INDUSTRIAL MINERALS EVENTS
2nd Graphite Conference

Session V: Graphene

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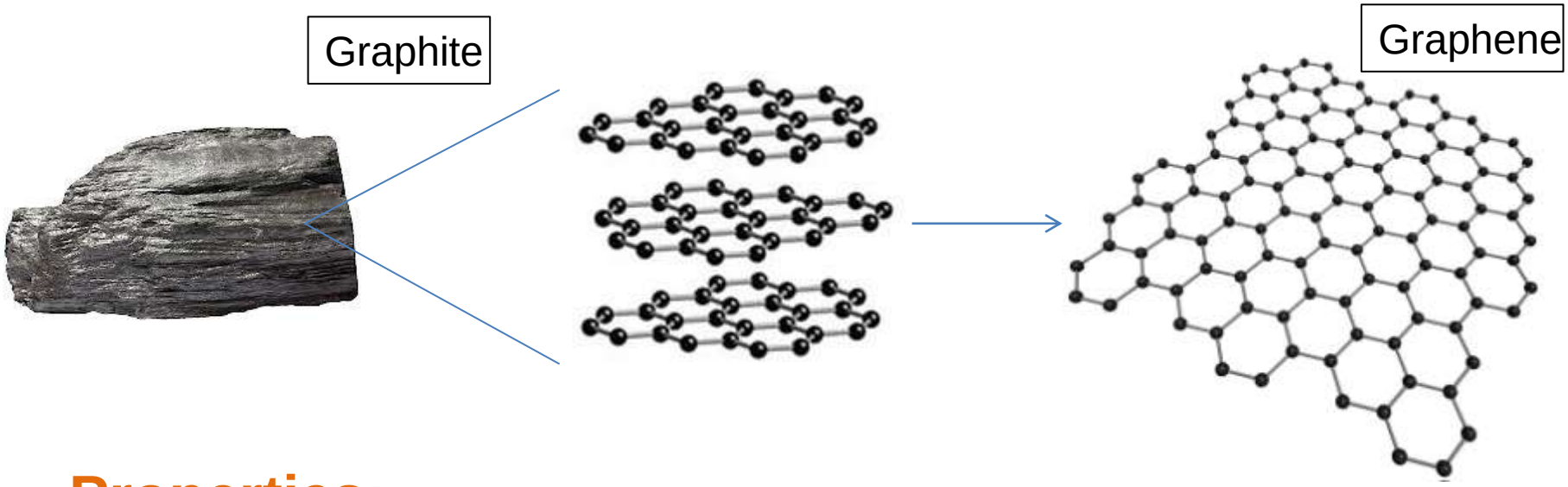
NMS
NANOMATERIALS AND
SPECTROSCOPY GROUP

Graphene: Material in the Flatland



Single atomic plane of carbon atoms

Properties:

- Thinnest imaginable material
- Good(and tunable) electrical conductor
- Strongest ever measured
- Stiffest known material (stiffer than diamond)
- Highly stretchable crystal (up to 20%)
- High flexibility
- Chemical stability
- High charge carrier mobility (>10^6 cm^2 $V^{-1}s^{-1}$)
- High transparency (97.7%)

Fields of potential application

Electronics	Composites	Energy
Nanoelectronics/ Quantum computing	Lightweight & Superstrong materials	Electrodes for batteries and supercaps
Fast photodetectors/ Optoelectronics	Epoxy based composites	Fuel cells
Light emitting devices	Polymer composites	Paper batteries
Conductive inks (Printed/flexible electronics) RF tags	Bone regrowth	Replacement for Indium-Tin-Oxide (ITO)
Sensors	Siloxane base composites	Flexible and transparent solar cells

- *"The World Market for Graphene 2017"*, Future Markets, Inc. 2011
- "*Carbon Nanotubes and Graphene for Electronics Applications: Technologies, Players and Opportunities"*, IDTechEx, 2010

Large scale pristine graphene productiontion

Parameters	Chemical Vapor Deposition	Carbon Segretation	Liquid Phase Exfoliation
Starting material	Hydrocarbon	Substrate itself	Natural graphite
Max. Temperature	High (1000 ^{o}C)	High (>1000 ^{o}C)	Room temperature
Substrate	Cu or Ni	SiC	None
Major process steps	3 to 4	3 to 4	2
Area limited to	Substrate size (m)	Wafer size	Substrate size (>m)

