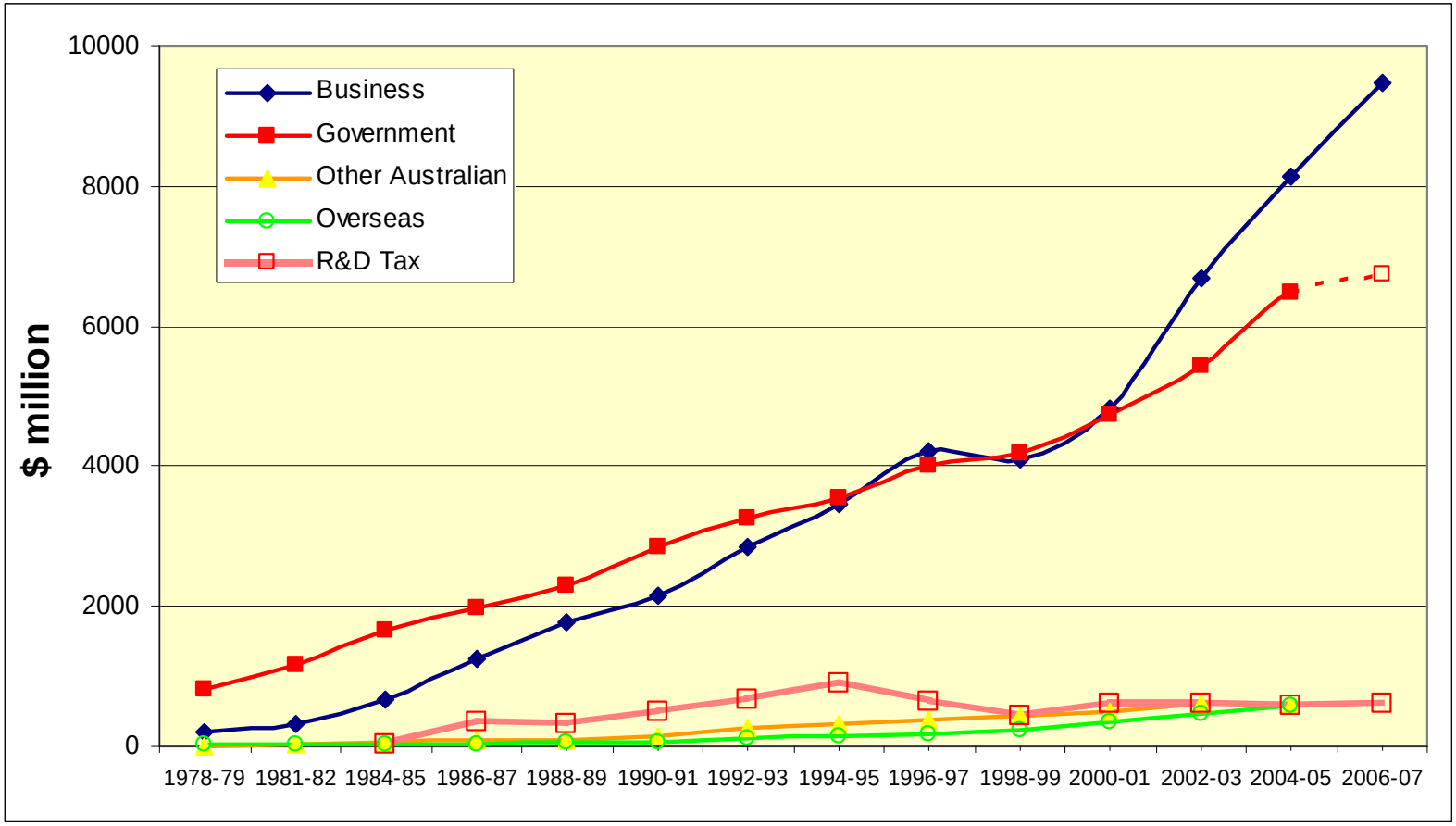
Fundamental Nanomaterials Research and Development: An Australian Perspective

Professor Max Lu

FTSE, Fed Fellow, Director

Gross Domestic Expenditure on R&D

Australia



Source: Compiled from data in DEST 2006, *Australian Science and Innovation System: A Statistical Snapshot*, pp 33, 34 & 56

Nanotechnology Programs

Australian Research Council

Centers of Excellence Program:

- Functional Nanomaterials
- Quantum Computing
- CUDOS
- Quantum Atom Optics

Federation Fellowship Program:

- Around 15 Fed Fellows

Research Networks Program

- ARC nanotechnology network (ARCNN)
- Australian research network for advanced materials (ARNAM)

Discovery and Linkage Projects

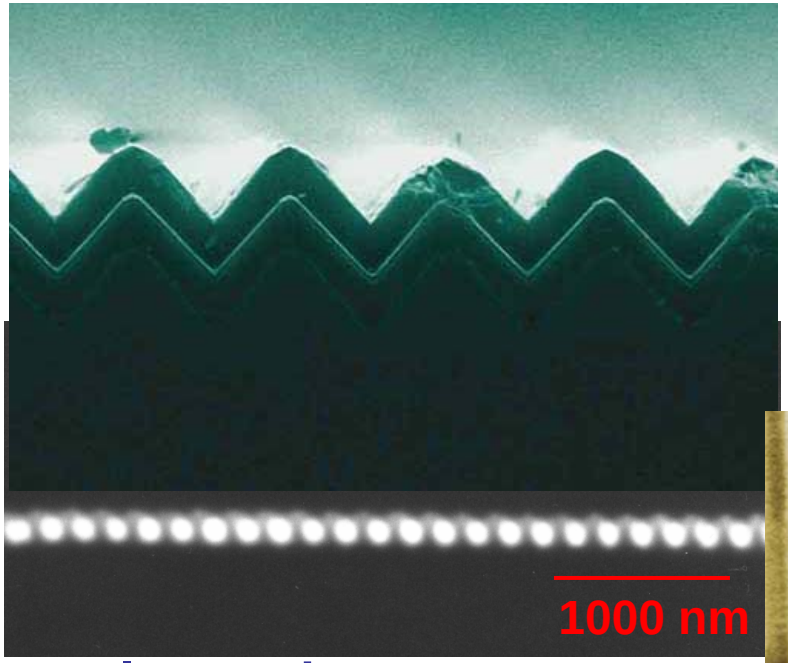
Total funding $100 million p.a.

