Versarien®

Delivering **next generation** advanced materials

Versarien®
Technologies

2-DTECH
Two dimensional materials

TOTALCARBIDE

Vision

Build a **high technology engineering** group specialising in **advanced materials**

- Working with **University** partners to **source and develop IP**
- Developing own IP around **applications**
- Growth through **acquisition**

Versarien developments

- Floatation on AIM - 13/06/13
  Raising £3m, Oversubscribed placing of £5.5m
- Total Carbide Acquisition
- 2-DTech Acquisition
- Joint venture
  DV Composite Tools
- Partnership with NGI

Acquisition - what do we look for?

- Income generating, patentable or patented technology
- Clearly defined commercialisation path
- Customer demand

Agenda - Our speakers for today

Graphene Update → **Dr. Aravind Vijayaraghavan**
University of Manchester

2-DTech Update → **Dr. Nigel Salter**
2-DTech

Questions & Answers

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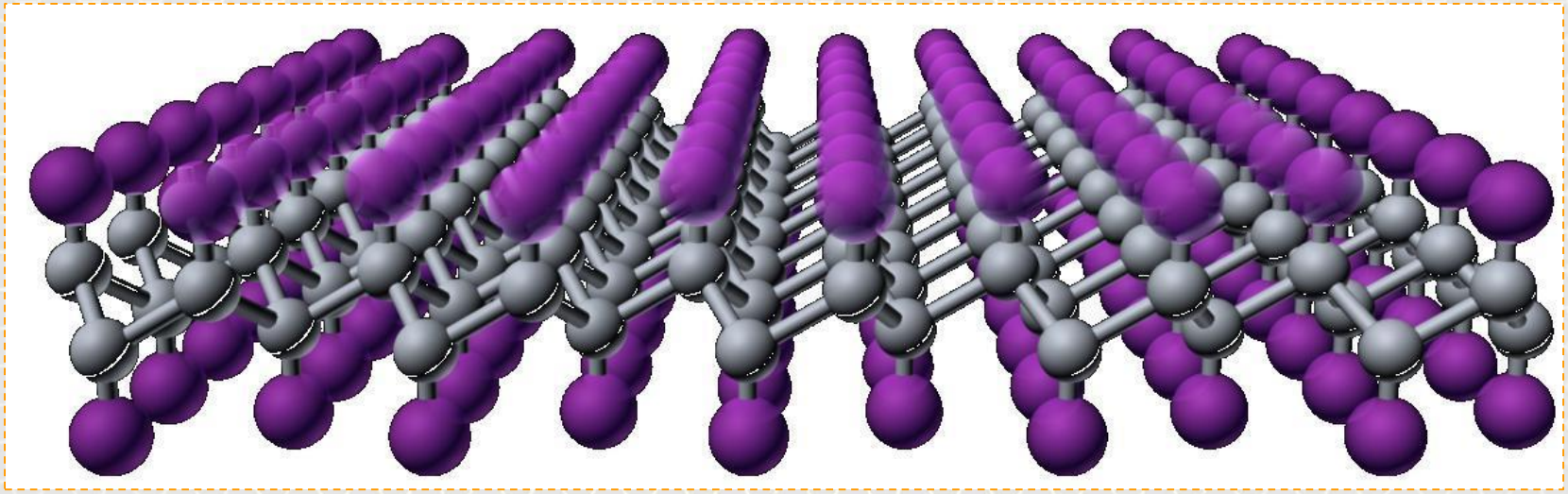
MANCHESTER 1824
The University of Manchester

2-DTECH
Two dimensional materials

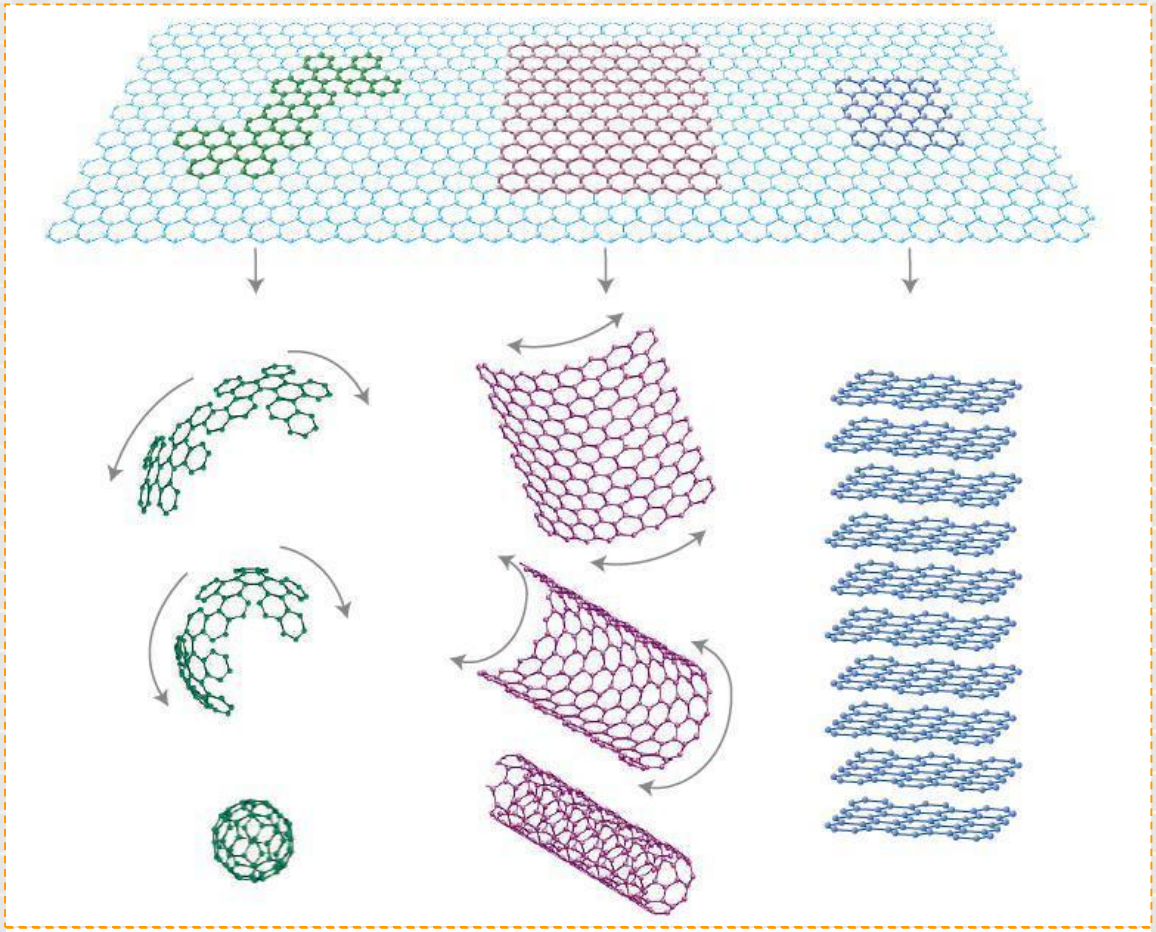
Graphene

Production, Properties and Applications



Dr. Aravind Vijayaraghavan
Lecturer in Nanomaterials
The University of Manchester

Graphene?



