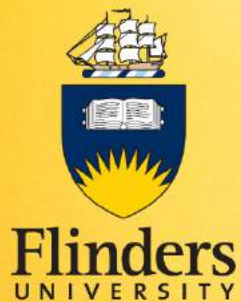


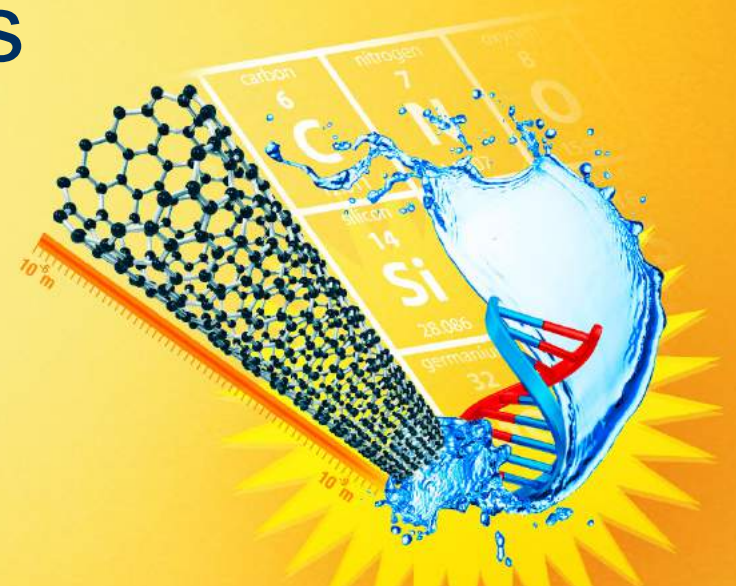
Structures and Interfaces

A Pathway to Future Technologies

David A. Lewis



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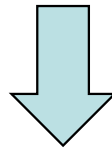




What were the key innovations to make this happen?

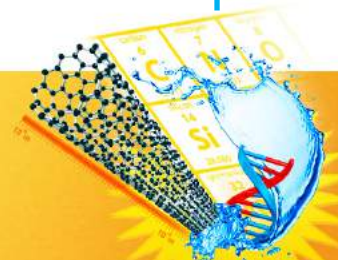


Miniaturisation and storage



Understanding and control of
Nano Structures and Interfaces

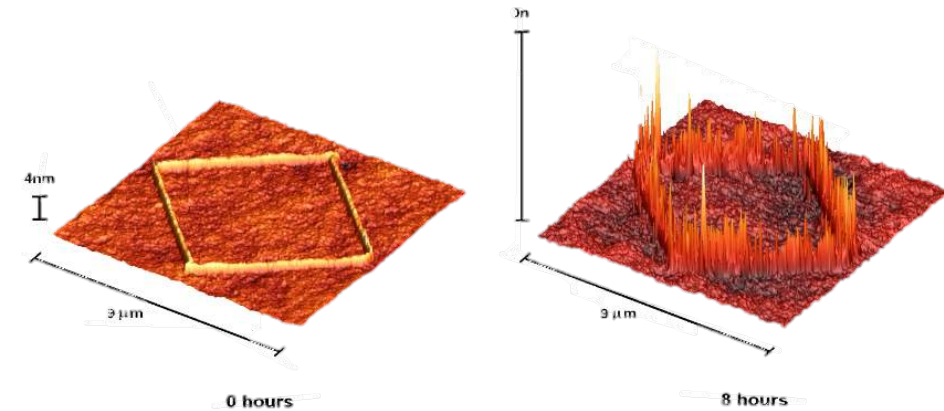
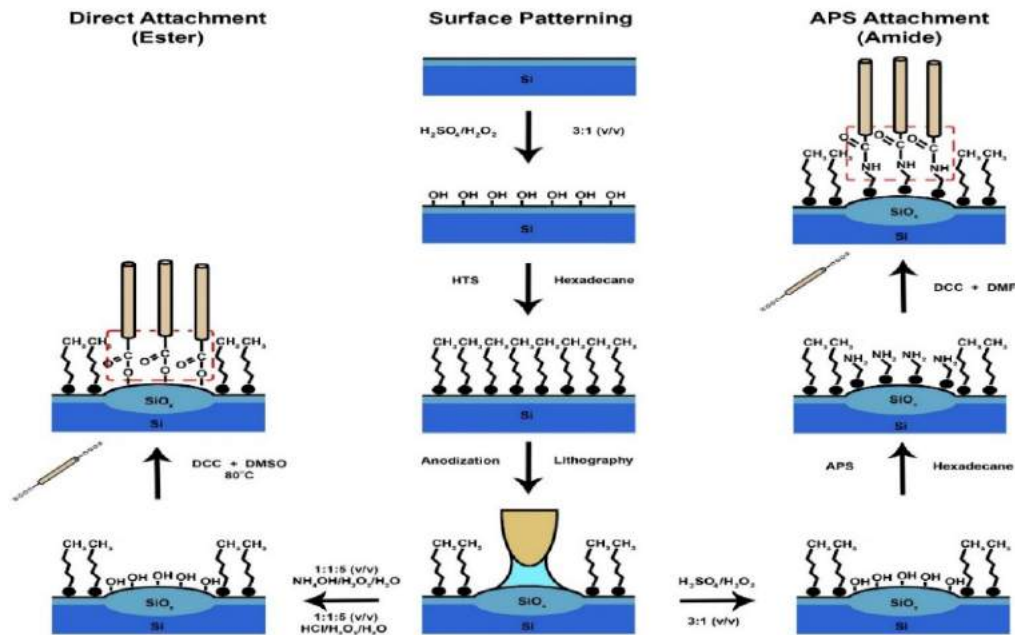
Top down
versus
bottom up



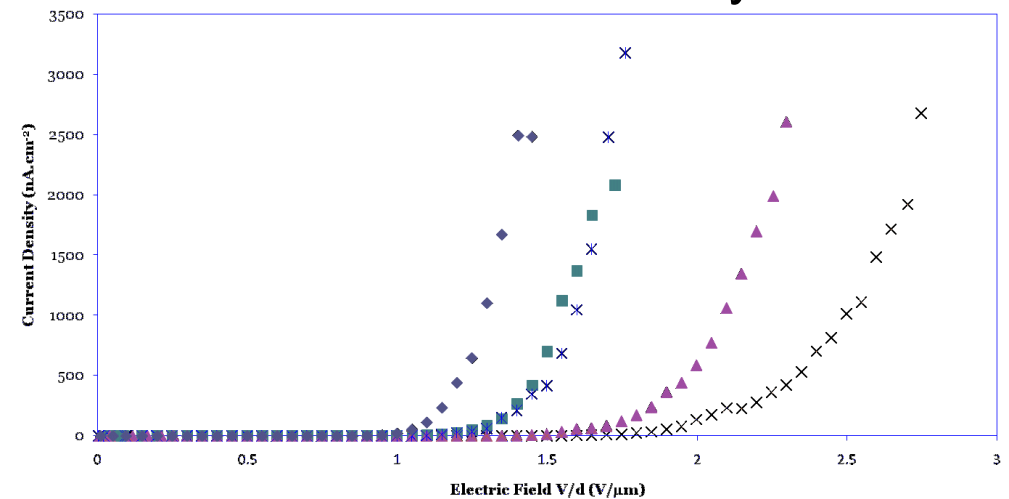
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Directed Self Assembly