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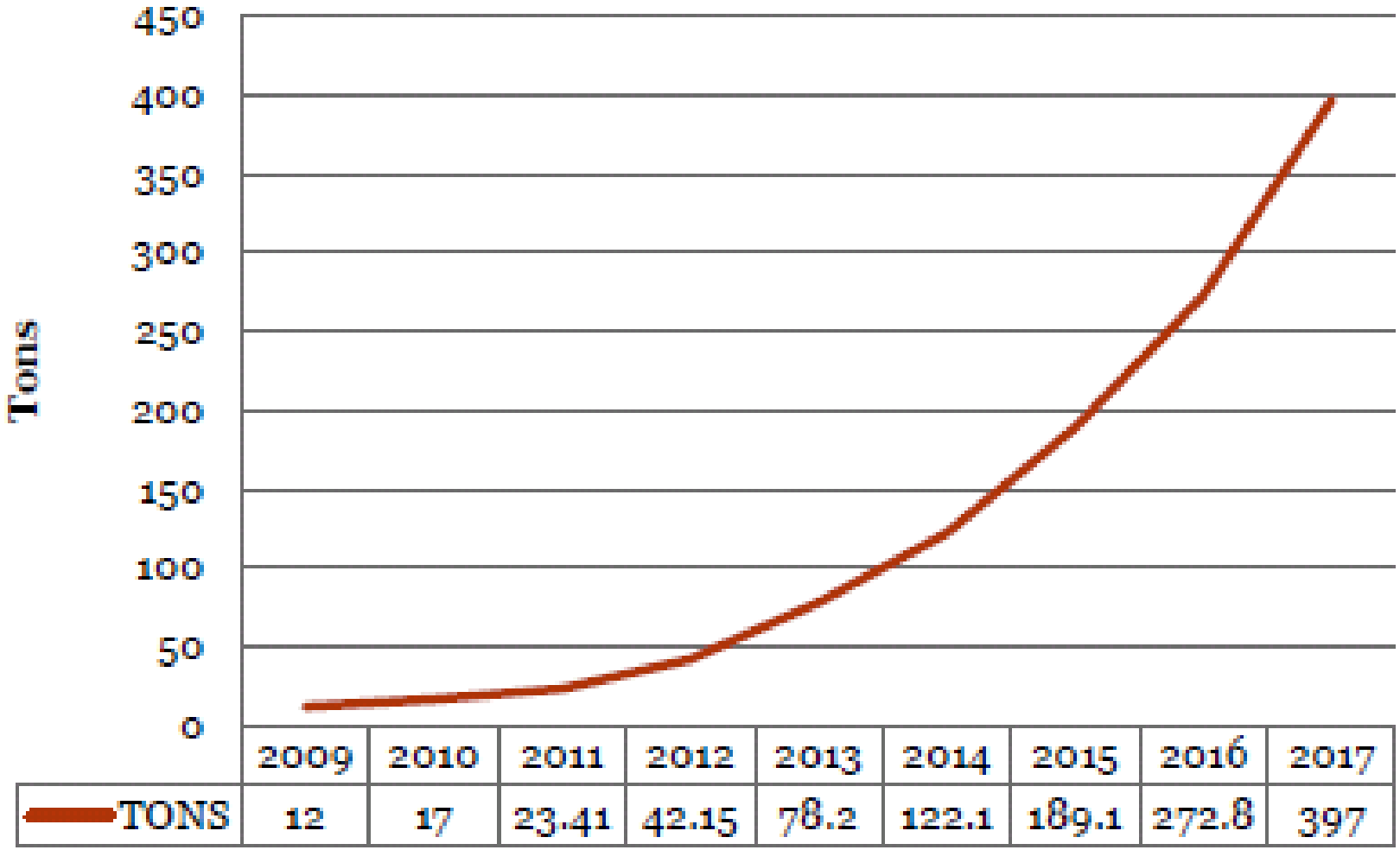
Graphene production, 2009-2017