Australian Research Council Nanotechnology Network

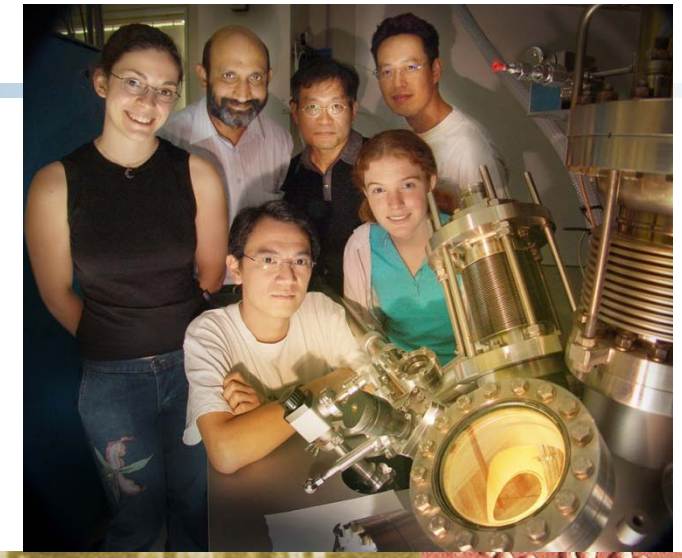
- 150 Groups, more than 900 members
- Conferences, Workshops, Summer School
- Short Term and Long Term Visits
- Overseas Travel Fellowships
- Distinguished Lecturer Visits
- Young Nanotechnology Ambassadors
- Facilities and Expertise Database
- **Bilateral Workshops**

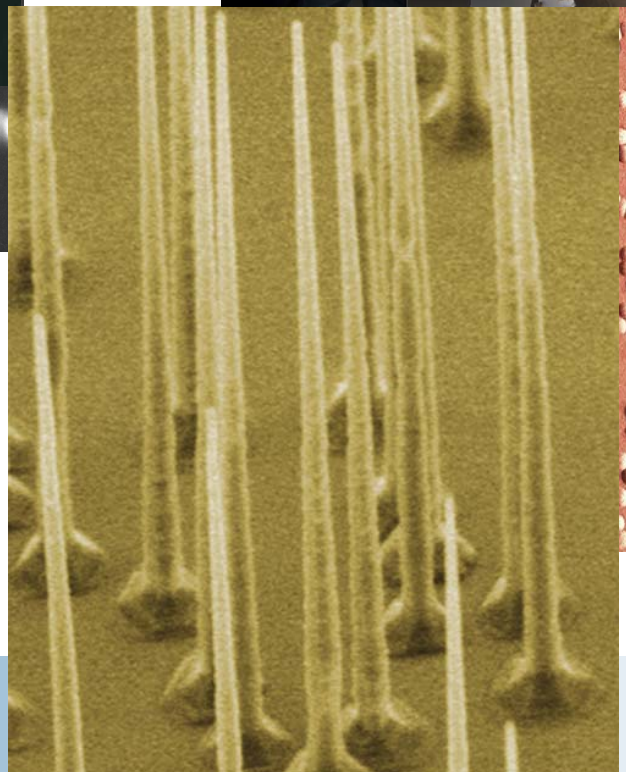
WWW.AUSNANO.NET **FREE to Join**

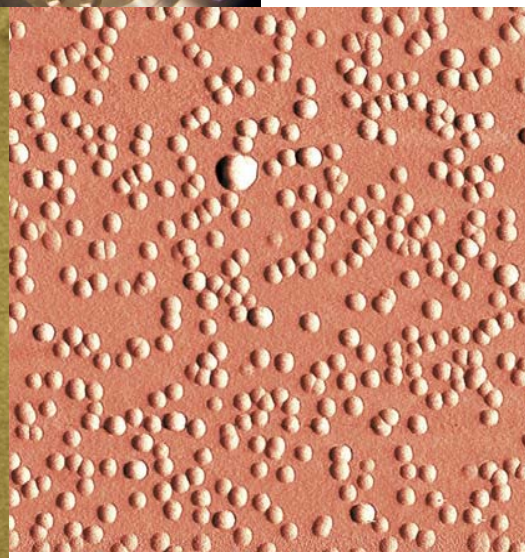
ANU: Quantum dot and wire lasers: Novel nanowires



laser wire array





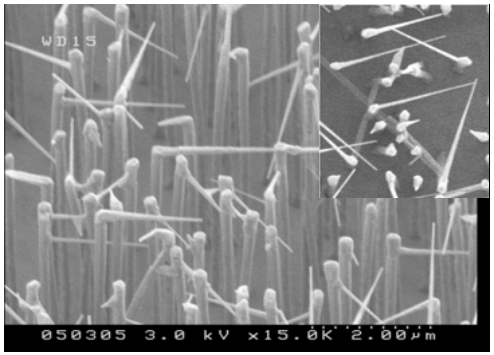


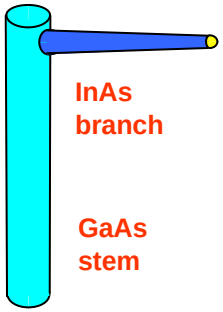
MOCVD growth,
novel processing
and integrated optics