Selective Attachment of Carbon Nanotubes to Silicon

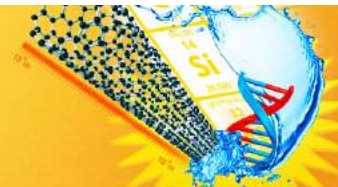


Electron emission for x-ray sources

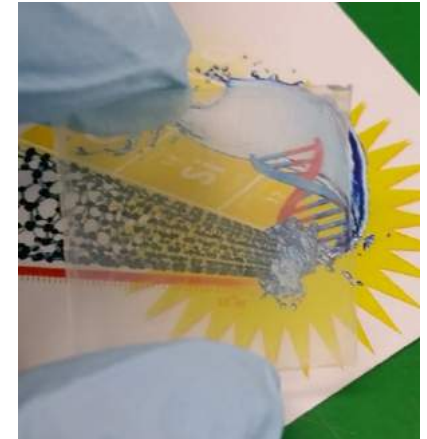
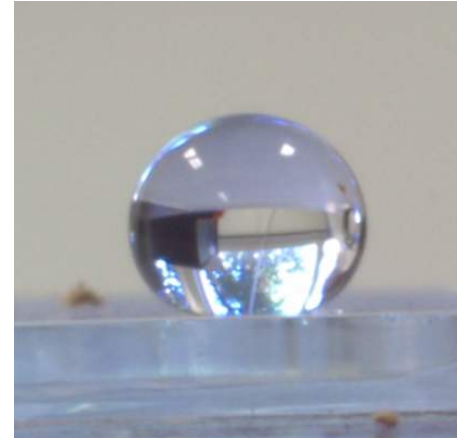
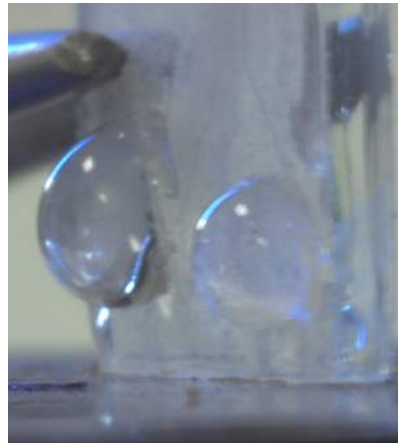
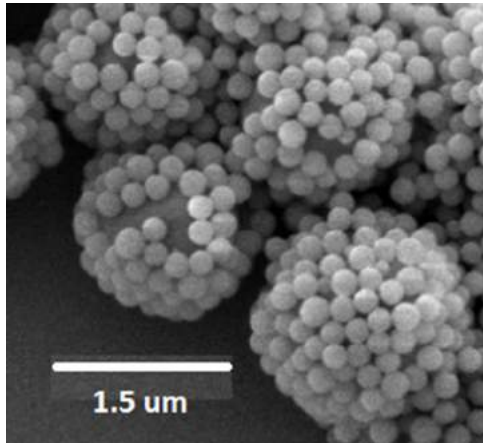


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J. Yu et al. PCCP **9**(4) 510-520 (2007).
I. Horcas et al. Rev. Sci. Instrum. 2007; 78:13705



Bio-mimetic surfaces



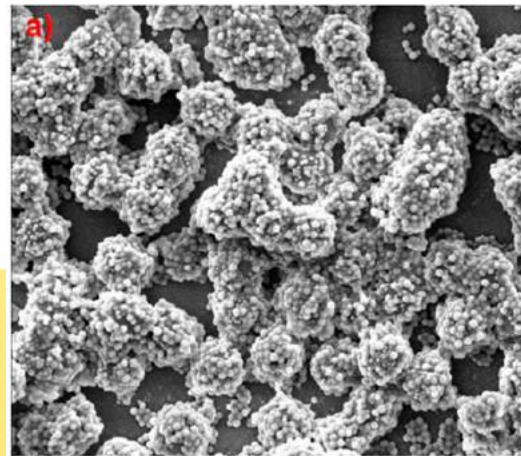
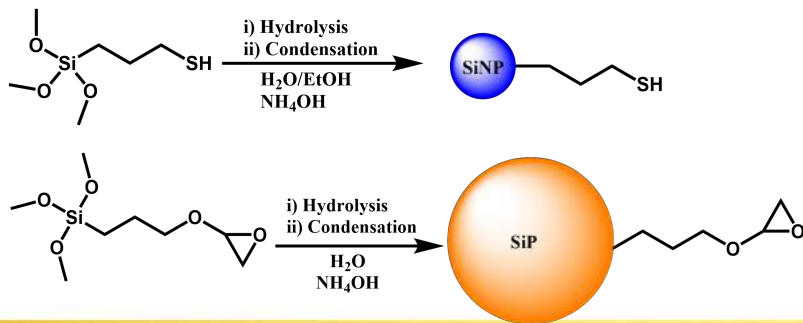
155°

Contact Angle

164°

Flinders surface

Lotus Leaf

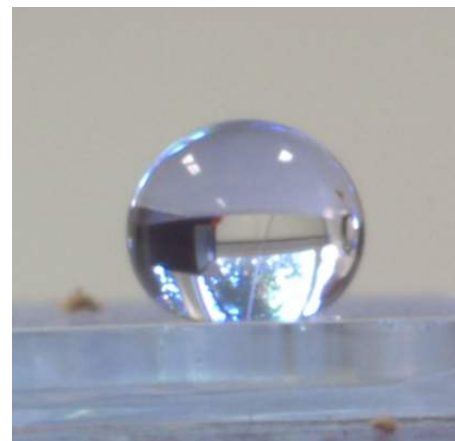
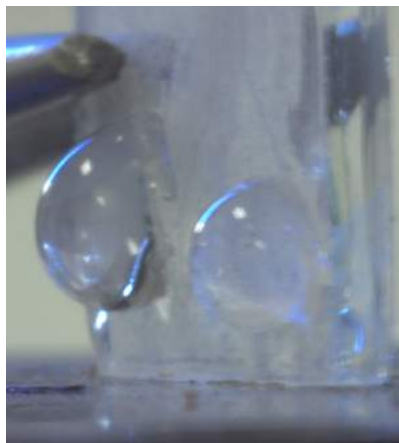
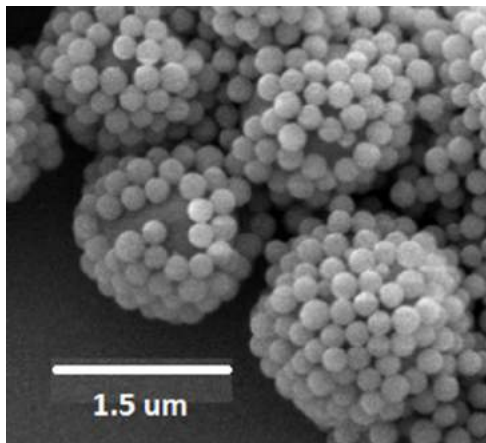


Leach, Univ Nottingham, 2004



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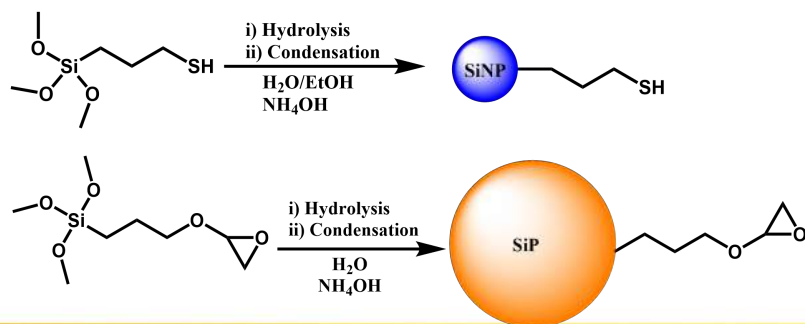
Bio-mimetic surfaces



