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New Materials and New Applications

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Textile Centre of Excellence

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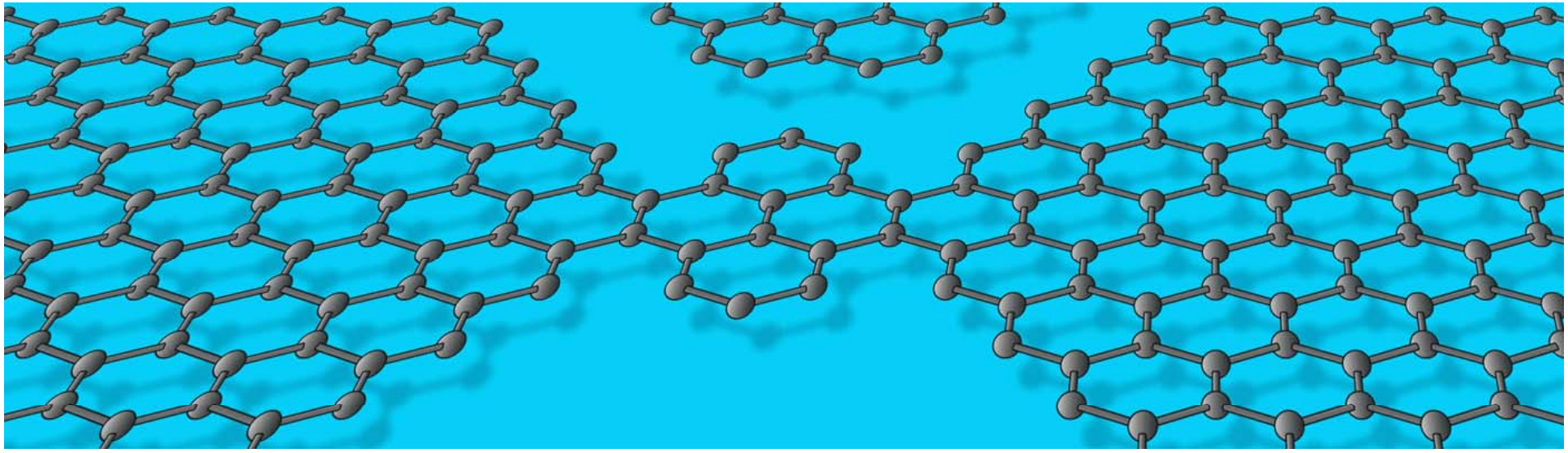
The Training Organisation for the Textile Industry of the UK

TCoE is an industry-owned, not for profit organisation created in 1976. TCoE supplies good quality apprenticeship training supported by funding agencies and government departments designed to meet the needs of the sector. TCoE also focuses on current and emerging needs of the industry as well as opportunities for the sector.

TCoE has 105 member companies who pay an annual fee for membership. The majority of the members are SMEs. Most of the companies are local textile manufacturers.

Graphene - The World's First 2D Material



Graphene

Many thanks to the University of Manchester and the National Graphene Institute UK for the information provided in this presentation.

About Graphene?

Graphene was first isolated at The University of Manchester in 2004 and boasts superlative properties of strength, conductivity and flexibility

To best utilise graphene's properties for a wide-ranging number of potential applications it can be produced and used in different forms

As a naturally occurring form of carbon, Graphene cannot be patented. However Graphene devices and processes can be protected by patents

What is Graphene?

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Graphene

A single-atom-thick sheet of hexagonally arranged, bonded carbon atoms, either freely suspended or adhered to a substrate. The dimensions of graphene can vary from several nanometers to the macroscale. Monolayer (single-layer) graphene is the purest form available and is useful for high-frequency electronics. Bi- and tri-layer graphene, two and three layers respectively, display a range of different qualities as the number of layers increase, as well as becoming progressively cheaper as the layers multiply.

What is Graphene?

Graphene Oxide (GO)

Chemically modified graphene prepared by oxidation and exfoliation. Graphene oxide is a monolayer material with a high oxygen content. Thin membranes that allow water to pass through but block off harmful gases are a major use for GO

Graphite Oxide

This precursor to GO is a bulk solid made by oxidation of graphite through processes that functionalise the basal planes and increase the interlayer spacing. Graphite oxide can be exfoliated in solution to form (monolayer) graphene oxide or partially exfoliated to form few-layer graphene oxide

What is Graphene?

Few-layer graphene (FLG) or multi-layer graphene (MLG)

A 2D, sheet-like material, either as a free-standing flake or substrate-bound coating, consisting of a small number (between two and about 10) of well-defined, countable, stacked graphene layers of extended lateral dimension. Individual flakes should still maintain a high aspect ratio. Few-layer graphene or graphene oxide dispersions can have a defined thickness distribution. MLG is useful for composite materials, and as a mechanical reinforcement

Reduced graphene oxide (rGO)

Graphene oxide (as above) that has been reductively processed by chemical, thermal, microwave, photo-chemical, photo-thermal or microbial/bacterial methods to reduce its oxygen content. Conductive inks are just one potential use for rGO

What is Graphene?