ARC Centre for Functional Nanomaterials

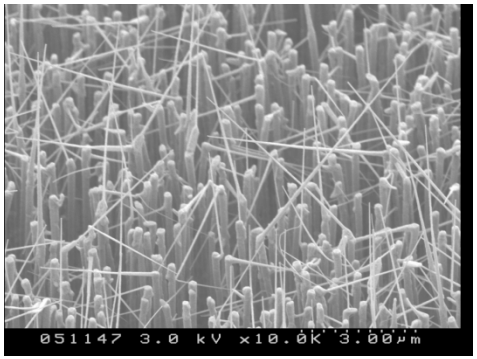
InAs/GaAs NW Heterostructures

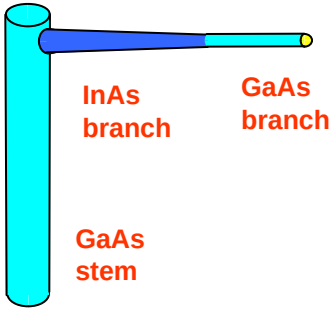
In Collaboration with UQ



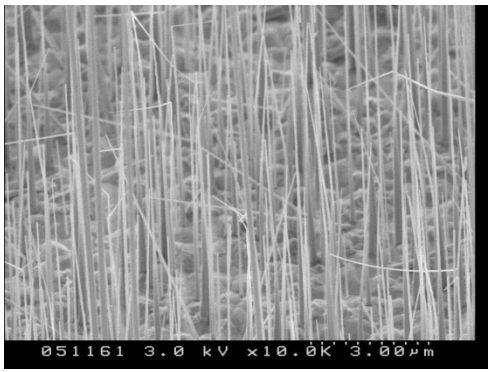


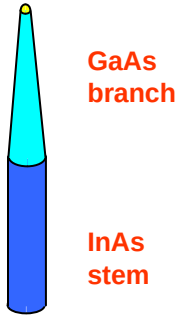
InAs/GaAs nanowires
(The inset is the top view)





GaAs/InAs/GaAs nanowires





GaAs/InAs nanowires

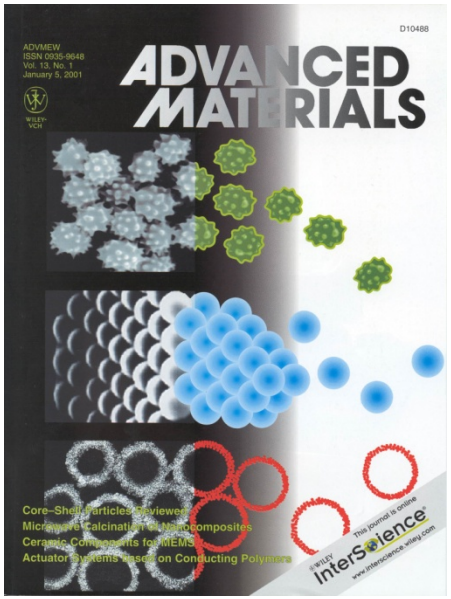
Bending of nanowire when growing on nanowire with smaller lattice constant

eg: InAs (a = 0.606 nm) on GaAs (0.565 nm)

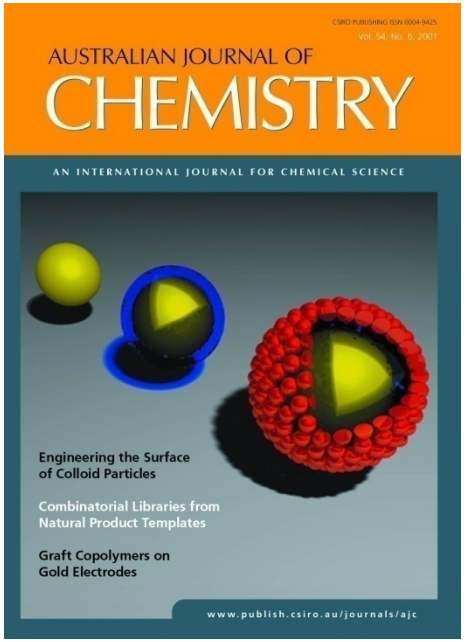
GaAs Nanowires are Zinc Blende and **InAs Nanowires are Wurtzite**

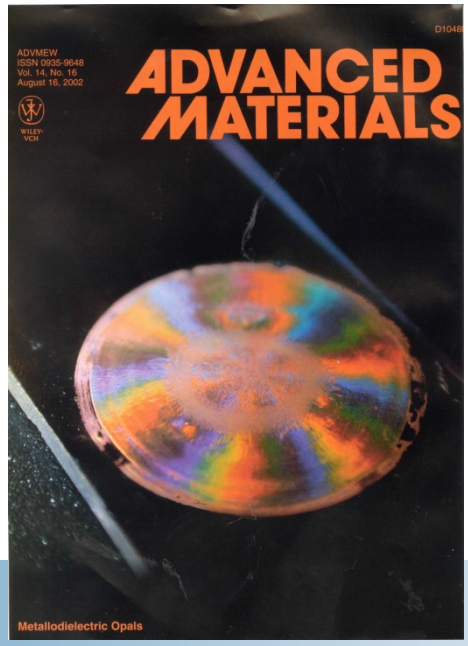
Nanoscience Research Group (Prof. Frank Caruso, Melb. Uni.)

Biocolloids (Cells) to Colloidal Crystals to Hollow Capsules



Nanoscale surface coating of particles with polymer layers (blue) and nanoparticles





Metallodielectric colloidal crystals prepared from gold nanoparticle/ polymer-coated polymer particles.

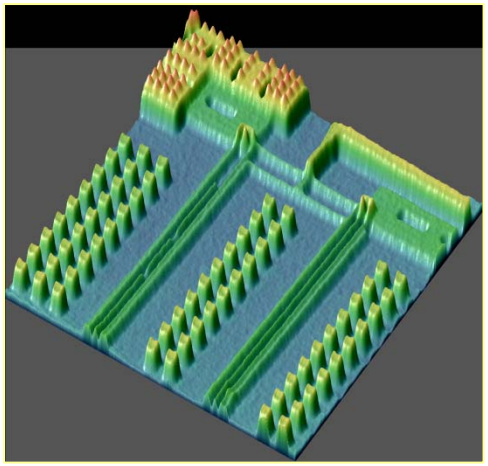
The image shows an area of ~2 cm diameter. The colours arise from Bragg diffraction of light.