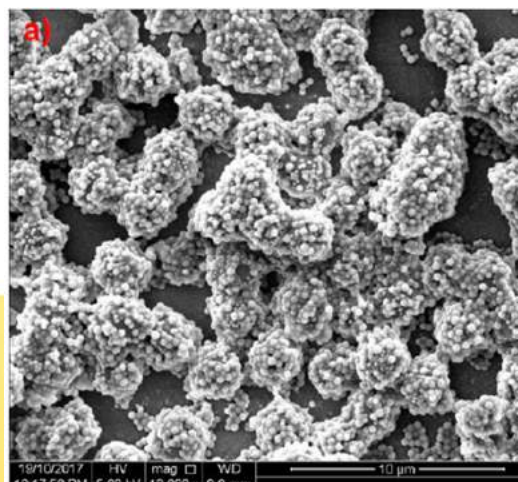
155°
1°

Contact Angle Sliding Angle

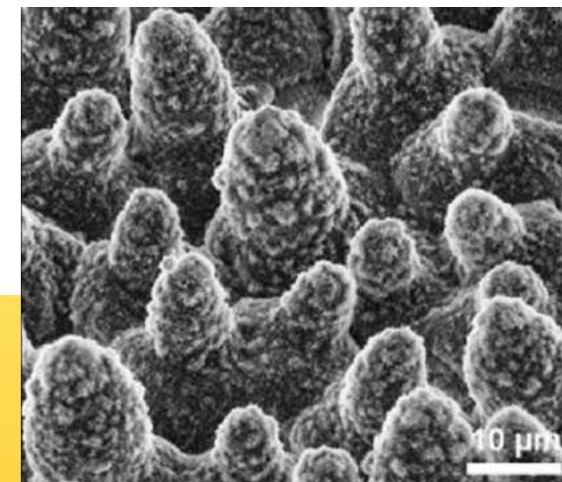
164°
3°

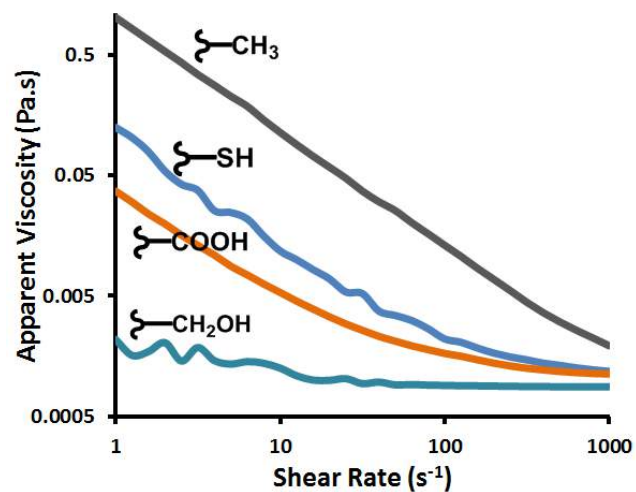
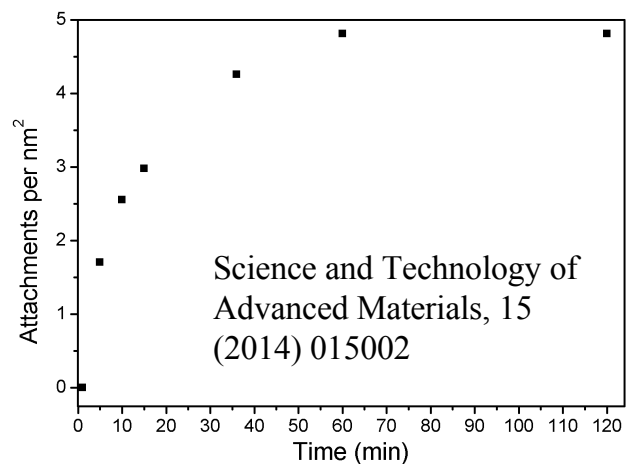


Flinders surface

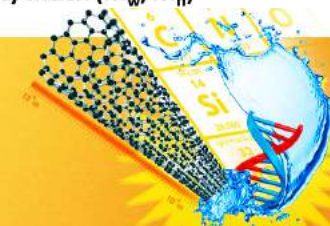
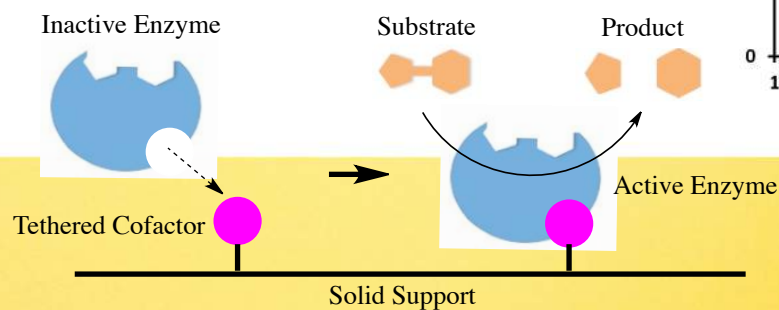
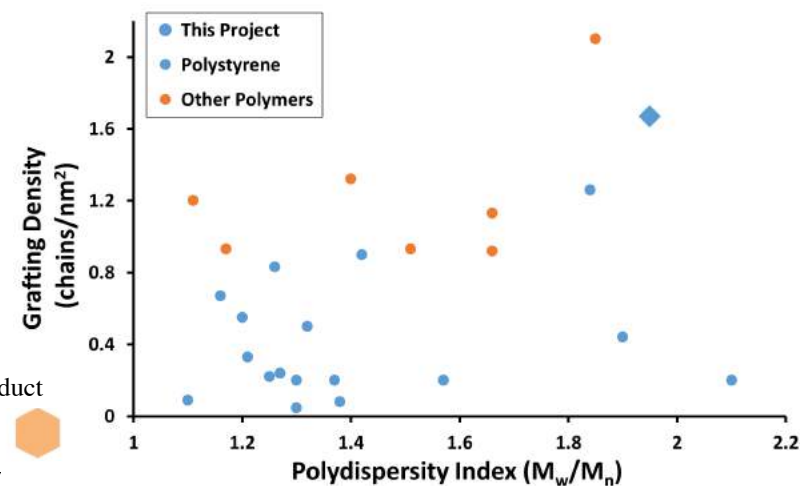
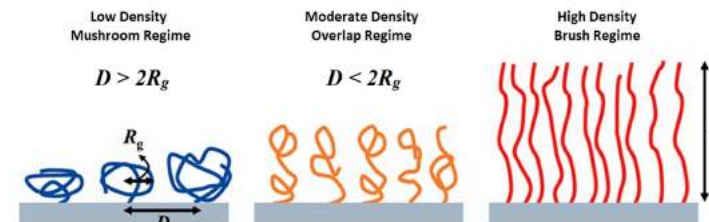
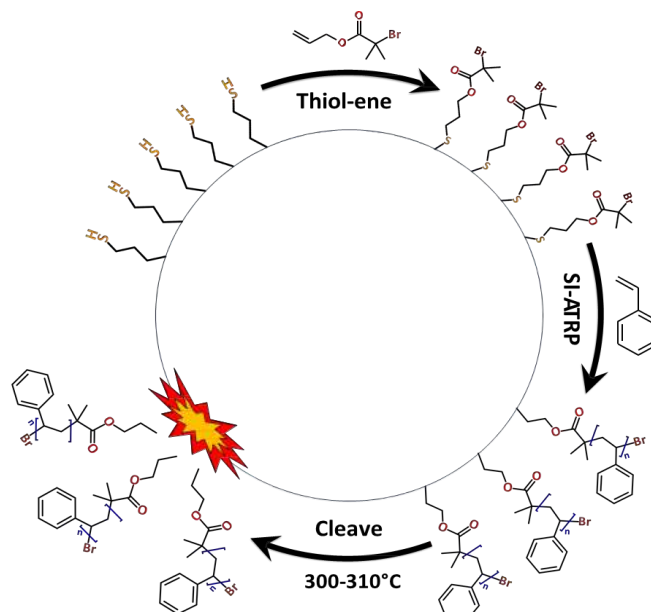