Graphite nanoplatelets; graphite nanosheets; graphite nanoflakes

2D graphite materials with a thickness and/or lateral dimension of less than 100 nanometres. The use of nanoscale terminology here can be used to help distinguish these new ultrathin forms from conventional finely milled graphite powders, whose thickness is typically more than 100 nanometres. Excellent for electrically conductive composites

What is Graphene?

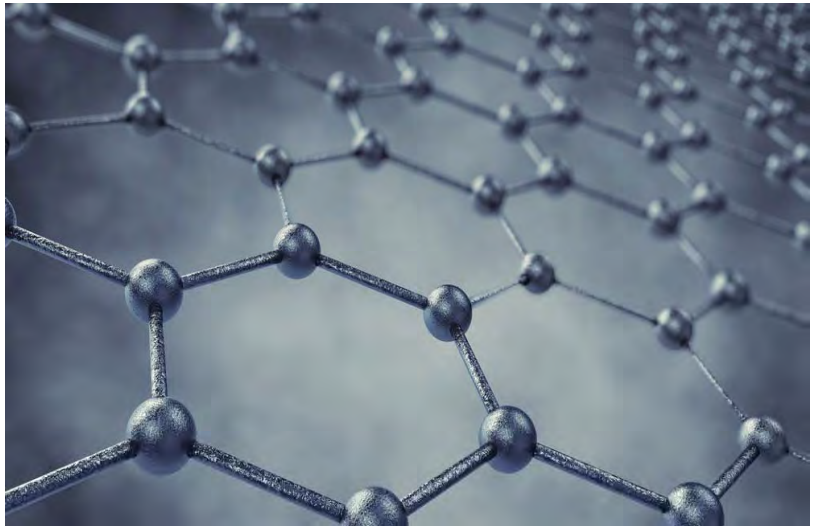
What does graphene look like?

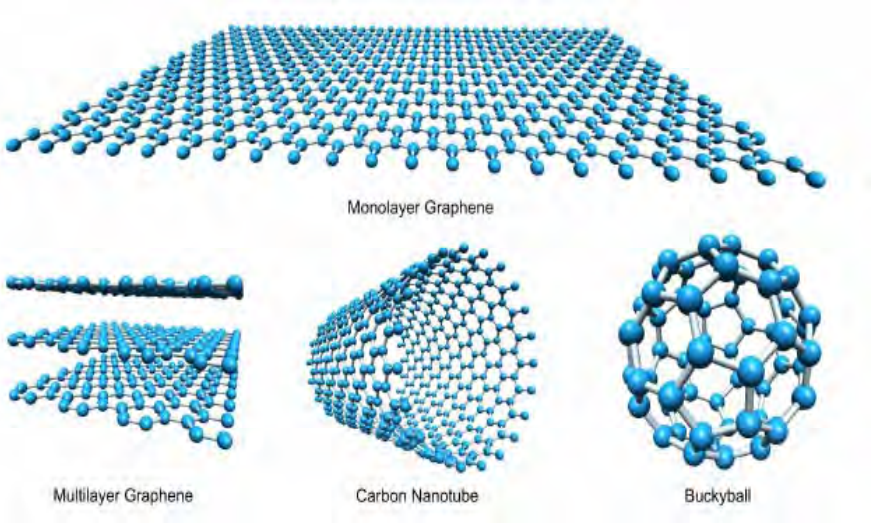
Graphene is made up of a hexagonal lattice of carbon atoms in a honeycomb like structure.

It is just one-atom thick but absorbs 2.3% of light so it can be seen with the naked eye.

It can potentially be used to create semi-transparent electronics

What is Graphene?





Uses for Graphene

The use of graphene to develop conductive fibres for smart textiles has been regarded as the “killer app” to commercialise graphene as well as wearable technology not only for healthcare and well being but also for the Internet of Things

Graphene modification of a textile surface could not only improve its flame-resistant qualities, but prevent the penetration of heat and gases, and the decomposition (burning) of the fabric. Graphene’s resistance to abrasion and rupture means that all of these qualities could be added to PPE textiles in one lightweight application

Properties of Graphene

It is ultra-light yet immensely tough

It is 200 times stronger than steel, but it is incredibly flexible

It is the thinnest material possible as well as being transparent

It is a superb conductor and can act as a perfect barrier - not even helium can pass through it

Combining all of graphene's amazing properties could create an impact of the scale last seen with the Industrial Revolution.