ARC Centre for Functional Nanomaterials

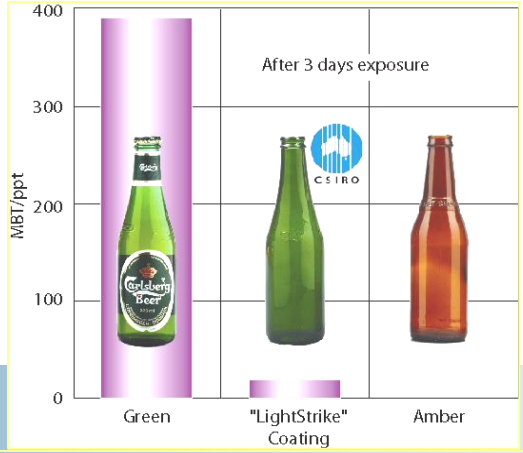
CSIRO Nanotechnology R&D

- **Established in 1926, CSIRO is Australia's national research organisation with 6,600 staff located at 60 sites**
- **12+ research units with NT activities**
- **Around $60 million pa**
- **Local and overseas nanotechnology companies are using CSIRO-generated IP in their core business**
  - ca 8 different IP platforms currently in marketplace + >6 undergoing final field trials

Soft nanolithography for coins and banknotes



XRT Pty Ltd - spin out company makes X-Ray Microscopes with 50 nm resolution



Nanostructured coatings prevent light degradation of beer, milk, edible oils and wines

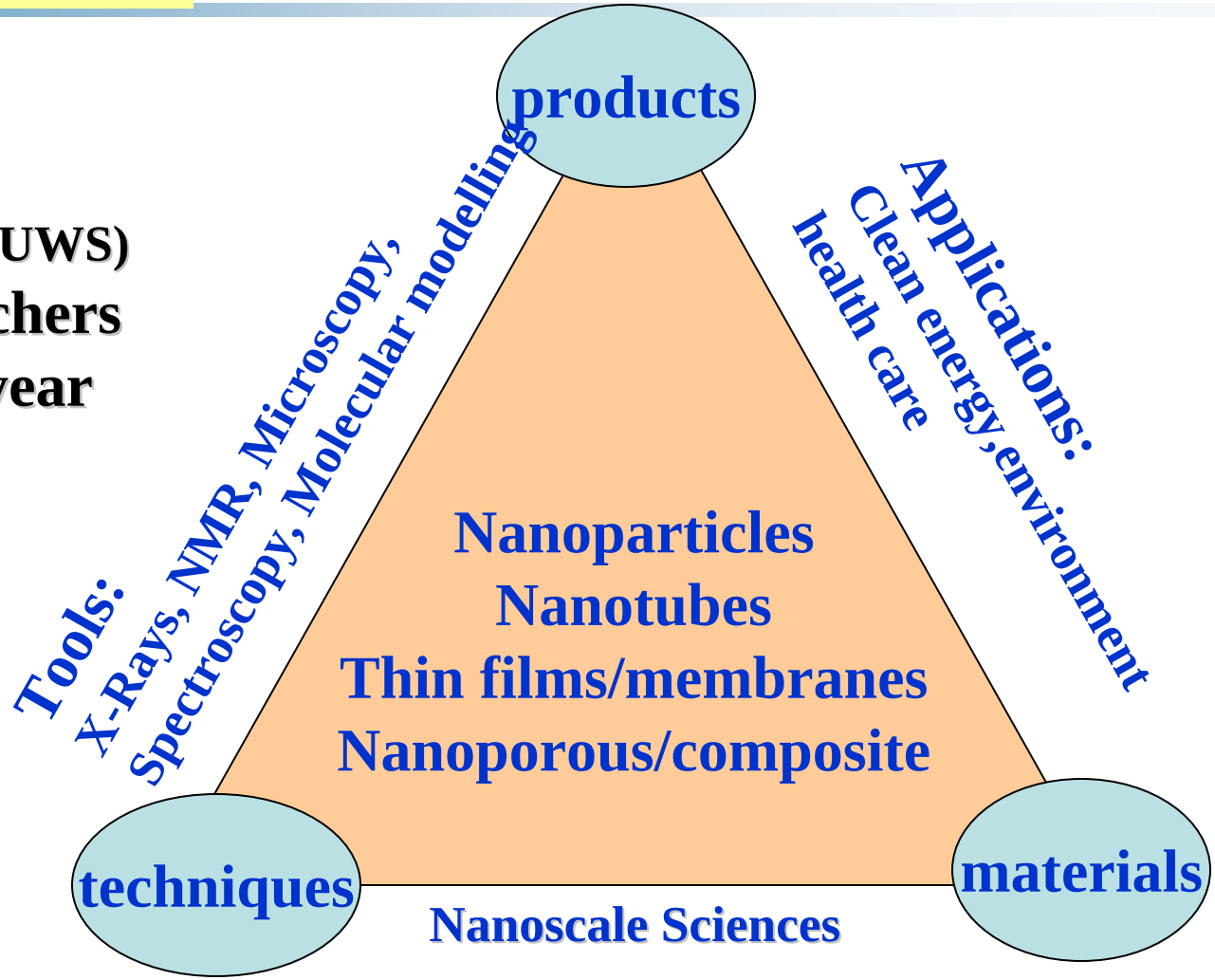
ARC Centre for Functional Nanomaterials

AIBN at UQ

$80m, 17 Groups/Centres, With 350 researchers

ARC Centre for Functional Nanomaterials

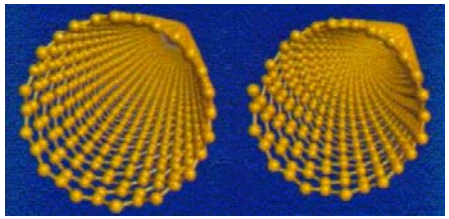
- **4 Universities**
  (UQ,UNSW, ANU, UWS)
- **over 110 researchers**
- **$24.8 m over 8 year**