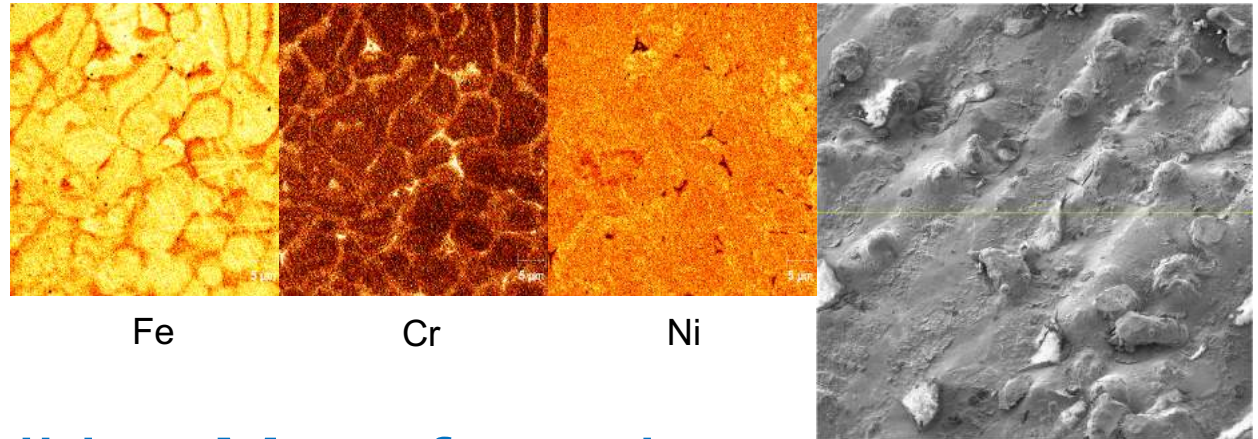
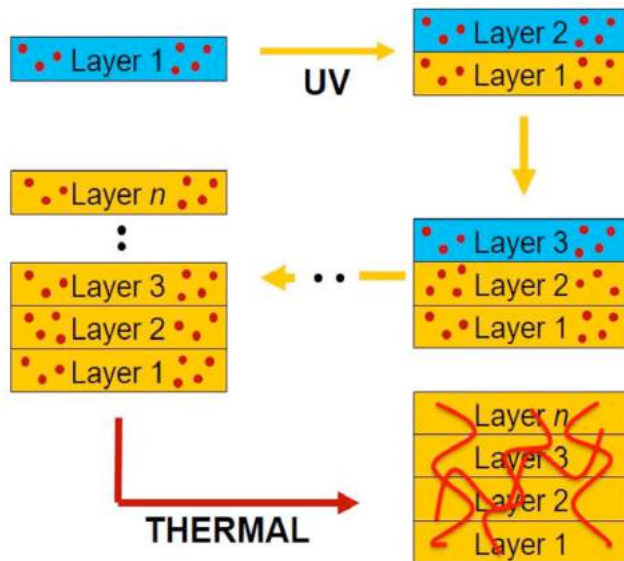
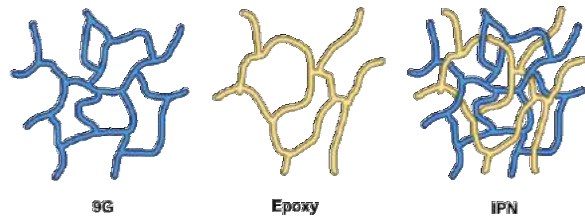
Lotus Leaf





New Definitions of Surface Functionality



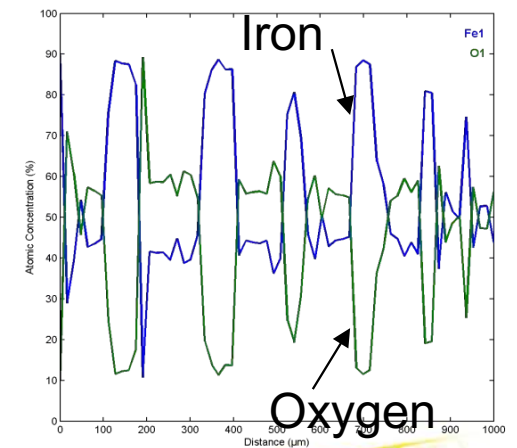
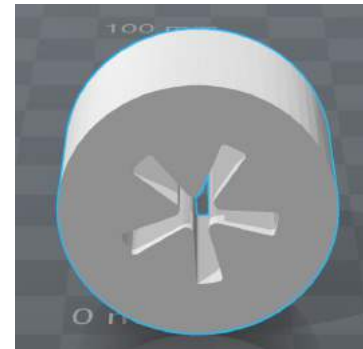


SS 316L

Additive Manufacturing



Rocketech Pty Ltd
DST Group
Flinders University
RMIT
Cranfield University

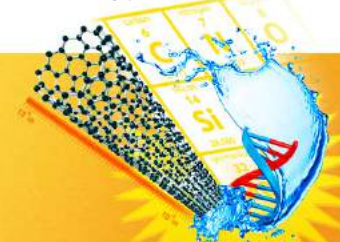


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Australian Government
Department of Industry,
Innovation and Science

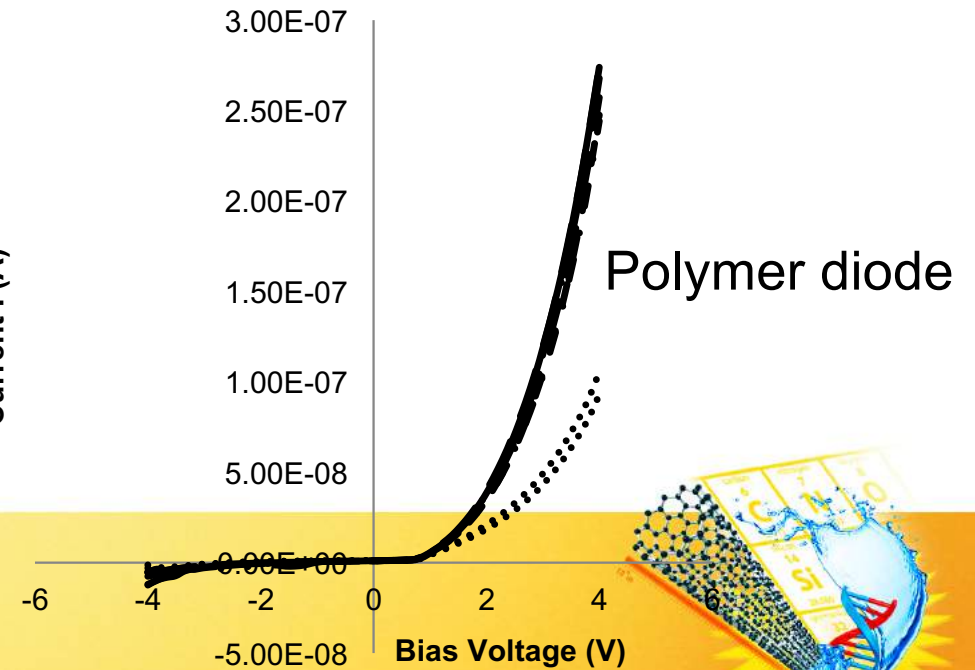
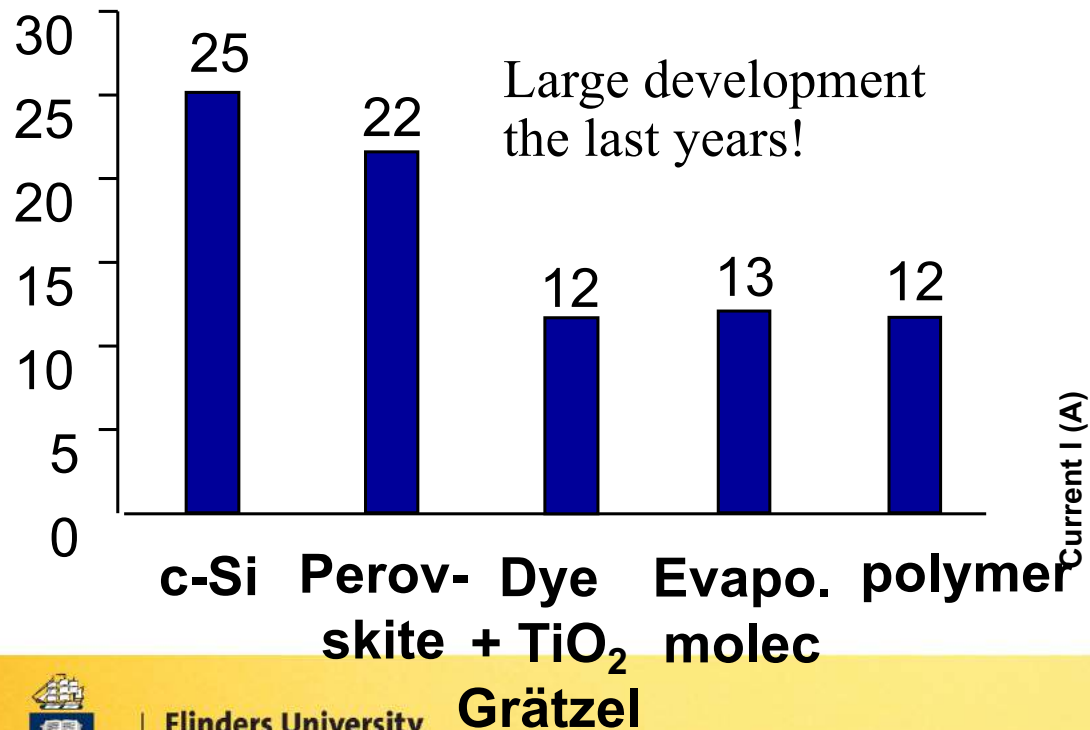
Business
Cooperative Research
Centres Programme