Buckyballs **Carbon Nanotubes** **Graphite**

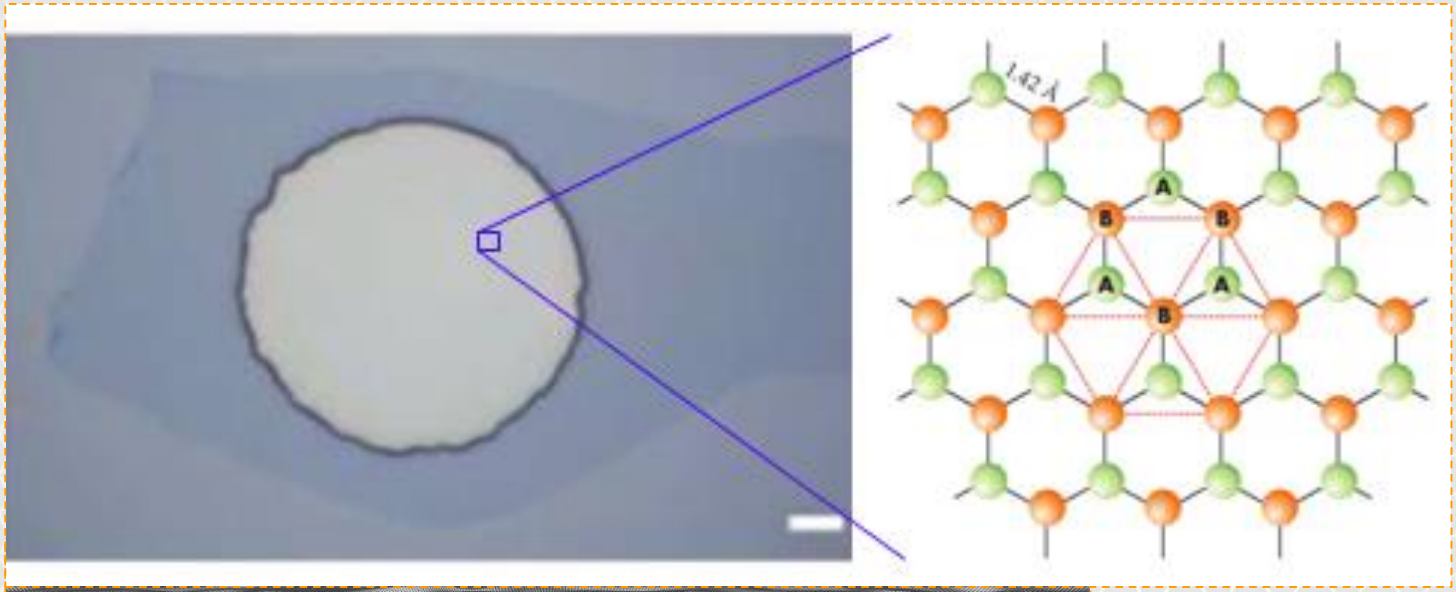
0D 1D 3D

Graphene is

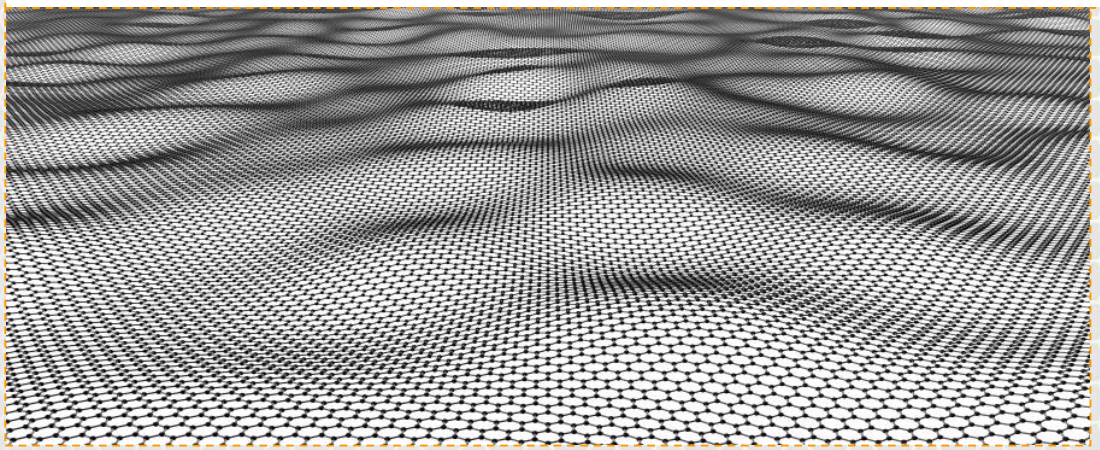
2Dimensional

A. K. Geim, K. S. Novoselov
Nat Mater ***2007,*** *6,* 183.