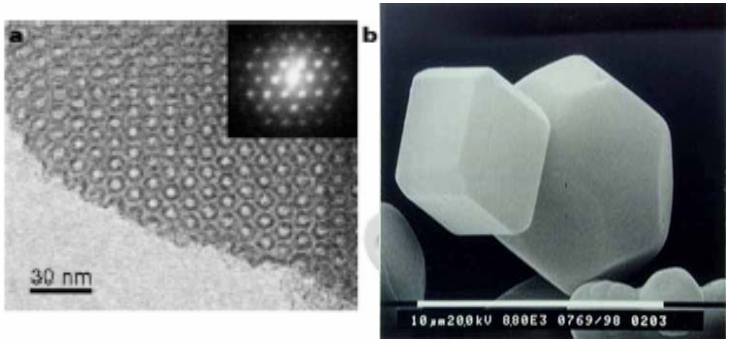


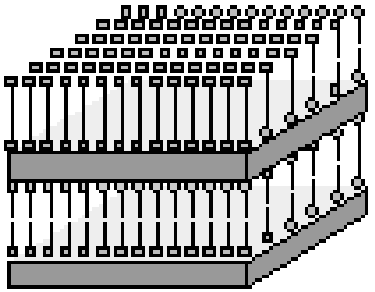
Http://www.arccfn.org.au

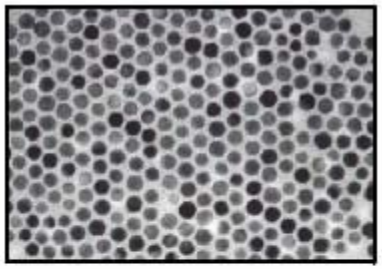
ARC Centre for Functional Nanomaterials

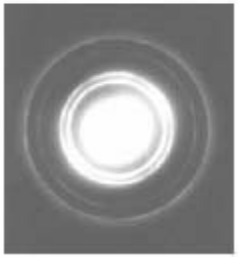
Functional Nanomaterials

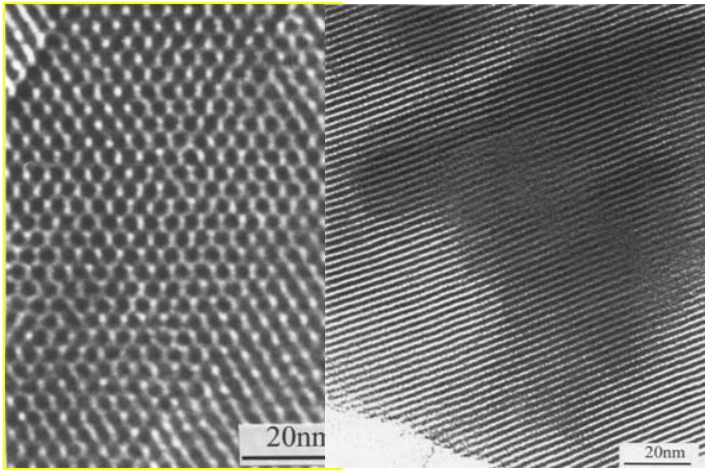


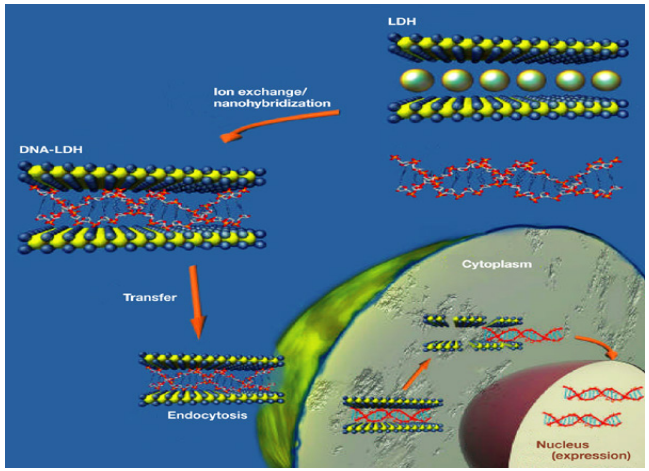








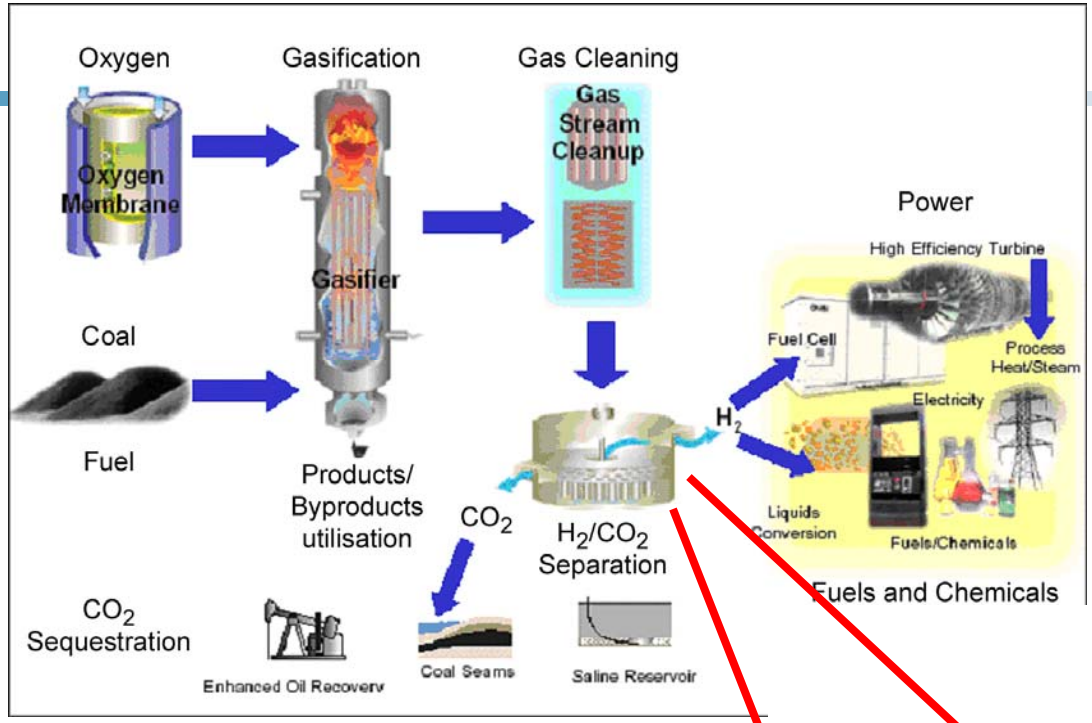




Programs and Researchers

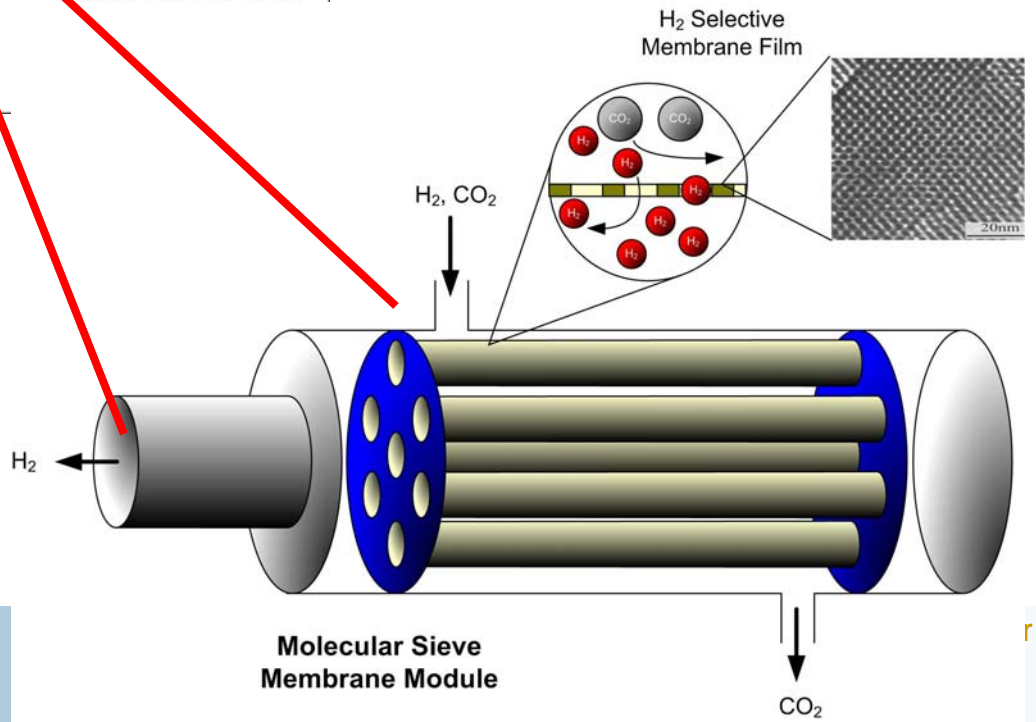
	Nanoparticles	Nanotubes	Nanofilms / membranes	Nano-biomaterials
H_2 production, storage, GTL, fuel cells	Lu, Smith, Beltramini, Wainwright,	Lu, Chen, Smith, Wilson	Da Costa, Lu & Drennan	
Energy Storage and Solar Cells	Smith, Lu, Drennan	Chen	Lu, Gentle, Drennan	
Environmental photocatalysis	Amal, Wainwright, Yu		Lu, da Costa, Amal,	Amal, Martin
Separation, Catalysis, desal.	Trimm, Amal & Wainwright	Da Costa, Lu	Da Costa, Lu	Gooding, Amal
Biosensors, tissue repair, nanotoxicology	Amal, Gooding	Wilson, Chen, Kannangara	Trau, Gentle	Martin, Trau, Gooding