Energy Harvesting: Wearable and Internal

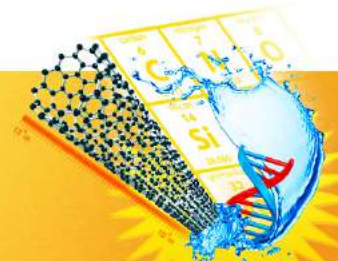
www.infinitypv.com

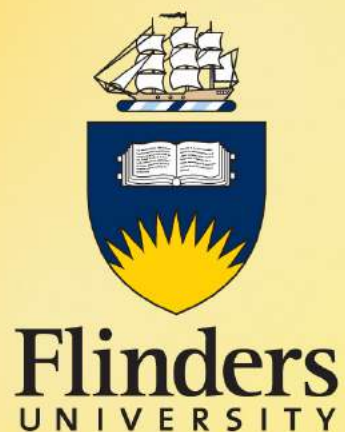
€92 EUR



Pathway to Disruptive Technologies

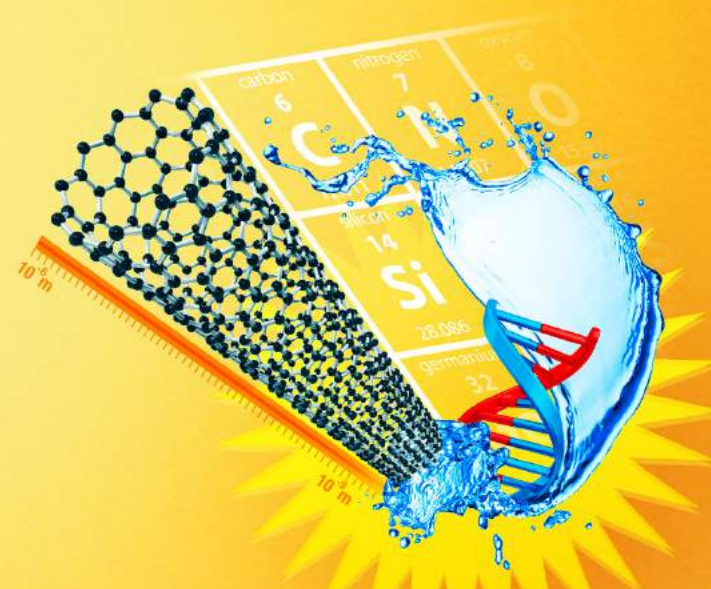
- **Self Assembled systems**
 - Light weight low voltage electron emitters as portable x-ray sources,
 - High surface electrodes for batteries
 - Surface architectures that are self cleaning, non-biofouling, etc.
- **“New” surfaces**
 - Fluids with unique properties (eg high heat capacity / conductivity but low viscosity nanofluids)
 - Separation / ion transport membranes
 - Anti-corrosion coatings
 - Biological chemistry on the surface
 - Point of sampling diagnostics (eg faster and more sensitive, specific cancer biomarker sensors)
- **Broad application of additive manufacturing**
 - Product personalisation
 - Disrupt Supply chains
- **Wearable / Inserted Energy Harvesting**
 - Flexible electronics, energy harvesting systems





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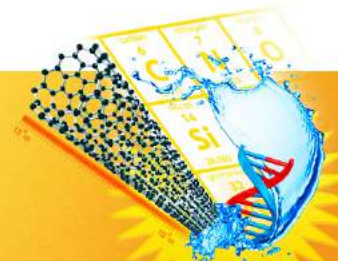


Pathway to Disruptive Technologies

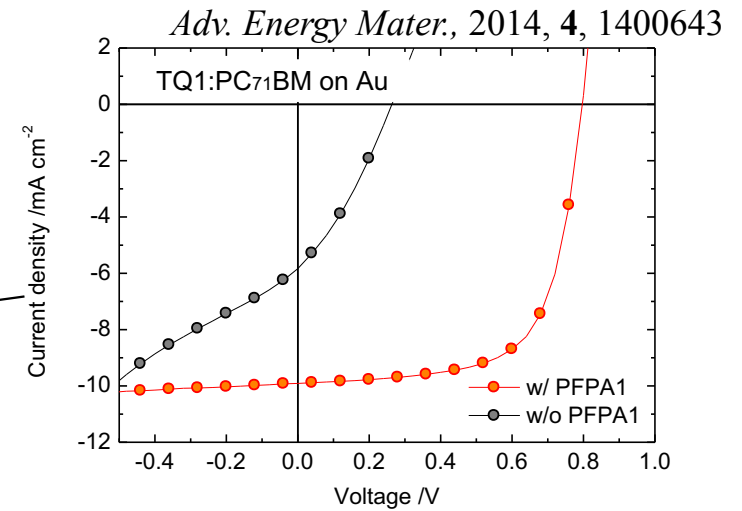
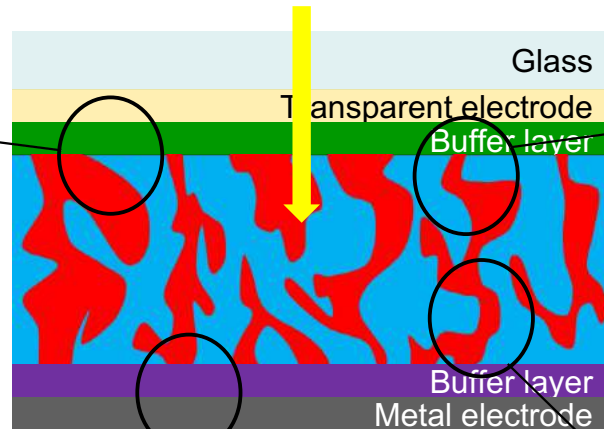
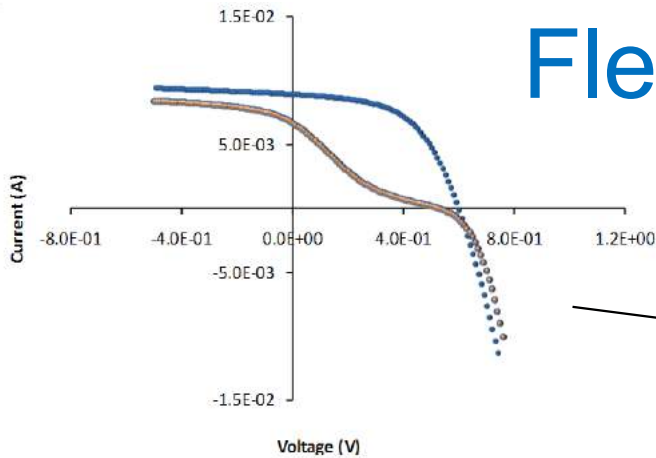
- Light weight low voltage electron emitters as portable x-ray sources, high surface electrodes....
- Flexible electronics, energy harvesting systems,....
- Nanofluids, separation membranes, anti-corrosion coatings, point of sampling diagnostics (eg faster and more sensitive, specific cancer biomarker sensors),....
- Durable surfaces that are self cleaning, non-wetting, non-biofouling, biocidal....
- Broad application of additive manufacturing, including energetic materials, product personalisation,...