Atomic structure of **graphene**

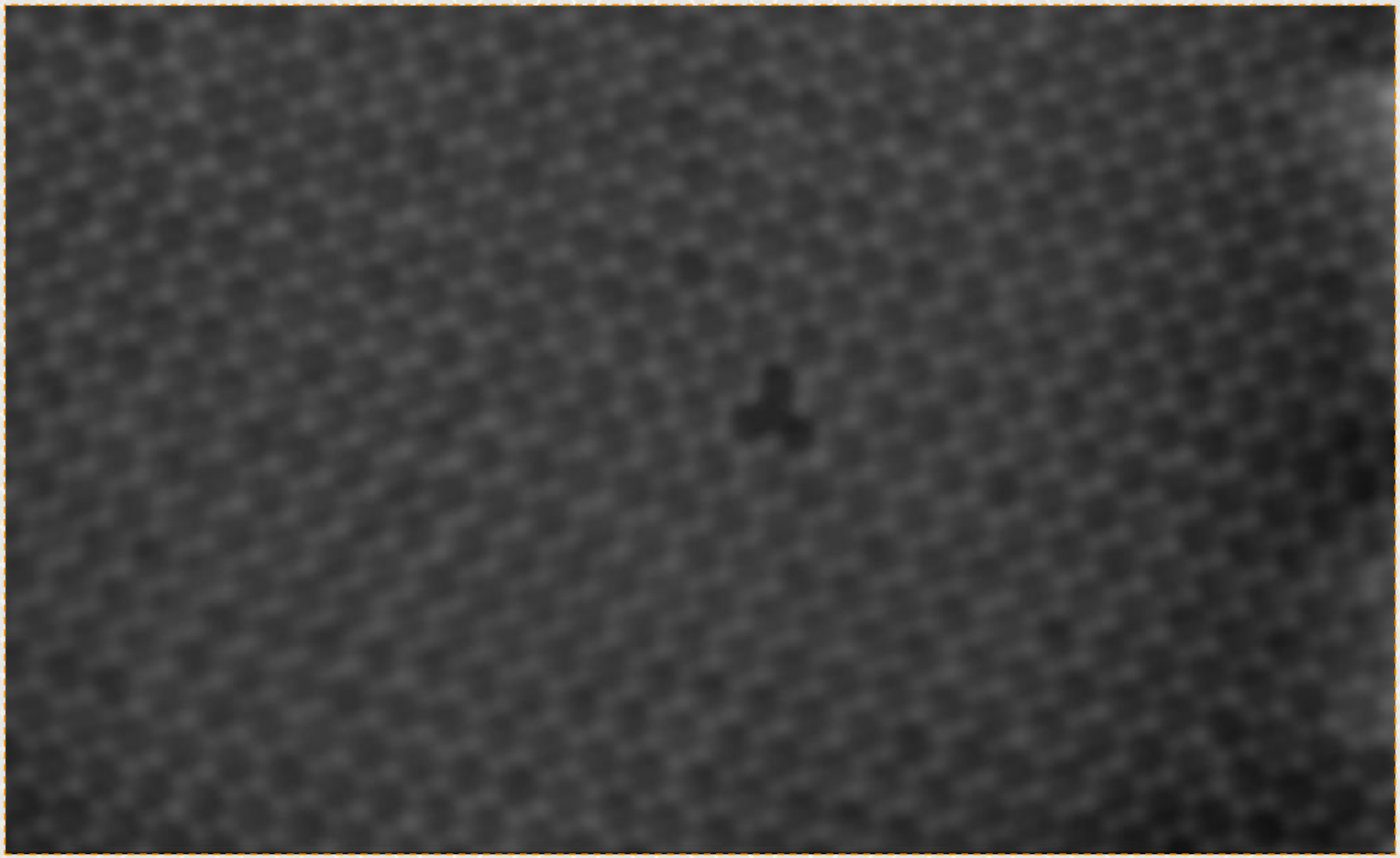


A. Geim, A. MacDonald
Physics Today ***2007,*** *60,* 35.



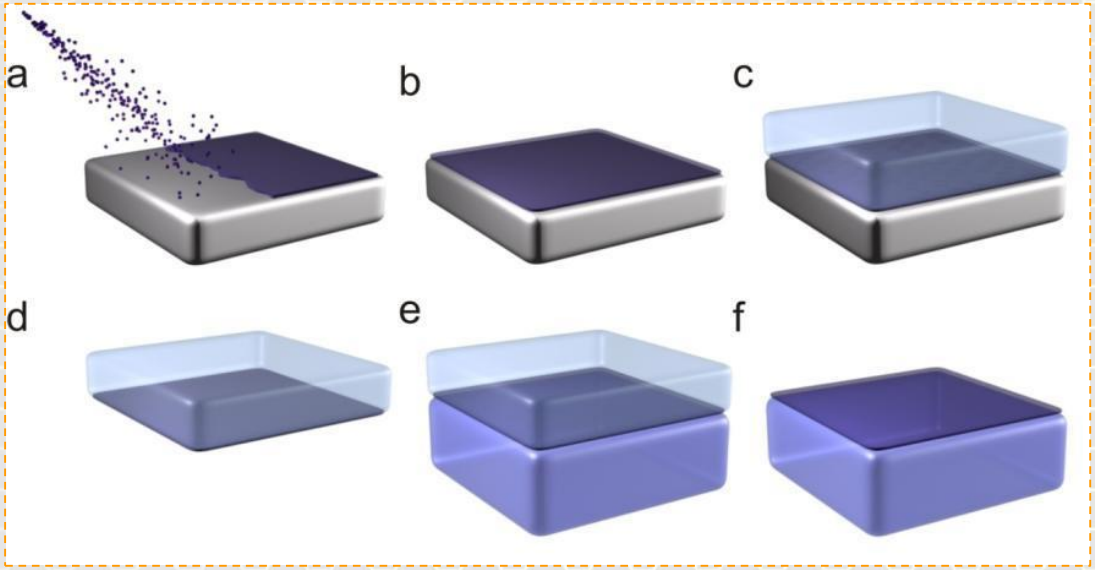
'Rippled graphene'
image courtesy J. Meyer

