graphene (G) or reduced graphene oxide (rGO), etc.

Conductive polymer-based fibres

Intrinsically conductive polymers (ICPs)

- Conjugated polymers properly oxidized or reduced with dopants
- 10^{-10} to 10^5 S/cm
 - PANI \square 30-200 S/cm
 - PPy \square 10^3 S/cm
 - PEDOT \square 0.4-400 S/cm
- Problem: poor mechanical properties



π -bond: eases electrons delocalisation
 σ -bond: ensures chain strength

CONDUCTIVE COATINGS, PRINTING PASTES AND INKS



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Conductive coatings & printing pastes

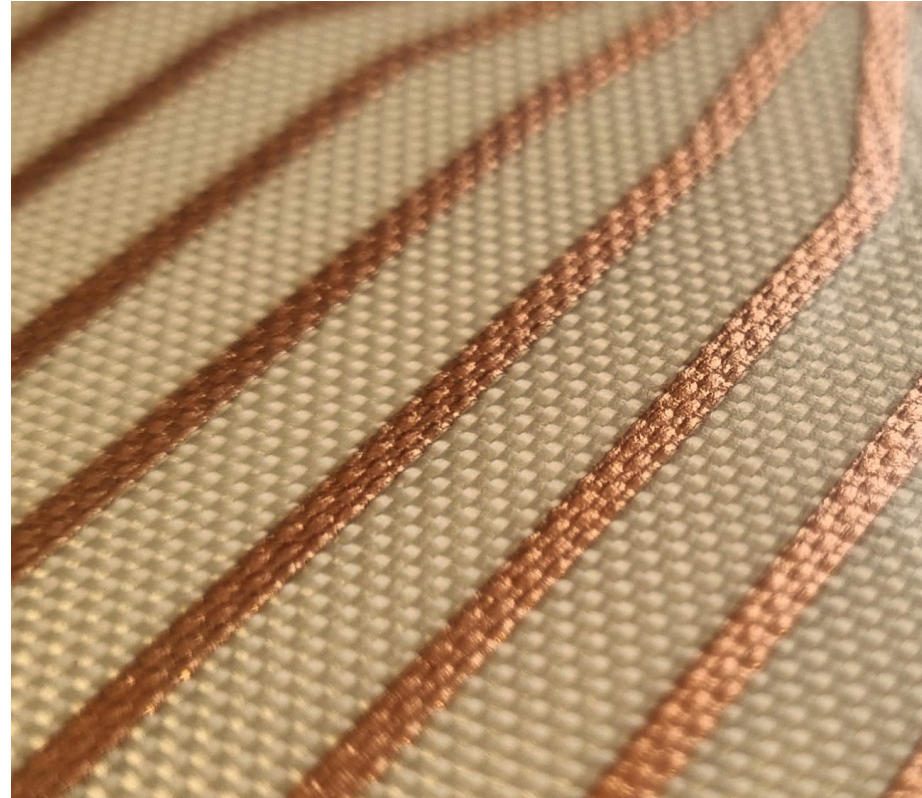
- Dispersion, in an organic or inorganic **solvent**, of:
 - **highly conductive particles** (such as carbon, silver, copper, graphene, etc.)
 - **binders**
- High viscosity
- Applied mainly by *screen-printing*



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Conductive inks

- Similar to printing pastes (solvent with conductive particles and binders)
- Low viscosity
- Applied by *inkjet-printing*