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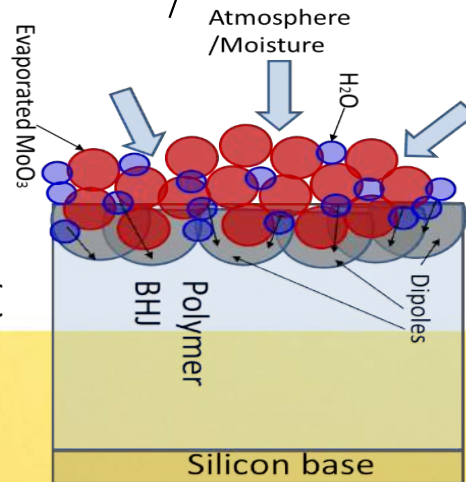


Flexible Solar Cells

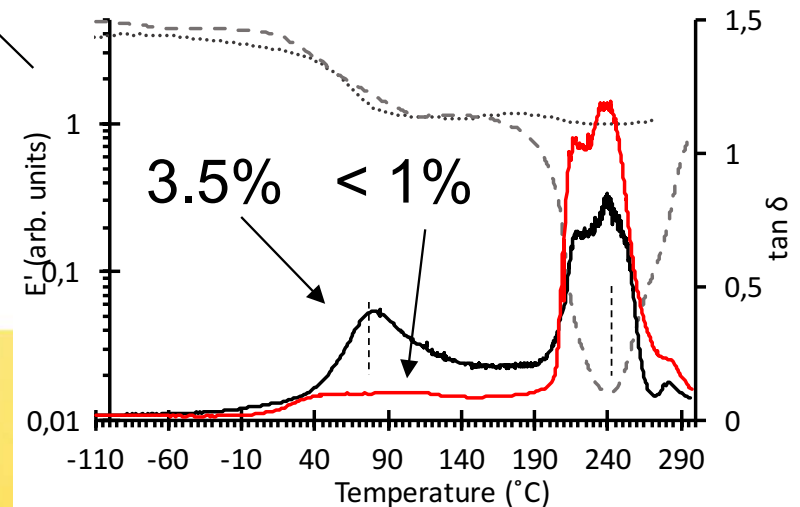


Exposure (stored for 48 hours)	Efficiency
Vacuum	2.9%
56% RH	0.6%
95% RH	1%

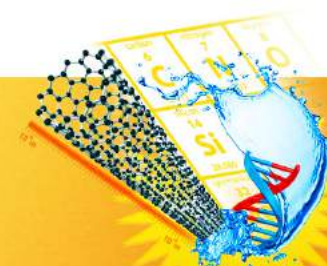
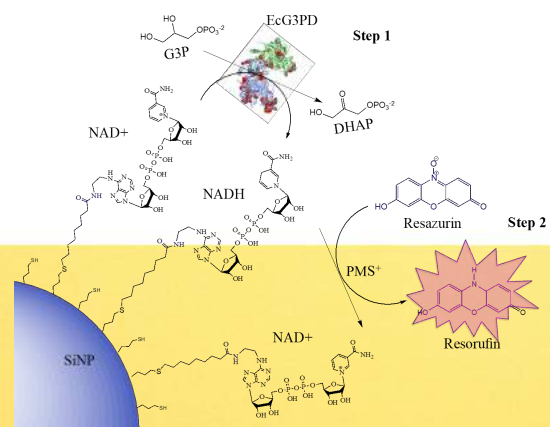
SOLMAT, 95, 3251-3255 (2011).
Physical Chemistry Chemical Physics, 13, 4381-4387 (2011).