Transmission Electron Microscopy of **graphene**



How to make **graphene?**

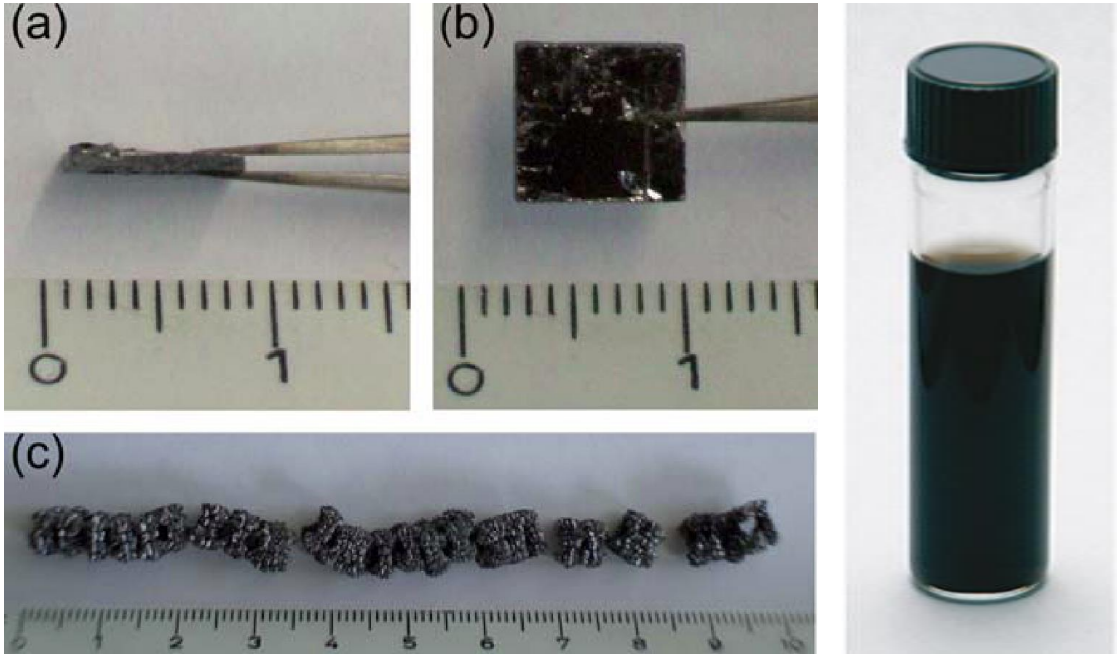
➔ Chemical Vapour deposition



- ➔ Carbon atoms are deposited on the surface of a metal
- ➔ At high temperature this forms graphene.
- ➔ A layer of polymer is deposited on top of the graphene.
- ➔ The polymer is removed and the graphene with it.
- ➔ The polymer is placed on a suitable substrate
- ➔ The polymer is dissolved away leaving the graphene behind.

How to make **graphene?**

➔ Solvent exfoliation… solutions of graphene



Malik. S;, et al., *Nanoscale* **2010**, 2, 2139.

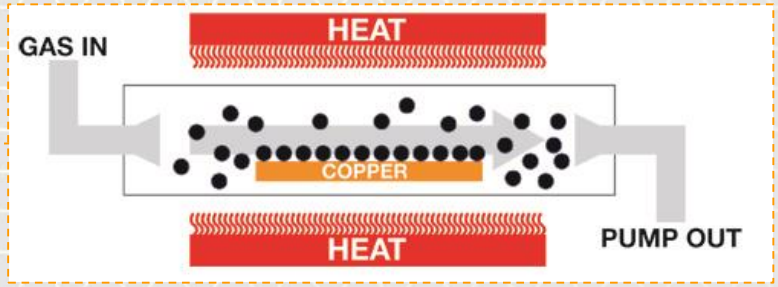
- ➔ Highly Ordered Pyrolitic Graphite (edge)
- ➔ HOPG (top).
- ➔ Expanded graphite
- ➔ Ultrasonicate and centrifuge to get stable graphene dispersion.