	2009	2010	2011	2012	2013	2014	2015	2016	2017
TONS	12	17	23.41	42.15	78.2	122.1	189.1	272.8	397

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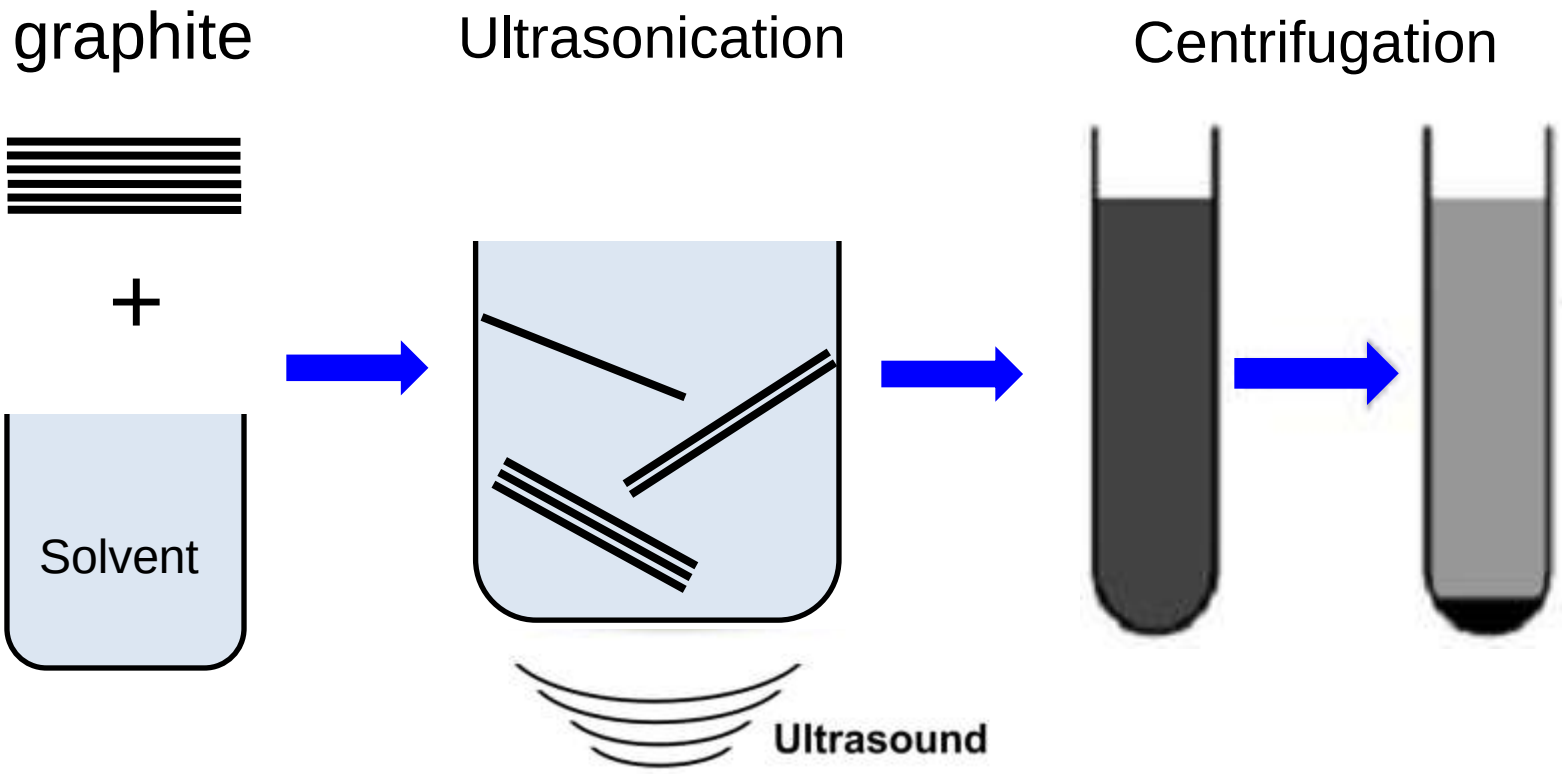
Graphene-inks for optoelectronics