LIGHT CONDUCTIVE FIBRES

OPTICAL FIBRES

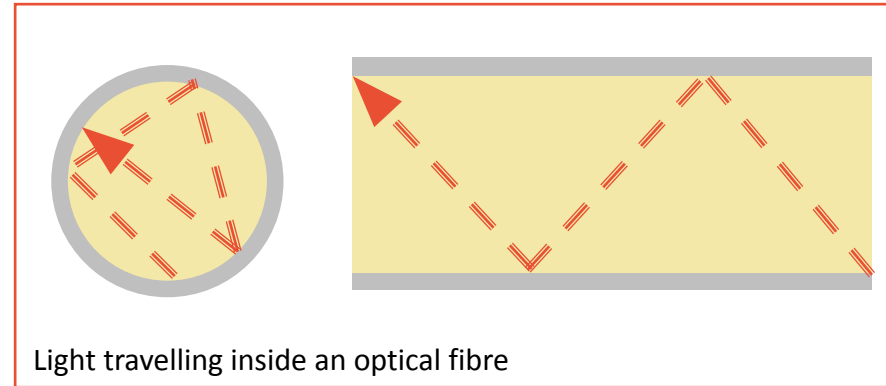


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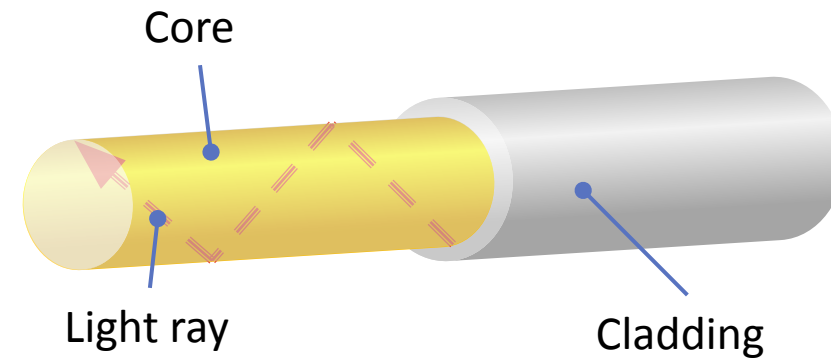
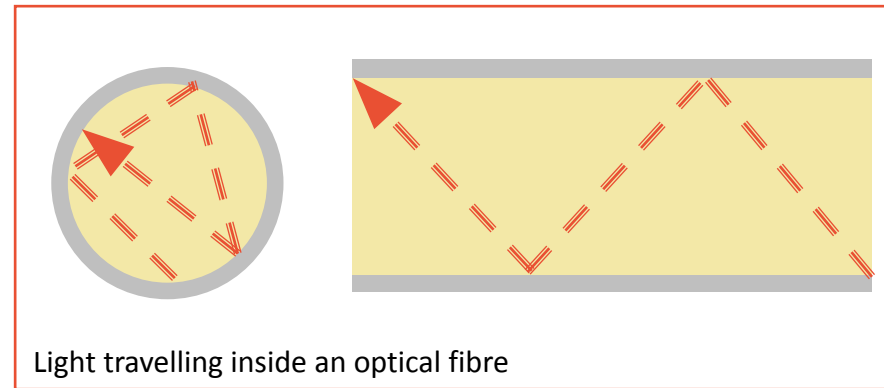
Optical fibres

- Used to transmit light and light signals over long distances
- Working principle: **total internal reflection (TIR)**



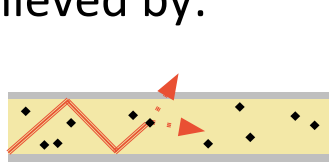
Optical fibres

- Used to transmit light and light signals over long distances
- Working principle: **total internal reflection (TIR)**
- Optical fibres consist of a:
 - Core
 - Cladding
 - Protective coating (sometimes)
- Typically made of glass, or **PMMA**, PC or PS

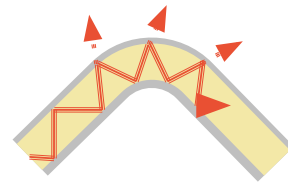


Optical fibres

- Light leakage generates a sidelight emission.
- Based on changing the angle of the internal reflection.
- Achieved by:



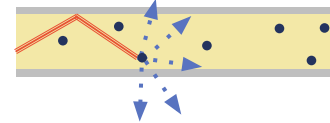
**Dopants addition
(bulk scattering)**



Bending



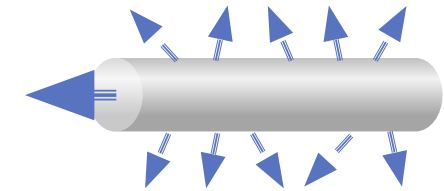
**Surface
damaging**



**Addition of
luminescent particles**



Standard optical fibre



Side-emitting optical fibre

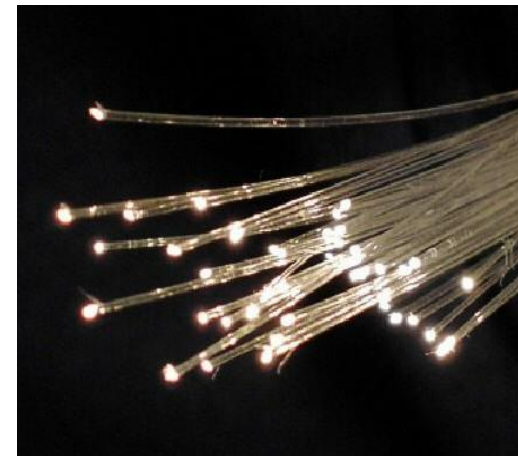


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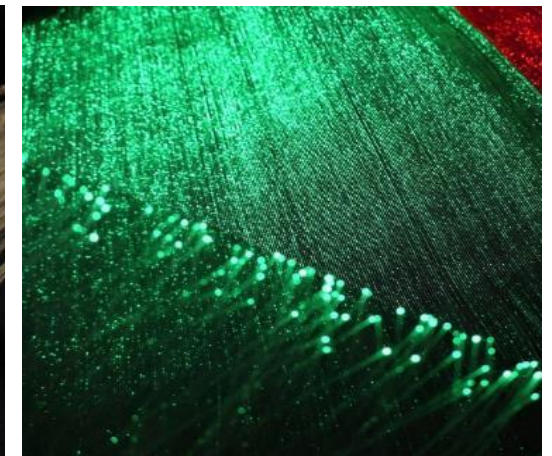


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Optical fibres

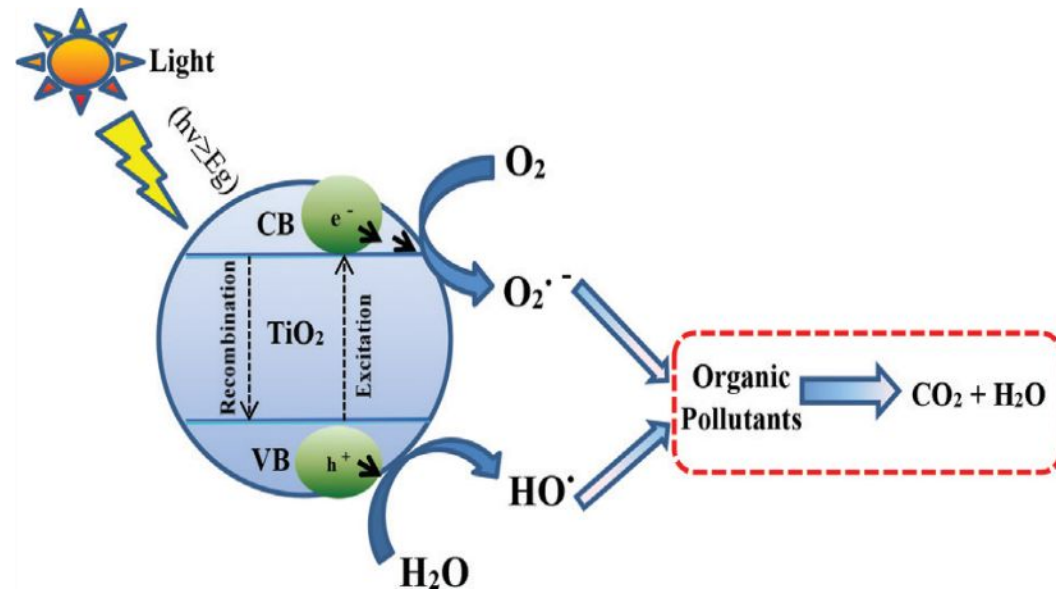
Applications of optical fibres in the smart textile field:

- *Lighting*: to create smart lighting in textiles, transmitting light to different parts of the fabric and creating a variety of lighting effects.
- *Sensing*: when the fiber is subjected to a change in the environment, the light signal transmitted through the fibre is altered and this can be detected to monitor changes in temperature, pressure, or other physical properties.
- *Data transmission*: to transmit data between textiles, such as in a network of wearable devices.

PHOTOCATALYTIC MATERIALS

Photocatalytic materials

- Cause photochemical reaction **induced by light**
- Applications on:
 - photodecomposition of hydrogen
 - self-cleaning
- TiO_2 , ZnO usually doped with other metals (Ag, Au, Pt)



By EMY MARLINA SAMSUDIN, SZE NEE GOH, TA YEONG WU, TAN TONG LING, SHARIFAH BEE ABD. HAMID & JOON CHING JUAN - Evaluation on the Photocatalytic Degradation Activity of Reactive Blue 4 using Pure Anatase Nano- TiO_2 , CC BY 4.0, <https://commons.wikimedia.org/w/index.php?curid=99563290>

Summary

In this lecture you have learned:

- The classification of electrically conductive fibres and the main characteristics of metal-, carbon- & polymer-based fibres, and conductive coatings, pastes & inks.
- About optical fibres, especially those based on polymers.
- The main photocatalytic materials used for textile finishing.

Partners:



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