Gas Separation Membranes



US DOE FutureGen

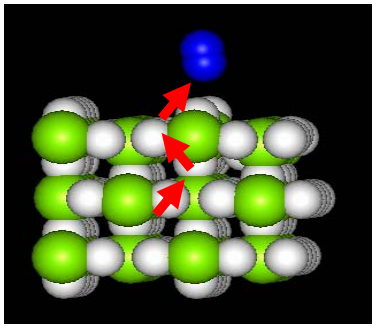
Molecular Sieve membrane

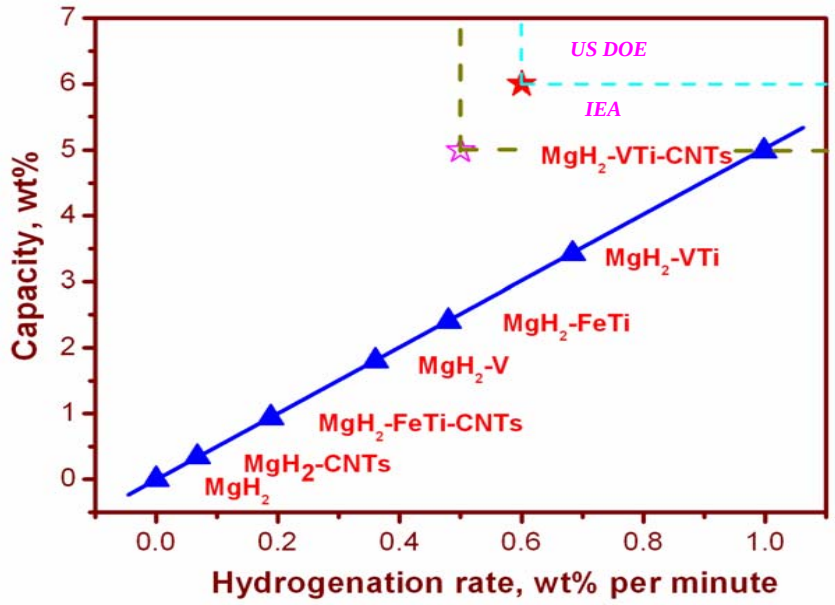


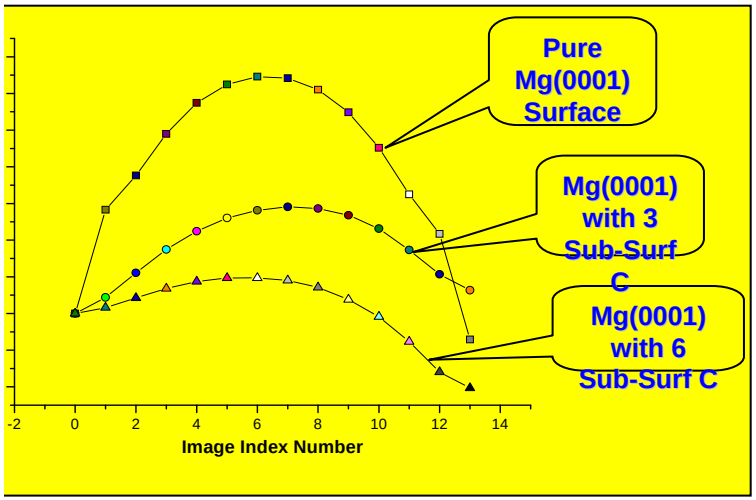
Hydrogen Economy

Catalyzed MgH_2 System for High Capacity H_2 Storage

	Mg-Cata1	Mg-Cata2	Mg-VTi-CNT	Mg-Cata4
200^{0}C/15min	4.7%H	5.8%H	5.2%H	5.2%H
150^{0}C/60min		4.8%H	4.5%H	





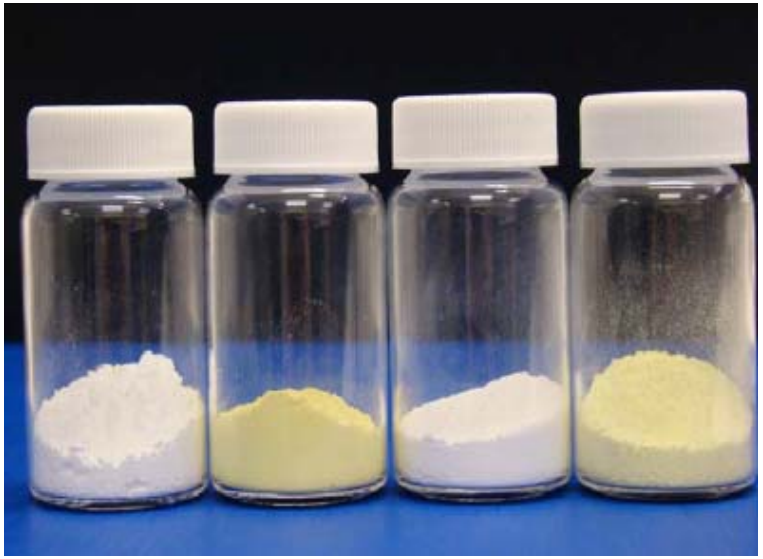


Du, Smith, Yao and Lu, J. Am. Chem Soc., 2007, 129,

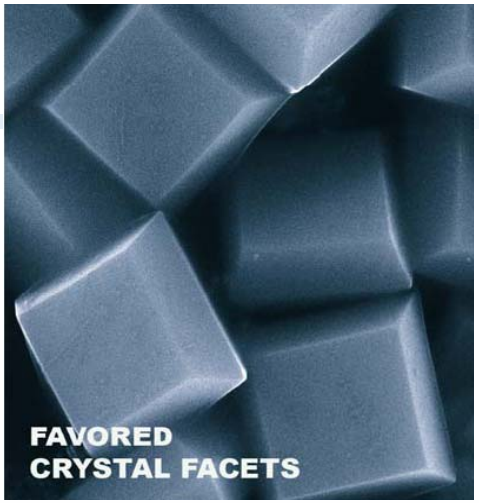
Yao and Lu et al,, JACS, 2007, 129,15650-15654