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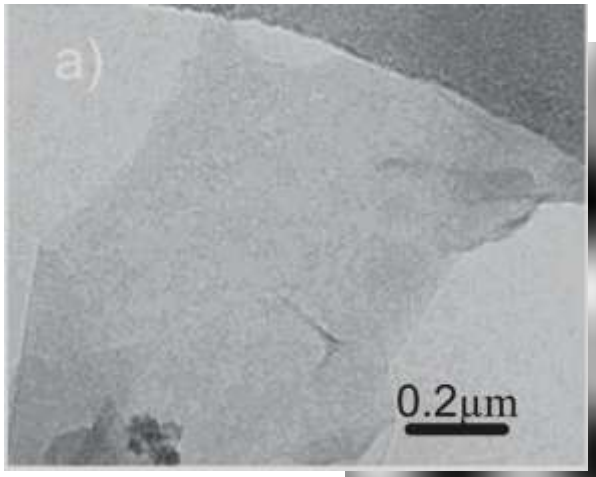
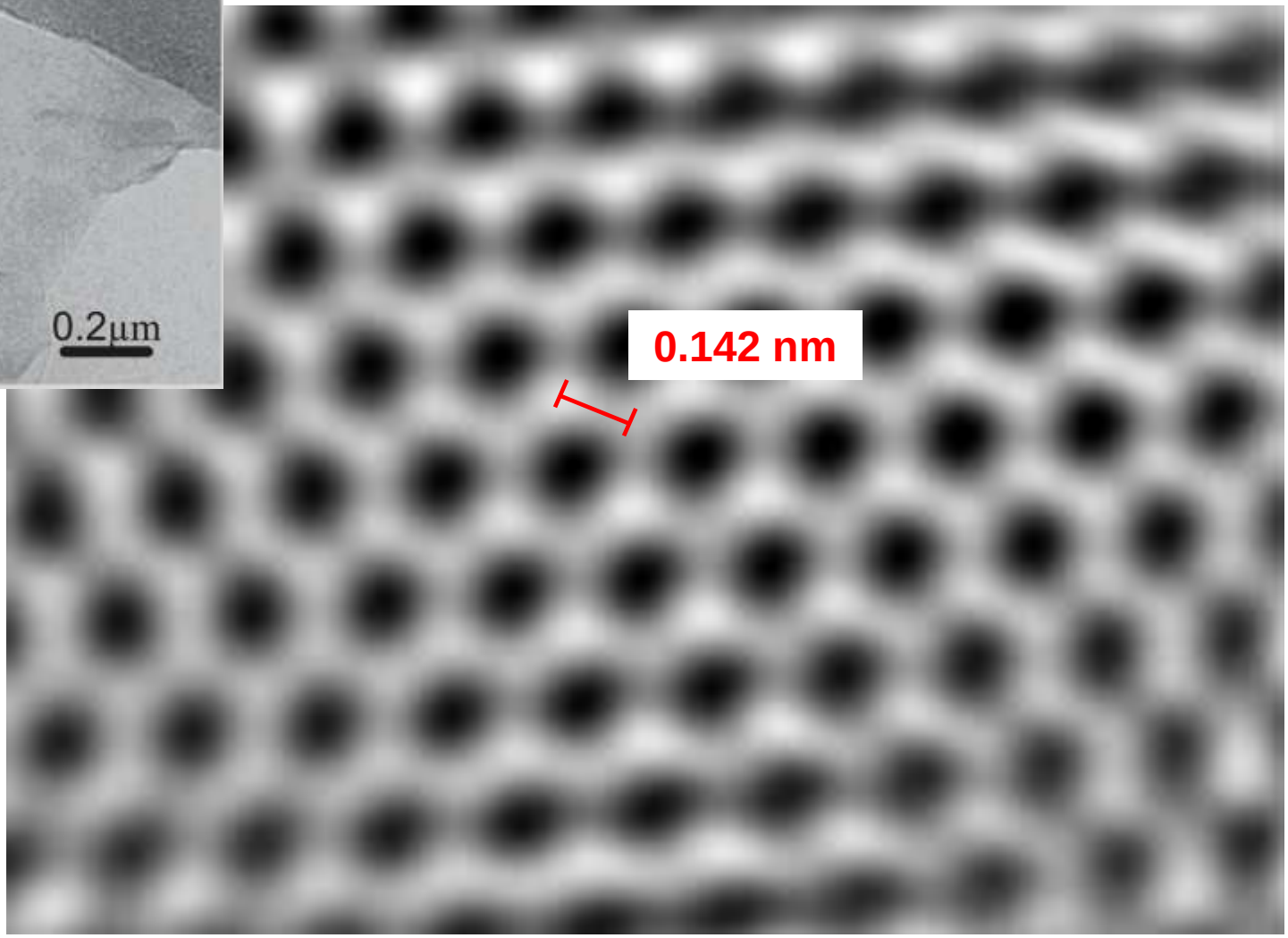
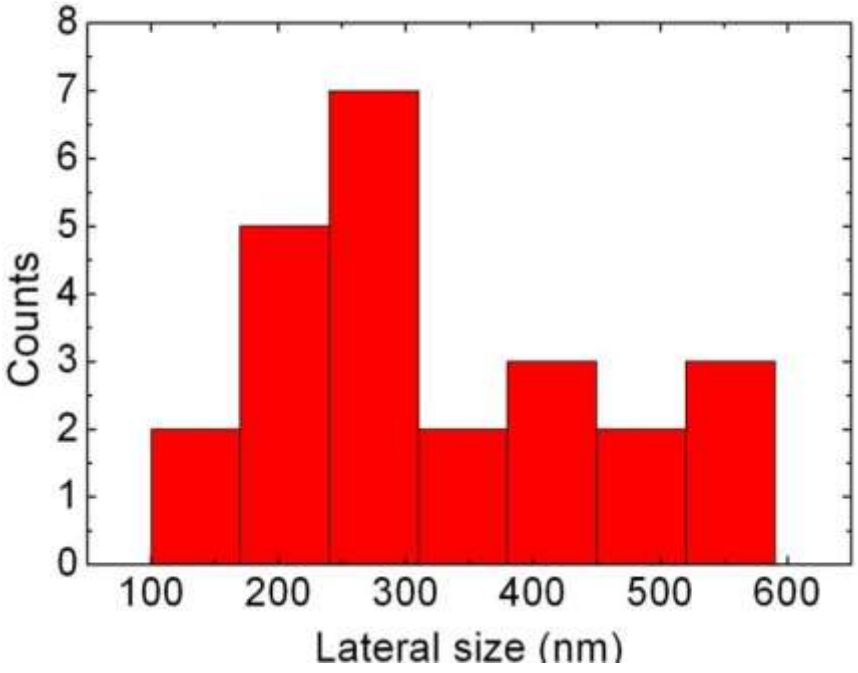
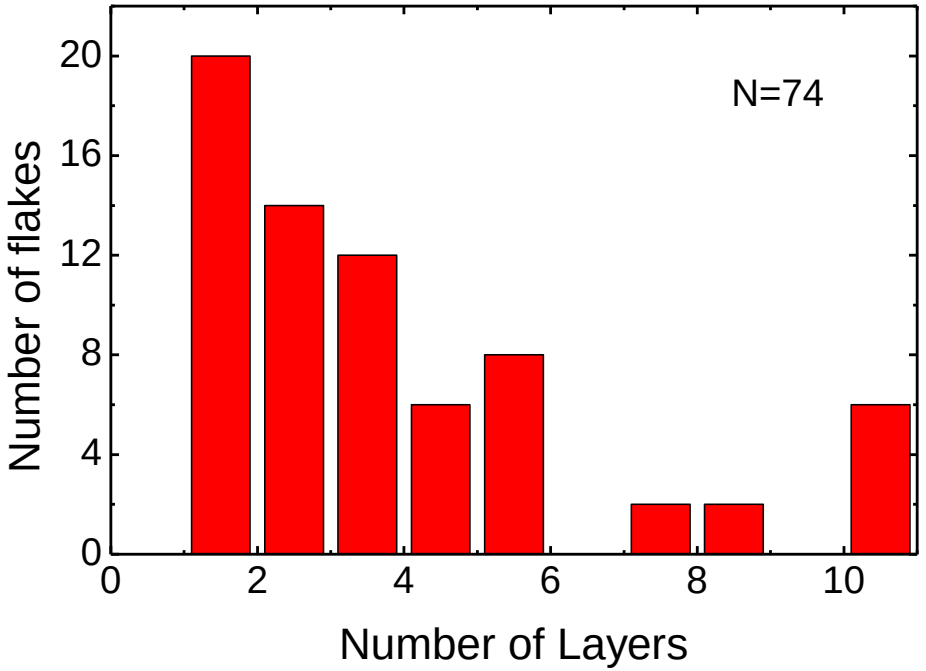