2-DTech Production Methods

- GNPs produced by grinding methods

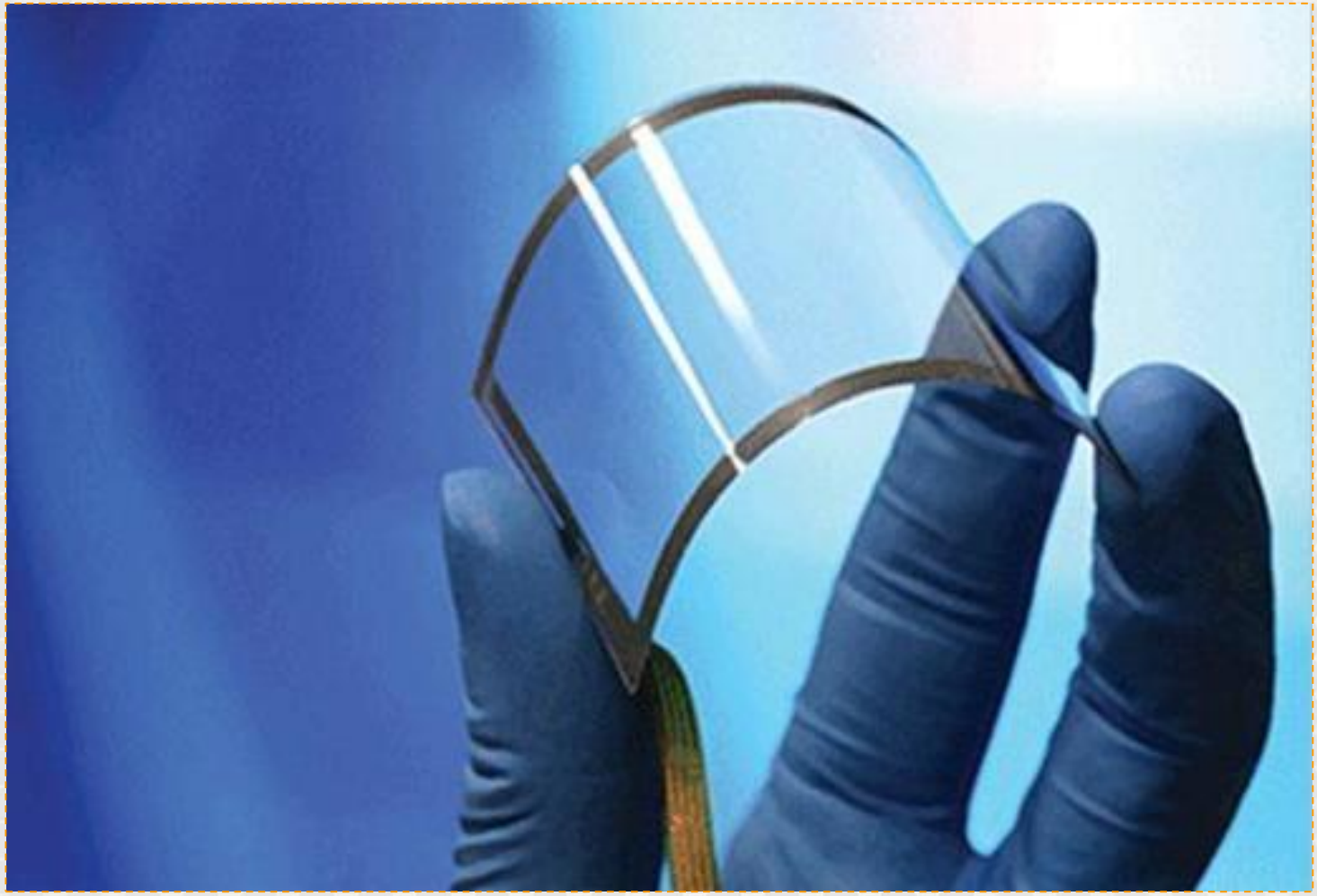
- GNPs produced by sonication

- CVD graphene



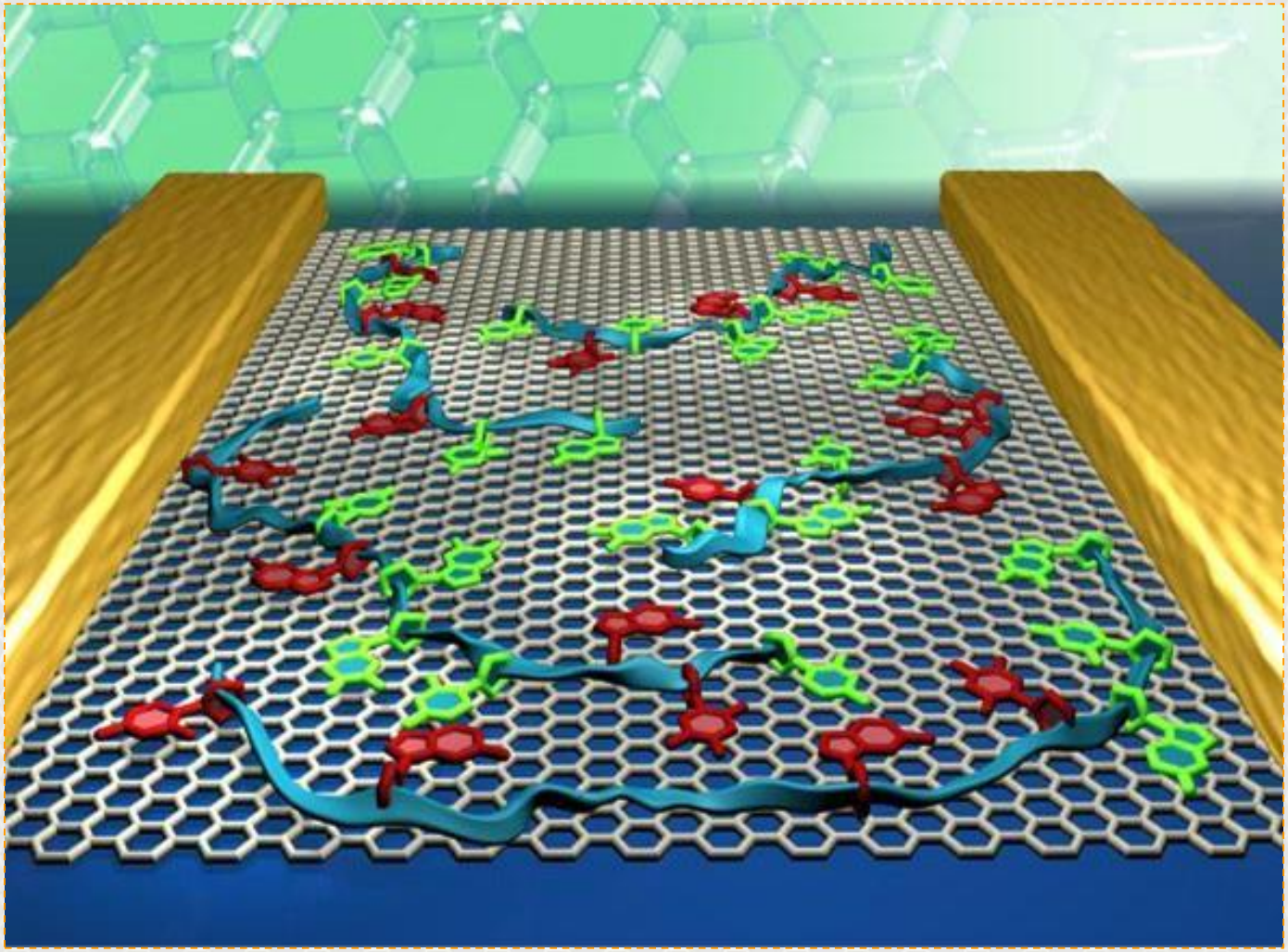
Applications of **graphene**

➔ Graphene touch-screen



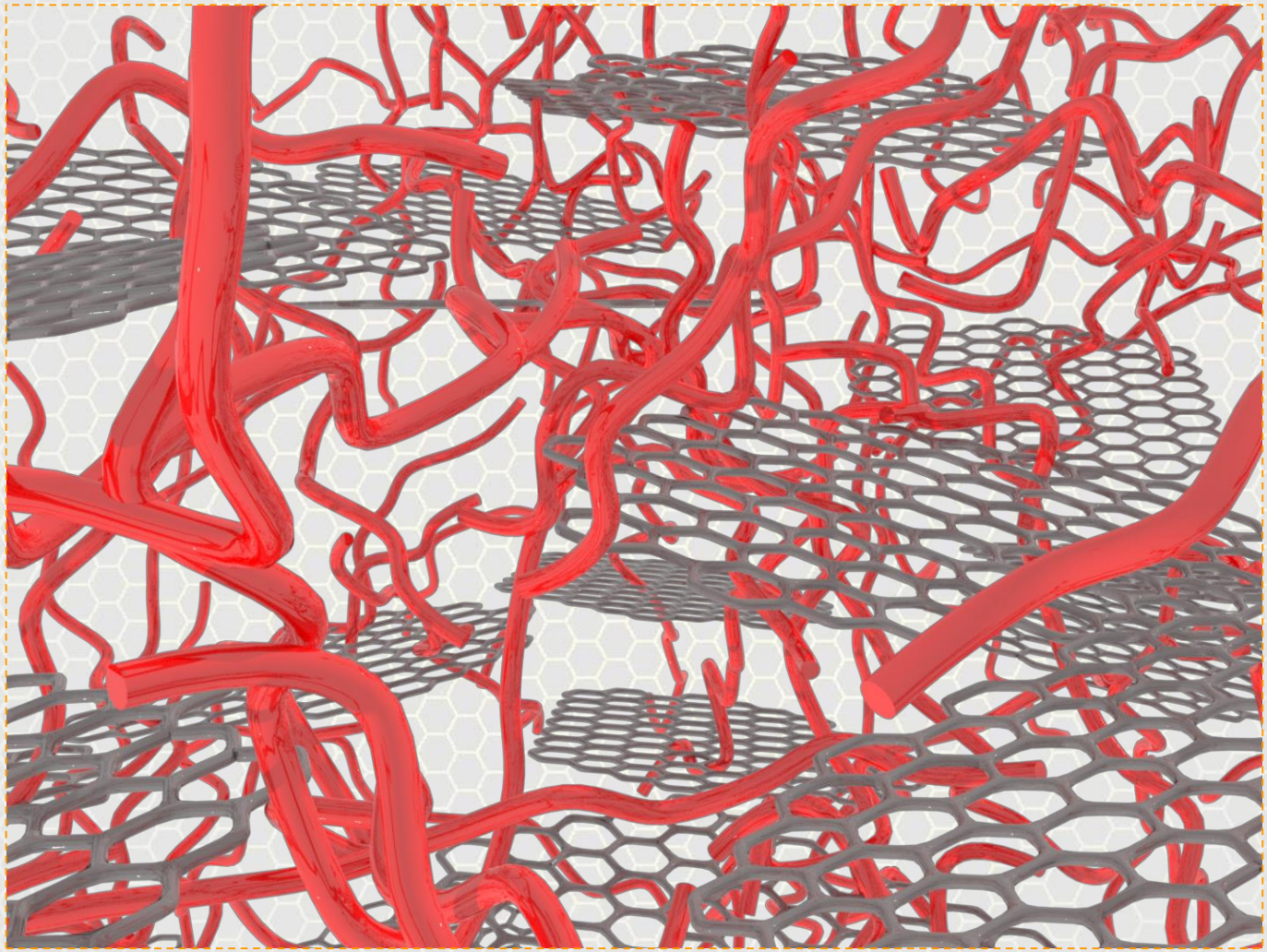
Applications of **graphene**