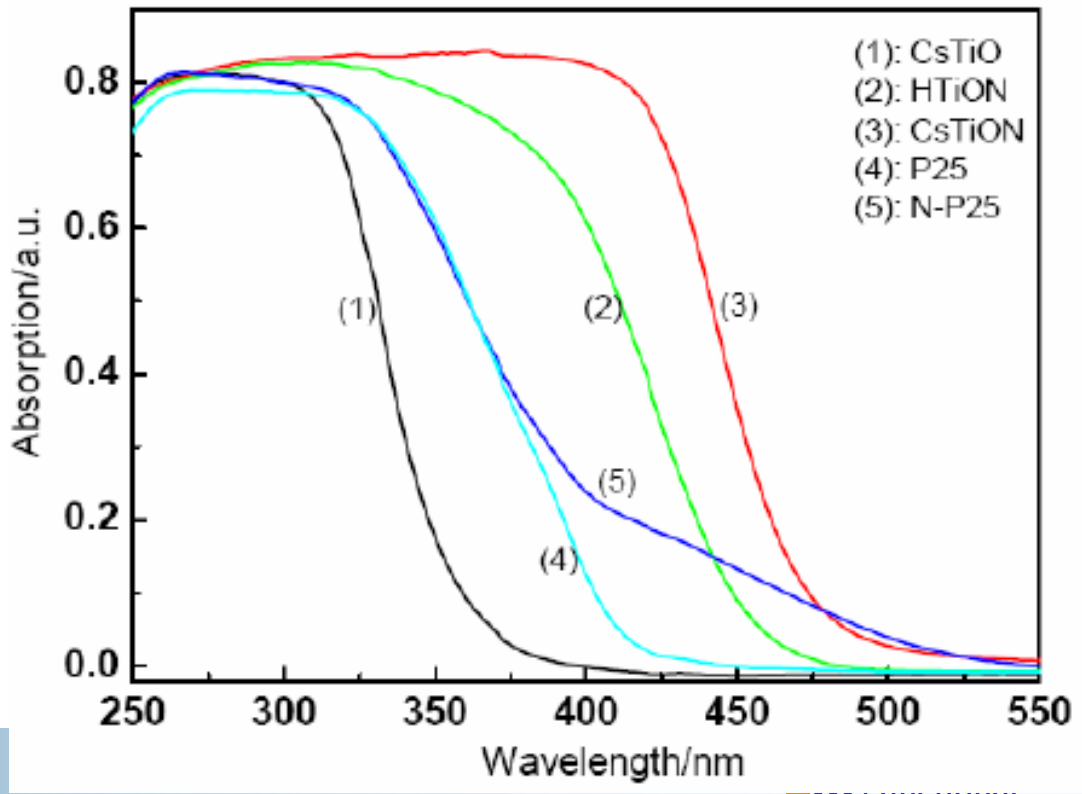
ARC Centre for Functional Nanomaterials

Novel Visible Light Photocatalysts



1. LT 3. LTN LT 2. HLTN

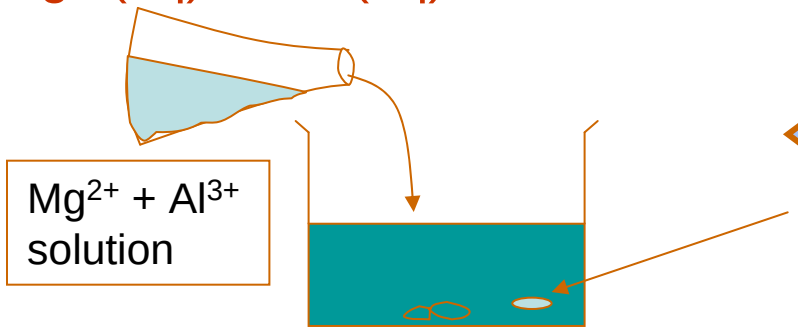


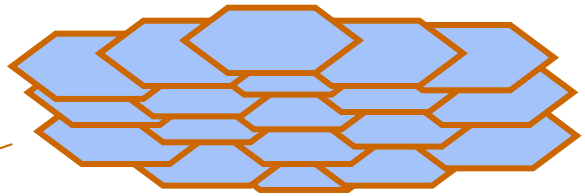


Visible light photocatalyst promising for high efficiency solar cells, cost-effective water purification, and hydrogen production from water splitting

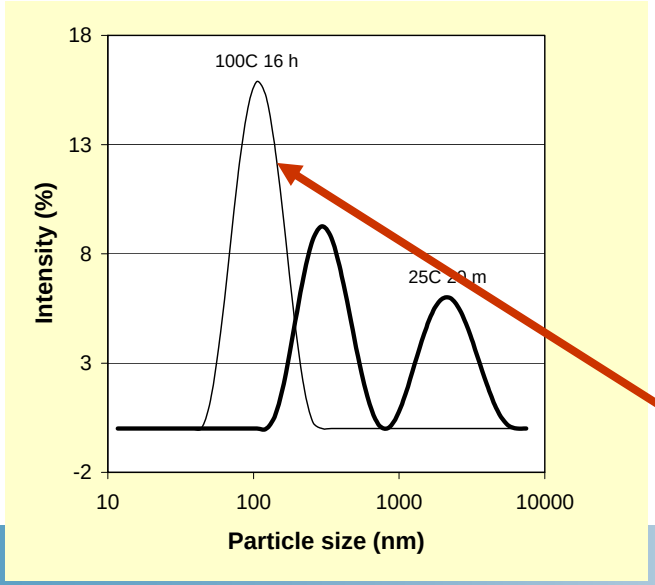
LDH Nanoparticles- Novel adsorbent, catalyst and molecular delivery agents

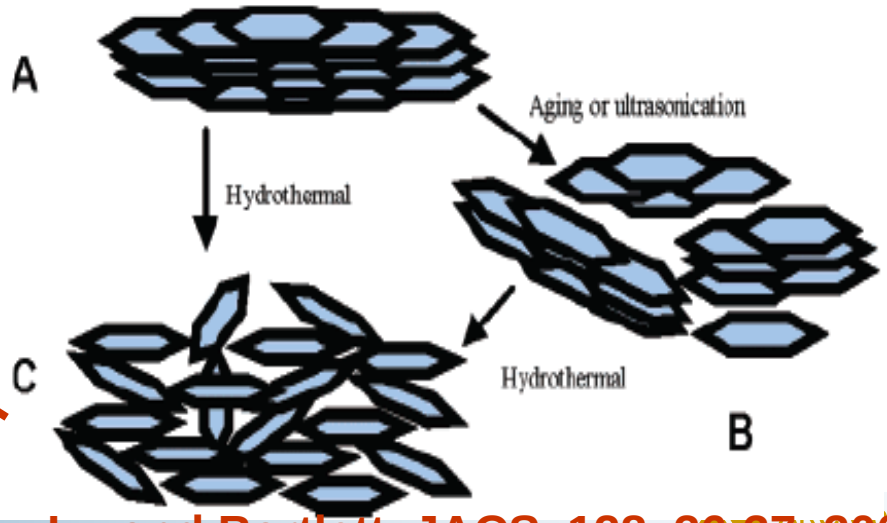
$2Mg^{2+}(aq) + Al^{3+}(aq) + 6OH^- + Cl^- \rightarrow Mg^{2+}_2Al^{3+}(OH)_6Cl\ (s)$





1-10 micrometers





Xu, Lu and Bartlett, JACS, 128, 36-37, 2006