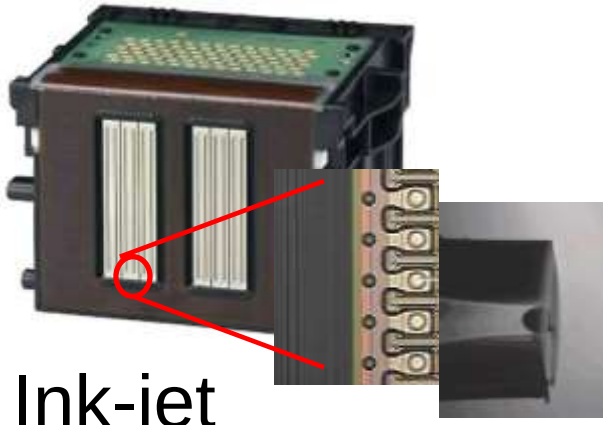
1 nm = 1 Billionth of a meter

Graphene-inks for optoelectronics





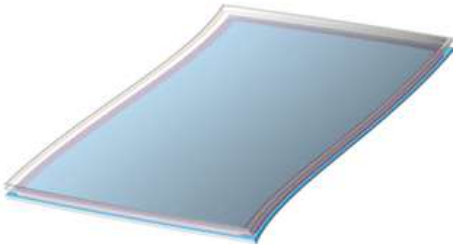
Inks adaptable to many present printing techniques