➔ Sensors for gas, chemicals, biological analysis



Applications of **graphene**

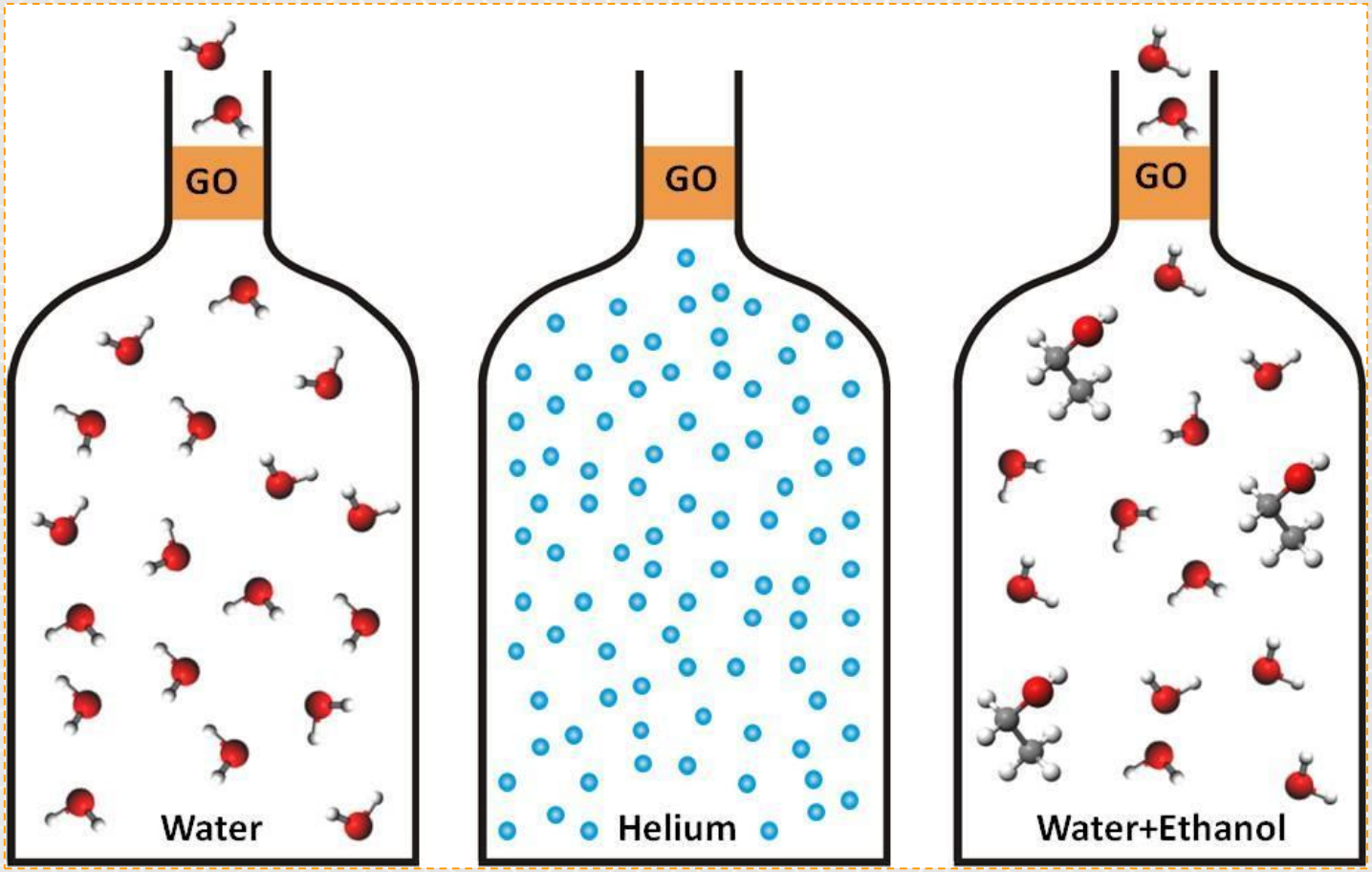
➔ Composites and Coatings



Applications of **graphene**

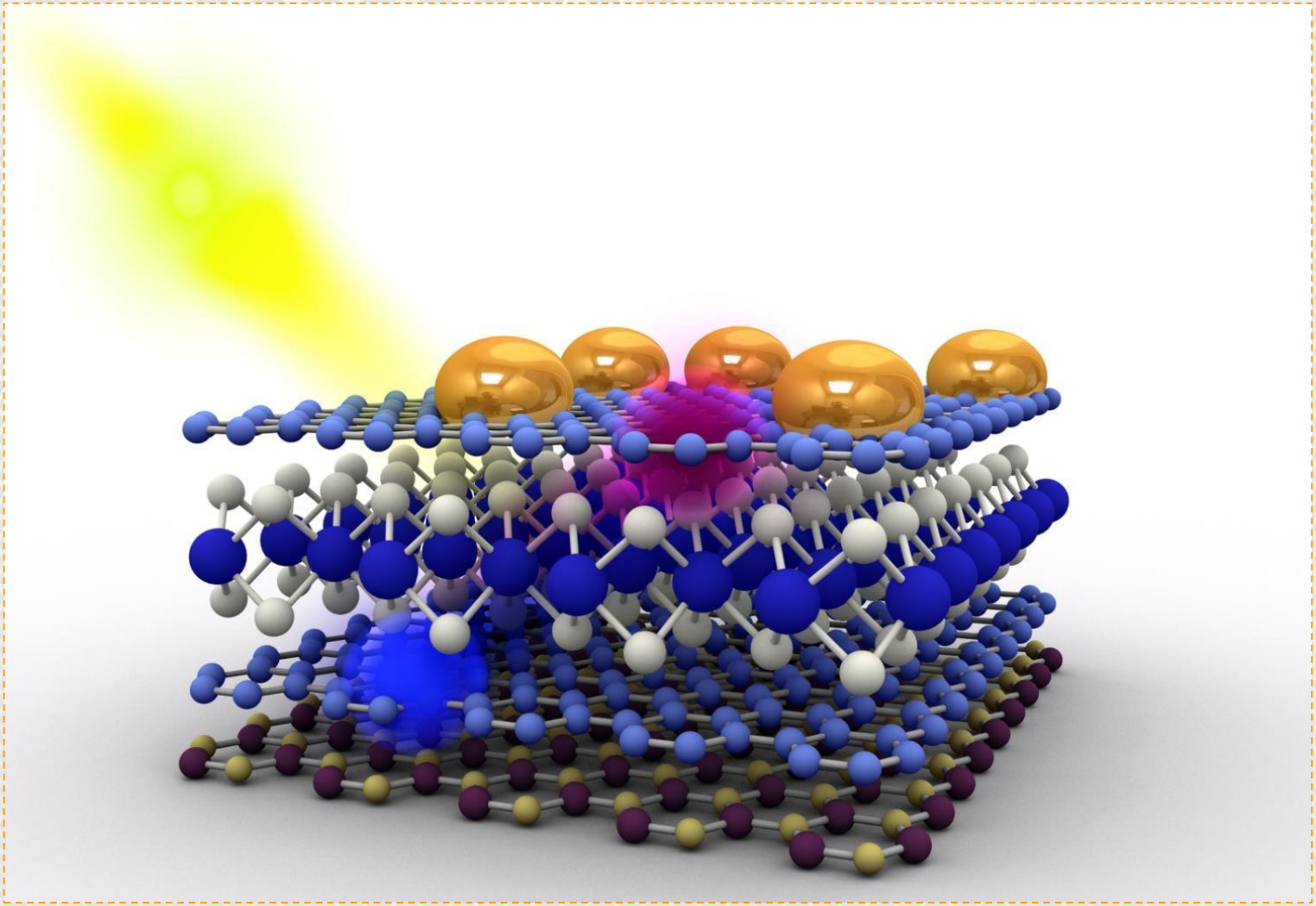
→ Filtration membranes

Corrosion protection



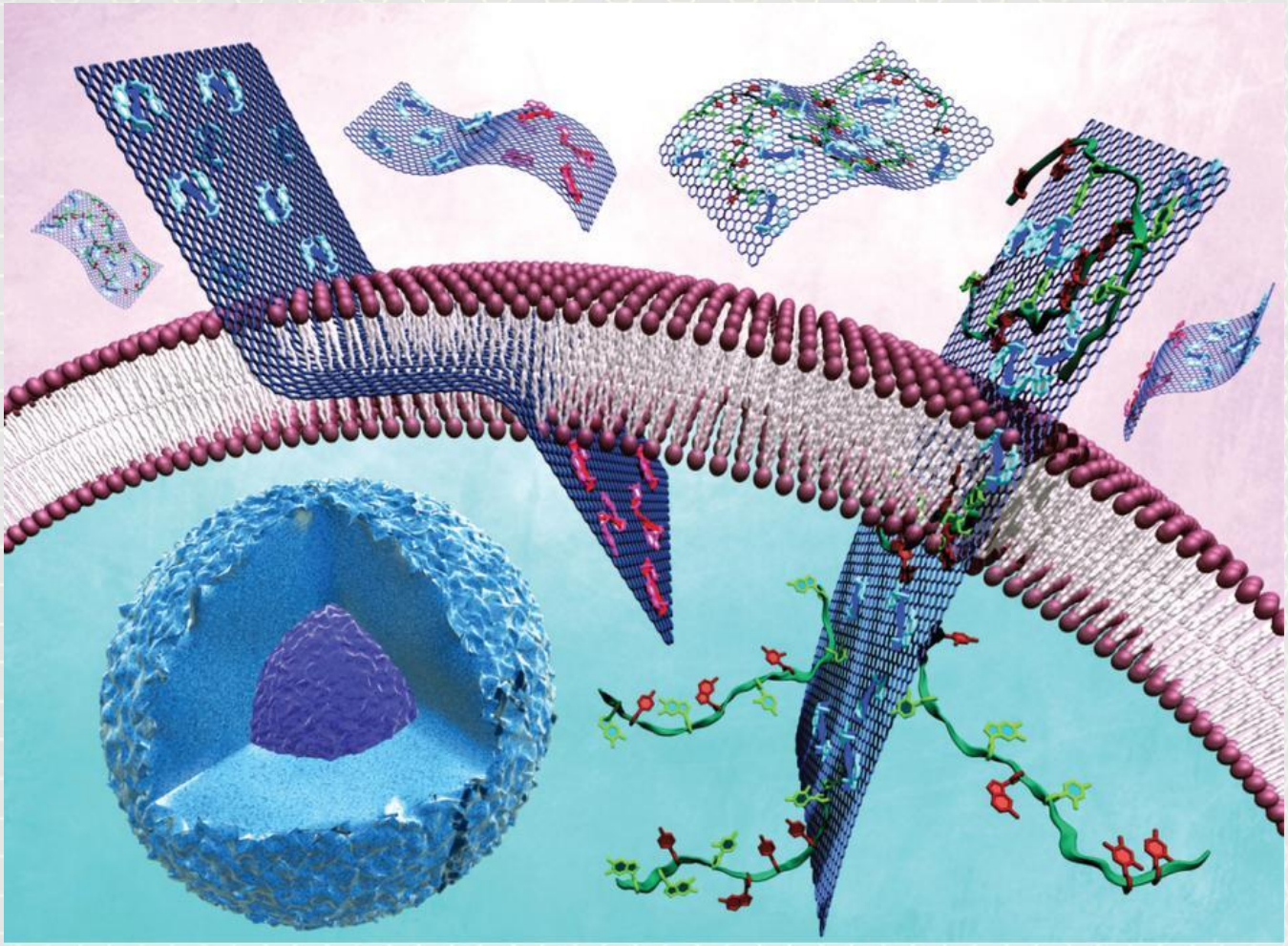
Applications of **graphene**

➔ Photovoltaic (solar) cells and photodetectors



Applications of **graphene**

➔ Nano-medicine and other bio-medical applications



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Dr Nigel Salter
2-DTech Managing Director

- ➔ *The 2-DTech Difference*
- ➔ *Projects and applications*
- ➔ *Production and services*
- ➔ *New key resources*