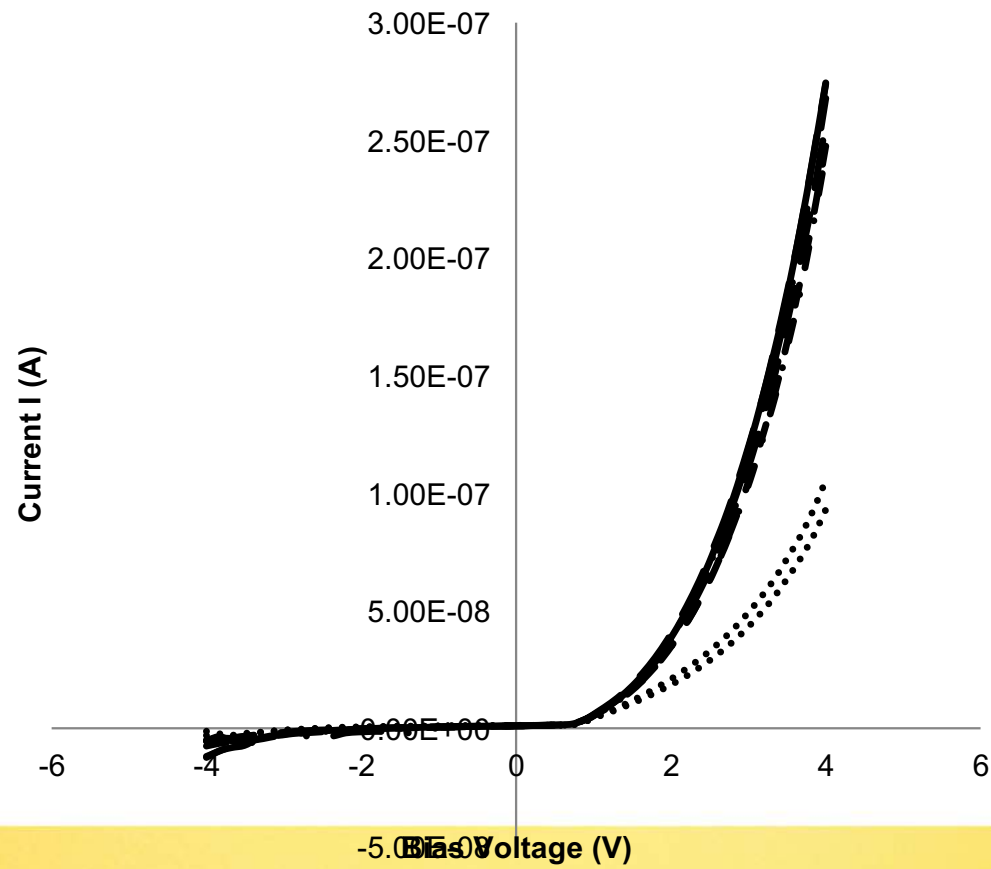


Macromolecules 2017, **50**, 3347

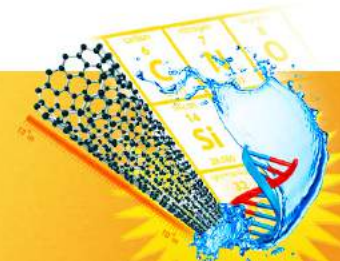


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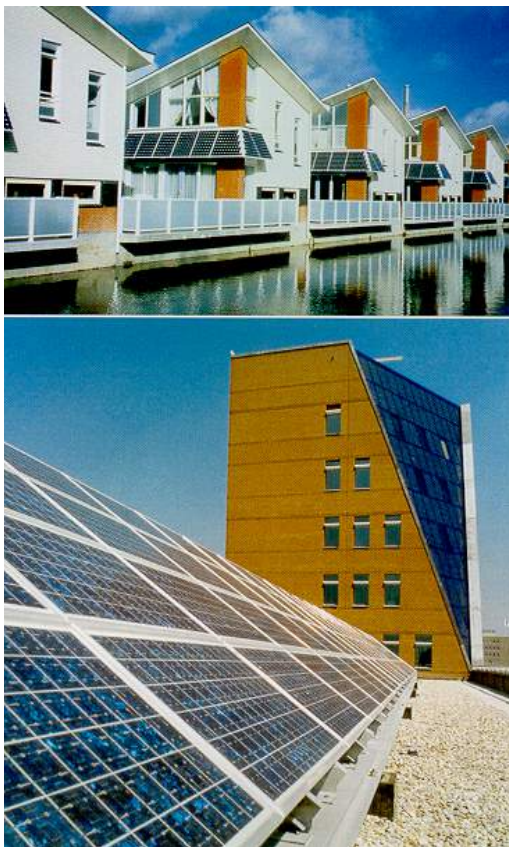




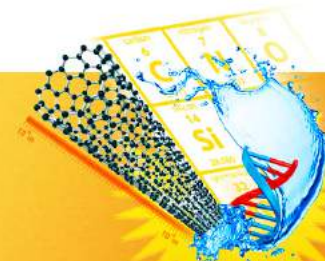
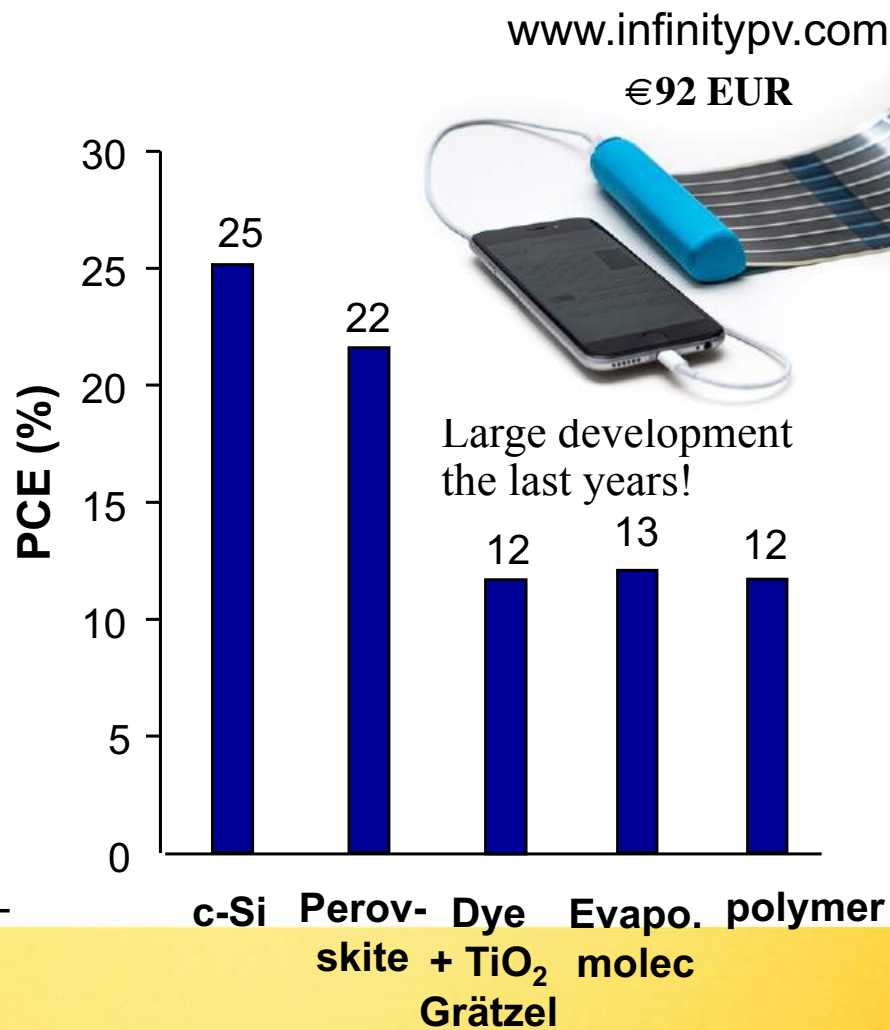
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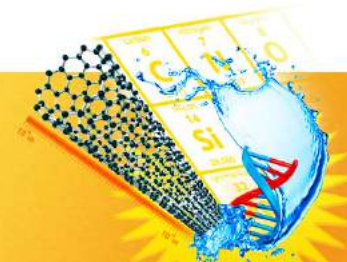
Efficiency of different solar cells



Theoretical limit for single-junction solar cells is 33%



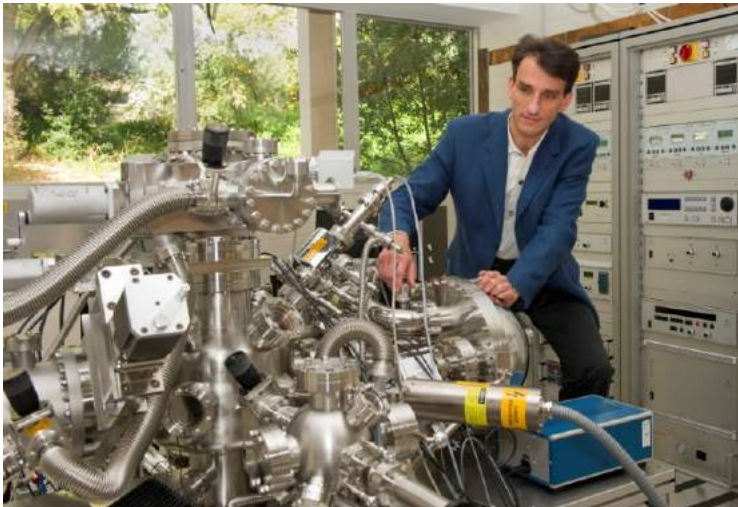
Biomimetic surfaces – lotus leaf



First understand surfaces, then the problem

Internationally unique equipment for

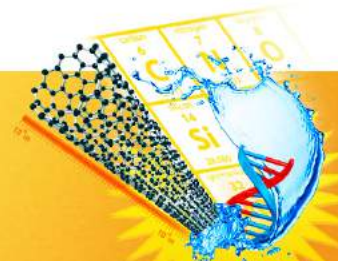
- Chemical composition of surfaces
- Depth profiling
- Surface topography and chemistry



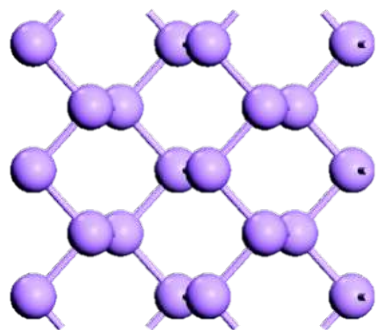
- Combine physics, chemistry, biology and engineering in a close-knit team
- Scanning Auger to determine chemistry of top few nm
- Polymer characterisation suite
- Device Fabrication facilities
- Clean room
- Then focus on the problem



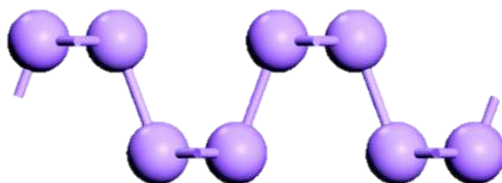
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Phosphorene