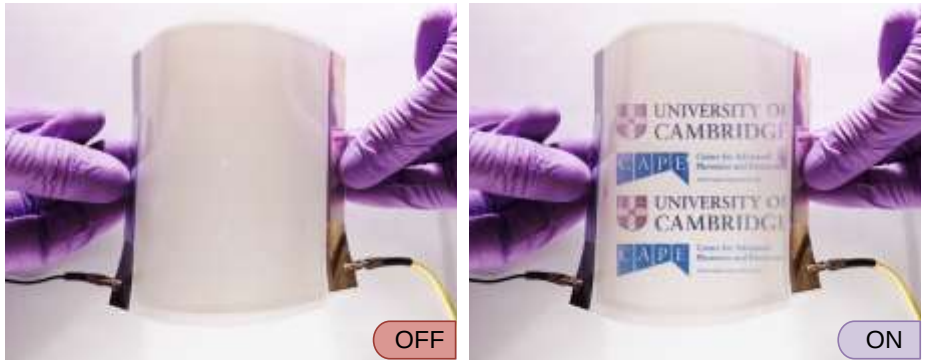
Ink-jet

Spray-coating

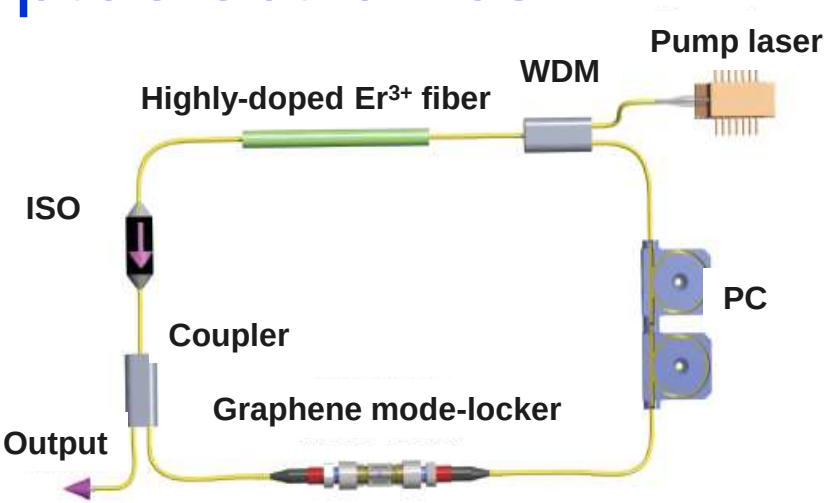
Roll to roll



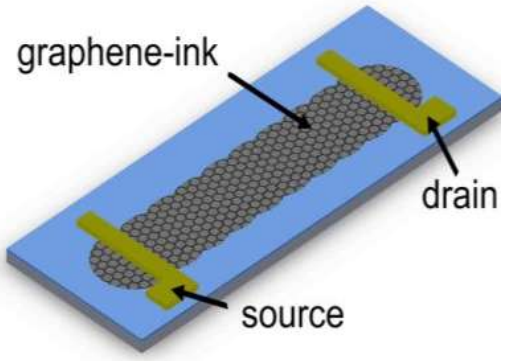
Graphene-inks for optoelectronics



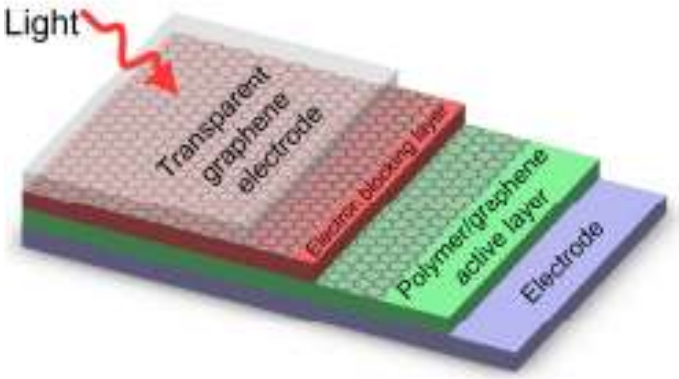
Flexible transparent opto-electronic devices



Graphene ultrafast lasers

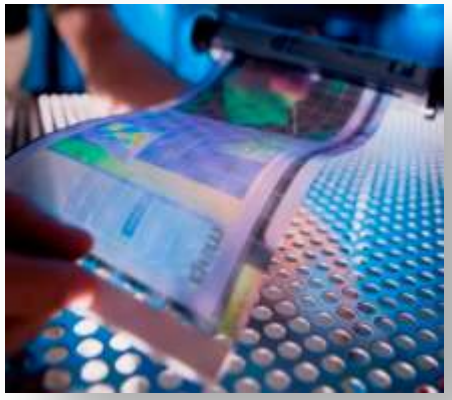


Thin film transistors



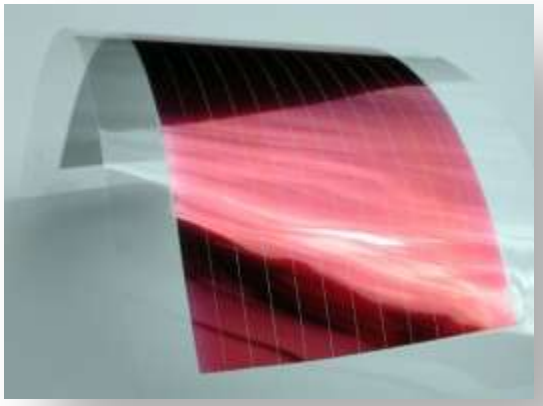
Photovoltaic devices

Graphene inks and CVD for optoelectronics



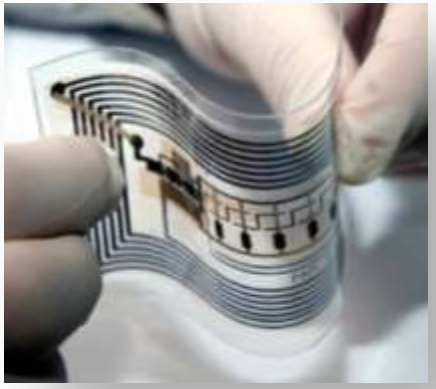
Touch screen displays

Electronic paper



Photovoltaic cells

Sensors



Radio frequency tags

Smart textile

Our speakers

Professor Ian Kinloch,
Professor of Materials Science,
The nanomaterials group,
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The University of Manchester

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GRAFOID INC.

Dr Gordon Chiu,
VP, Grafoid and Chief Scientist,
Focus Graphite (Canada)