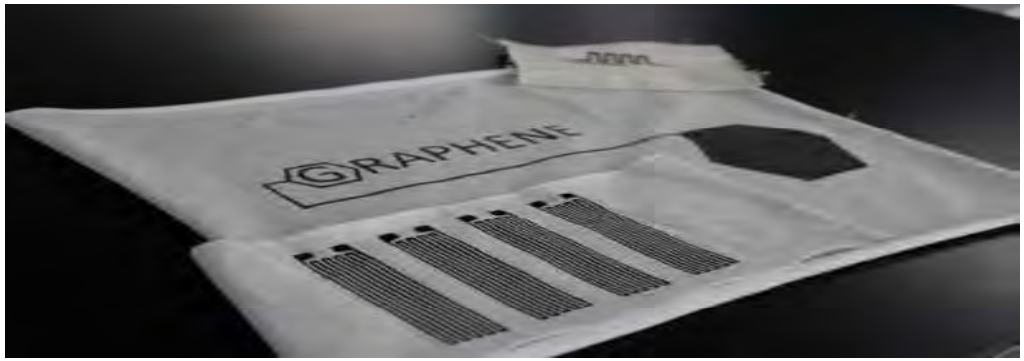
Transport, medicine, electronics, energy, defence, desalination; the range of industries where graphene research is making an impact is substantial.

This is only the start. These are only the first steps. The potential of graphene is limited only by our imagination.

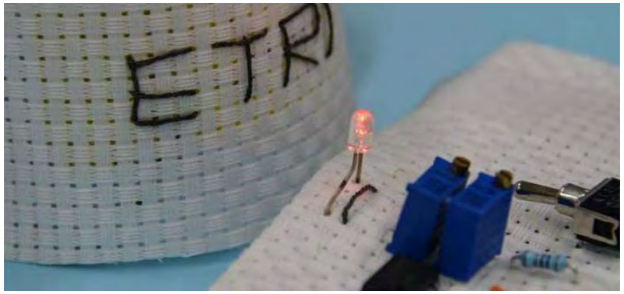
Could Graphene become the next ‘big thing’ for the Textile Industry?

Uses for Graphene

Printed Circuits for Smart Wearables by using Graphene flakes in ink



Korean scientists have created a new type of fabric that is coated in Graphene. The goal of this wearable fabric is to create a sensor system capable of detecting any noxious gases that are present in the air and alert the wearer



Uses for Graphene

A group of researchers based at the University of Manchester in the UK has developed flexible supercapacitors which can be printed on to textile substrates. The supercapacitors could be used to power electronics incorporated in such substrates.

Supercapacitors function in a similar way to batteries and can fully charge devices in very short periods of time.

The ink has excellent mechanical stability, is flexible, and is stable to washing.

It is thought that the supercapacitors could be printed on to fabric for use in the manufacture of:

- **health monitoring apparel;**
- **military gear; and**
- **sportswear which can monitor the performance of the wearer.**

The graphene-based ink is said to be more cost effective than inks which incorporate precious metals such as silver.

Also, it is said to be environmentally sustainable

Uses for Graphene

EUROJERSEY AND DIRECTA PLUS: PERFORMANCE FABRICS WHICH INCORPORATE GRAPHENE

Eurojersey—an Italy-based company which specialises in warp knitted fabrics—and Directa Plus, a UK-based provider of graphene-based treatments for consumer products, have collaborated in the development of new performance fabrics which incorporate graphene via a membrane known as Grafytherm.

Grafytherm membranes incorporate Directa Plus's G+ (Graphene Plus) graphene-based nanotechnology treatment. The membranes are made from either polyurethane (PU) or polytetrafluoroethylene (PTFE).

Grafytherm membranes provide fabrics to which they have been laminated with a number of performance properties, including bacteriostatic properties, antistatic properties and electrical conductivity. Furthermore, they help the wearer to maintain a comfortable body temperature as they facilitate the dissipation of heat in warm conditions and the homogenous distribution of heat in cold conditions.

Additional performance properties of the laminated fabrics include a high level of breathability, a high level of elasticity, resistance to pilling, resistance to shrinkage, waterproofness and windproofness.

Uses for Graphene

HOHENSTEIN INSTITUT FÜR TEXTILINNOVATION: COLLABORATIVE RESEARCH PROJECT TO APPLY GRAPHENE COATINGS TO TEXTILE SUBSTRATES

The project aims to identify how textile surfaces can be changed through the application of graphene coatings. In particular, it focuses on the development of graphene coated textiles for heat protective clothing.

Graphene is an excellent conductor of electricity and is impermeable to gases. Also, it is flexible, has very high tensile strength and is resistant to abrasion. By applying graphene to the surfaces of textiles, it is hoped that a new application area for graphene can be identified and that personal protective equipment (PPE) with excellent performance properties can be developed.

Uses for Graphene

Researchers have discovered that two layers of graphene stacked on top of one another can temporarily become as hard as diamond — and just as impenetrable — when struck by, say, a bullet.

Could Graphene be extruded as a bi-component fibre or be encapsulated and used as a filament yarn giving extra properties to fabrics or garments?

Could Graphene give additional properties to non-woven products or composite systems?

Are we on the cusp of a new Chapter in the Textile Industry Manual?

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Thank you!

Questions welcome

Project smedia