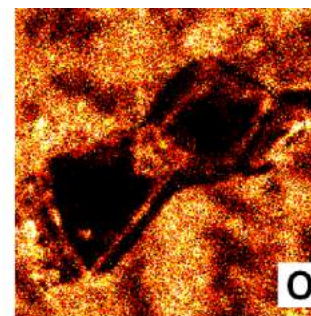
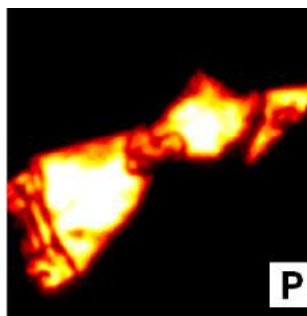
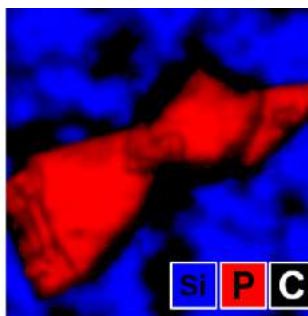
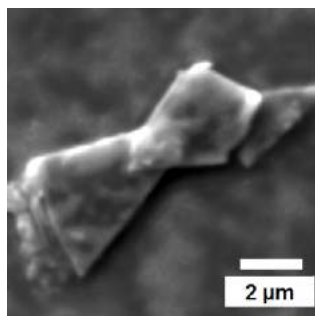
Top view of phosphorene



Side view of phosphorene



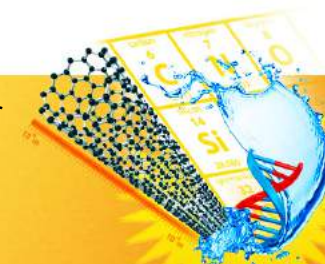
Structure of black phosphorus



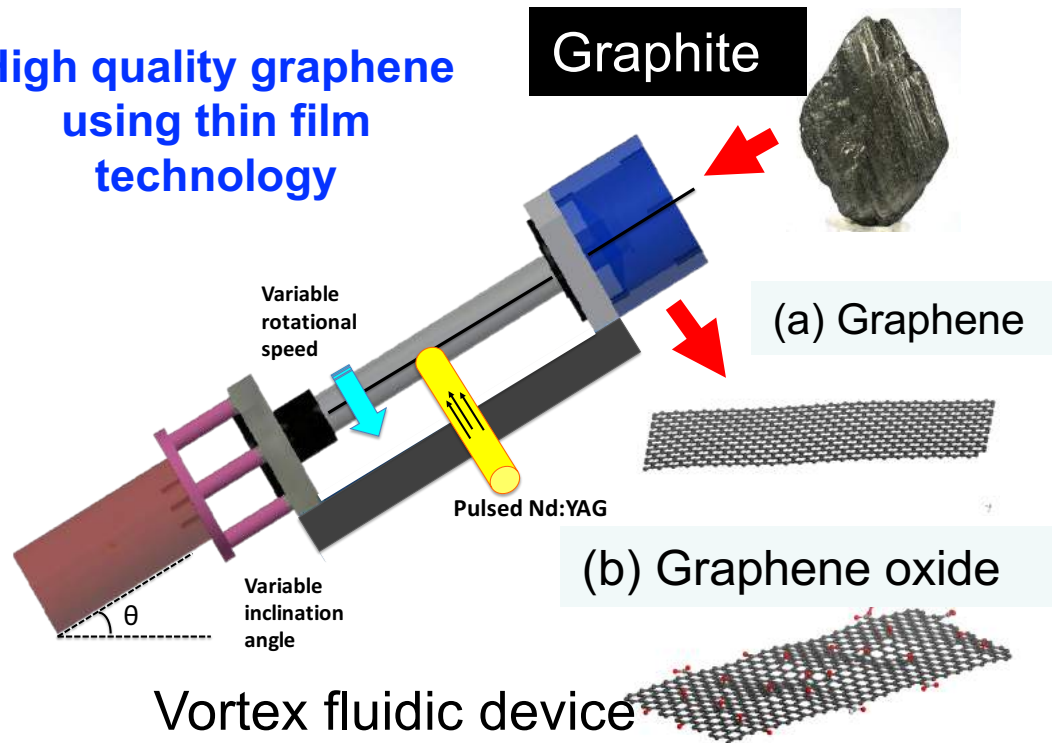
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Munkhjargal Bat-Erdene, Munkhbayar Batmunkh et al. "Efficient and Fast Synthesis of Few-Layer Black Phosphorus via Microwave-Assisted Liquid-Phase Exfoliation" *Small Methods* (accepted August 29, 2017).

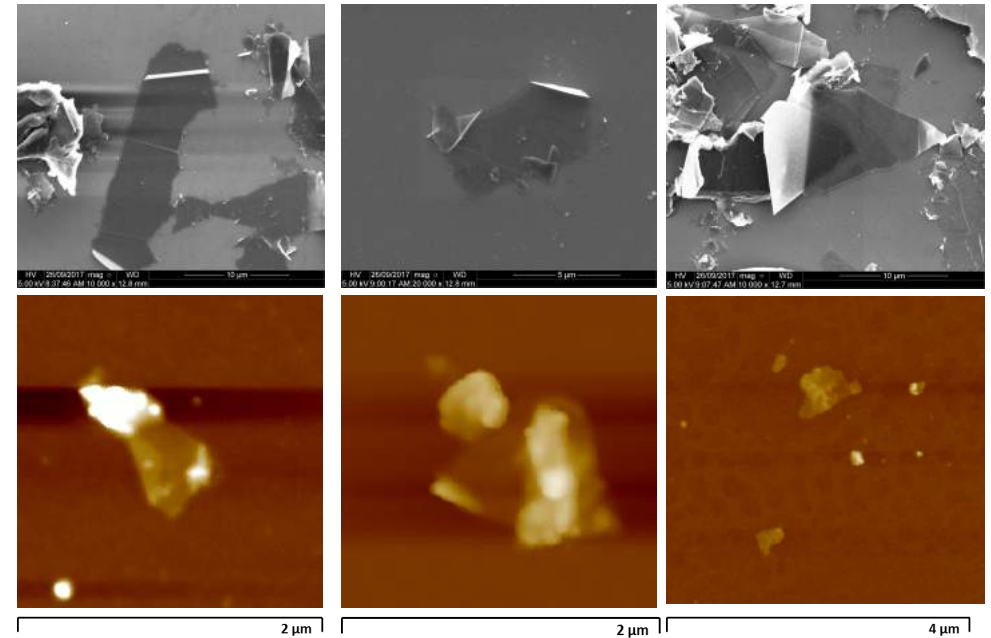
Munkhbayar Batmunkh, Munkhjargal Bat-Erdene and Joseph G. Shapter *Advanced Materials* 28, 8586–8617 (2016).



High quality graphene
using thin film
technology

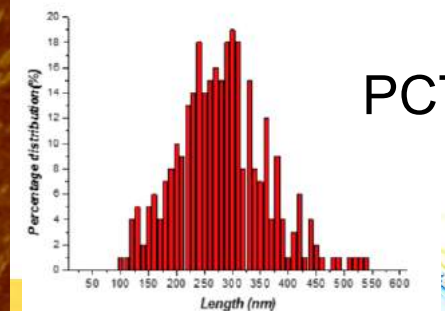
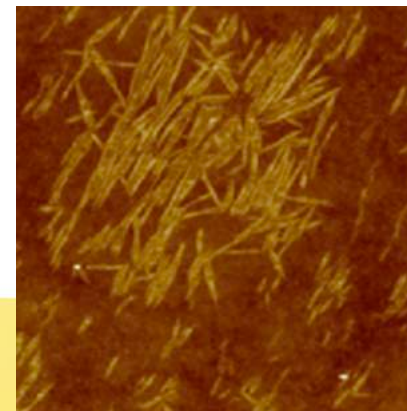


Provisional patent



VFD slicing SWCNTs and MWCNTs with length
control

Length ~80 nm to ~700 nm with
reduced side wall defects



PCT

< 300 nm >

PCT



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AgNW surface loading = 98