Manufacturing

Costs
Quality
Delivery
Standards
Range

2-DTech

Customers

Applications technology
Know-how
Enquiries
Product Development Projects

Products

Marketable
Competitive

Versarien plc

National Graphene Institute

Networks

Consortium
Grant Funding
Strategic Leadership
Investment

Market Focus - Materials

- **Graphene additions can modify properties**
  - Stronger
  - Stiffer
  - Tougher
  - Corrosion Resistance
  - Electrical/Thermal Conductivity
- **Current Projects**
  - Dental Prosthesis
  - Thermal pastes
- **Further Development**
  - Versarien funding further work at Manchester (£300k)
- **Commercial Collaborators**
  - SLS Powder

Market Focus – Energy Generation & Storage

➔**Graphene Benefits**

- ↳ High electrical conductivity
- ↳ Optically transparent

➔**Projects**

- ↳ Dye sensitised solar cells
- ↳ Batteries

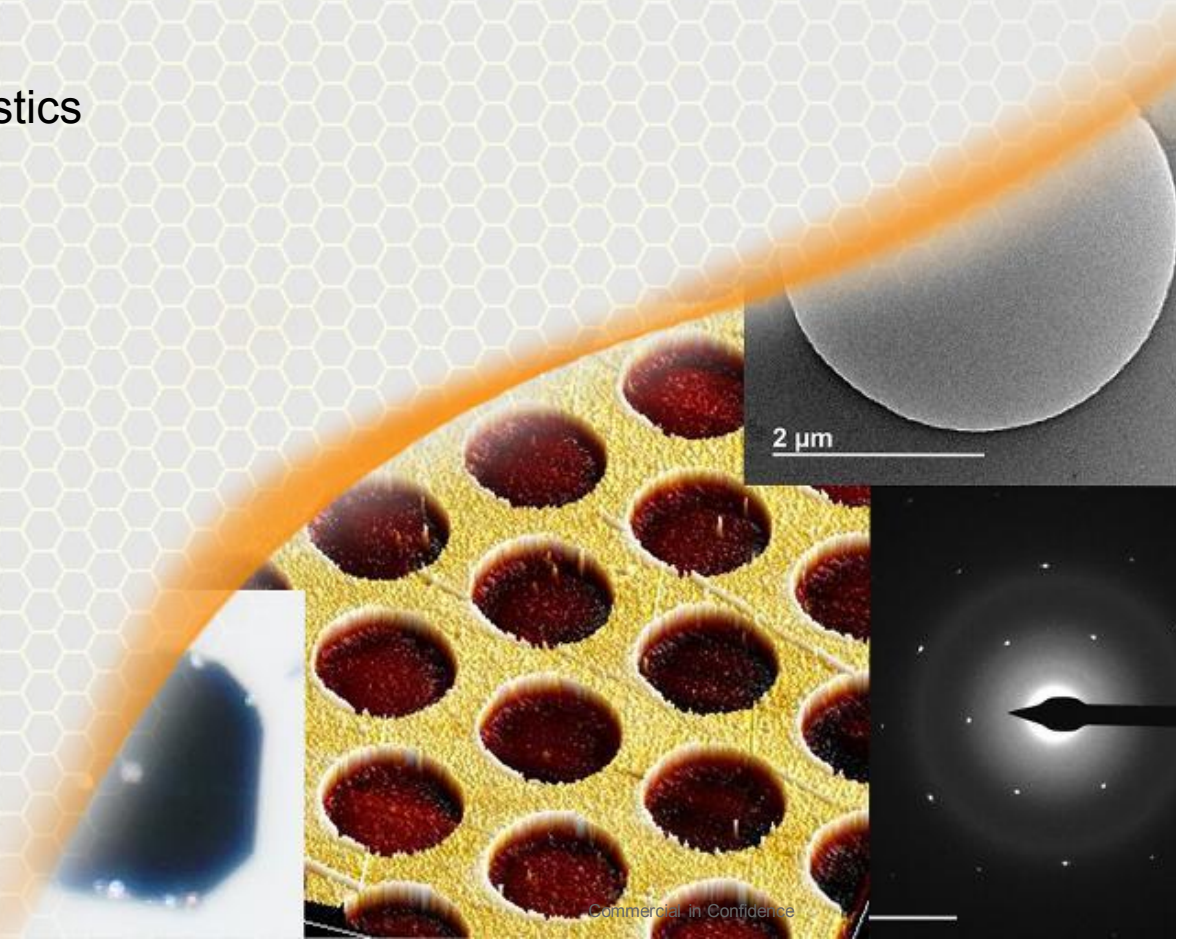
Market Focus – Sensors and Transducers

→ Graphene Benefits

- ↳ Flexible
- ↳ Strong
- ↳ Non magnetic
- ↳ Complex Characteristics

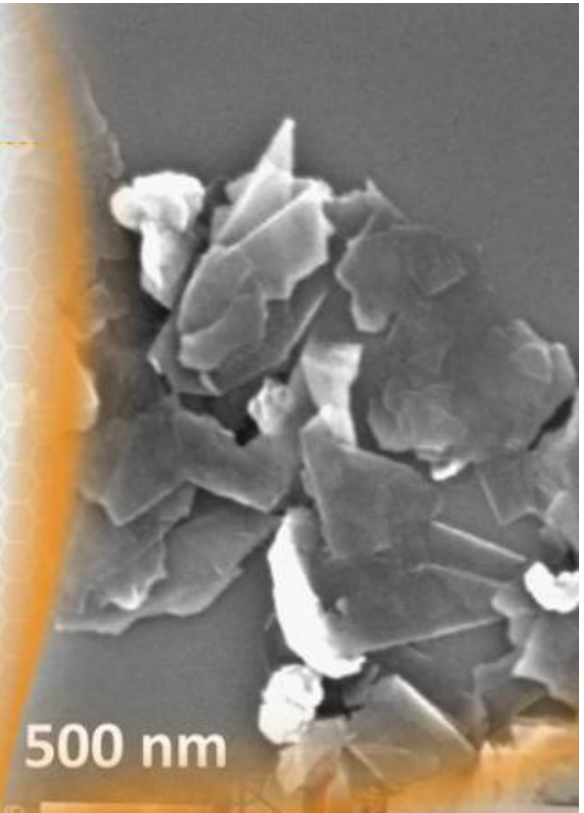
→ Applications

- ↳ Bio sensor start up
- ↳ Defence application
- ↳ Electron microscopy
- ↳ Loudspeakers



Production & Services Focus

- **Developing scale up of proprietary process**
  - Graphene nanoplatelets
  - Exclusive licence from University of Ulster
  - Scale up work started
  - Patent application filed
  - New product launched
- **CVD Production**
- **Graphene Oxide**
- **Analytical services**



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