

# The Nanotech/Biotech Interface at Curtin University

*Dr Bill Richmond*

*Senior Lecturer*

*Nanochemistry Research Institute*



NRI 

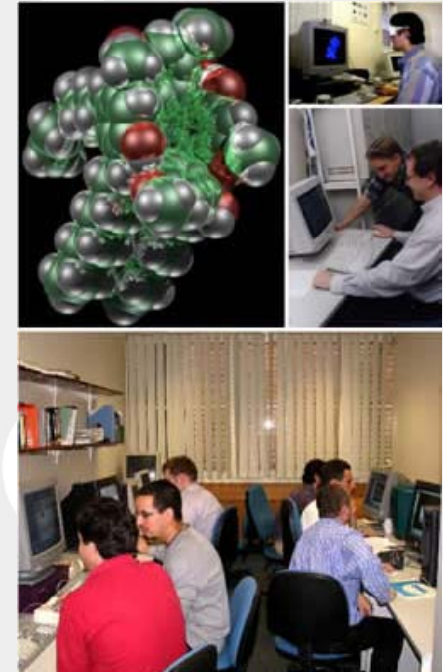


# The new chemistry building



# Nanochemistry Research Institute: Infrastructure

- Wet labs, crystallisers, synthetic chemistry
- Scanning probe microscopes
- Computational modelling
- In partnerships with centres providing electron microscopy, X-ray analysis facilities



# SPM Facility of the Nanochemistry Research Institute (NRI)



- Nanoscope E
- PicoForce with PicoAngler
- Dimension 3000 (with Nanoscope IIIa Controller and Extender)
- Dimension 3100 Nanoman™ (with closed loop xy- scanner and Nanoscope IV controller)



Dimension 3000



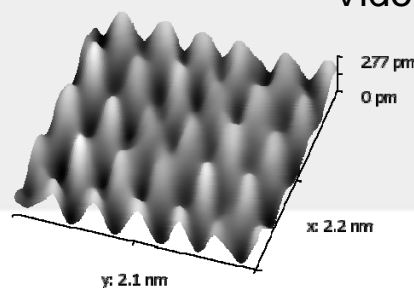
- 2 PicoSPM PicoScan 2100
- PicoPlus SPM (with Videomicroscope and environmental cell)



- Video AFM (air & liquid)



PicoPlus



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🌐 <http://www.nanochemistry.curtin.edu.au/facilities/spm.cfm>



# SPM facility of the NRI - Capabilities

- 7 Scanning Probe Microscopy (SPM) systems
- **Contact Mode**, Intermittent Contact Mode, Non-Contact Mode & MAC Mode™ operation
  - imaging of hard (crystals, metals,...) and soft (cells, polymers,...) surfaces
- **Interleave Scanning & Lift Mode** for Magnetic Force Microscopy (MFM), Electric Force Microscopy (EFM) & Surface Potential measurements (SKPM)
- Measurements in air and gaseous environments, including humidity and temperature control and *in-situ* measurements (in low and high pH and in most solvents)

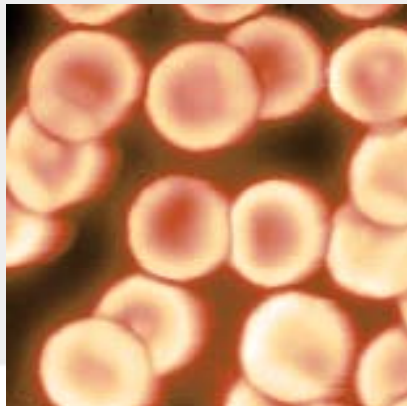
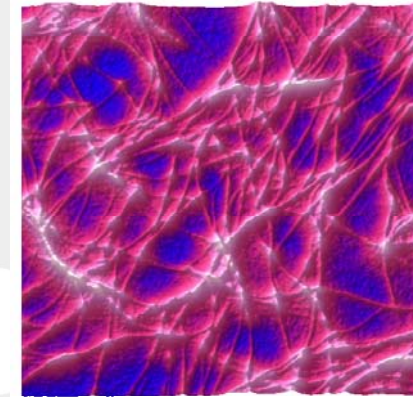
# SPM facility of the NRI - Capabilities

- **PhaseImaging™**
  - detection of variations in composition, adhesion, friction, viscoelasticity etc.
- **Force-Spectroscopy** incl. force feedback to “feel“ interaction forces between probe and sample
  - unfolding molecules, measurement of interaction forces between probe and sample etc.
- **Nanolithography, Nanomanipulation, Nanoindentation, -scratching & -wear testing**
- **Scanning Tunnelling Microscopy (STM), Scanning Tunnelling Spectroscopy (STS)**
- **VideoAFM** for realtime AFM measurements in air & liquids

# AFM applications – pharmacy & medicine

## → measurements on hydrogels (drug delivery, contact lenses)

Stimuli responsive gels are interesting for applications such as sensors and drug release. Tapping Mode AFM allows characterisation of the fibrous structure of the wet gels. The AFM height image shows a hydrogel formed from a solution of a chiral, water-soluble calixarene upon addition of  $\text{NaNO}_3$ . The gel was prepared as a thin film on a mica substrate.



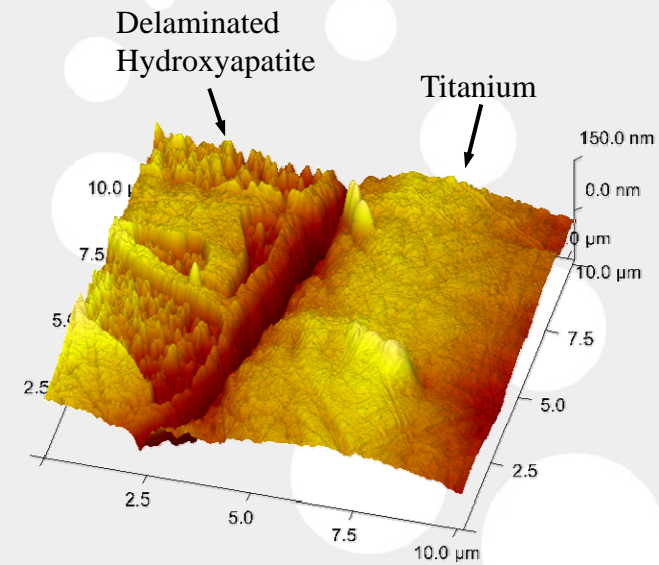
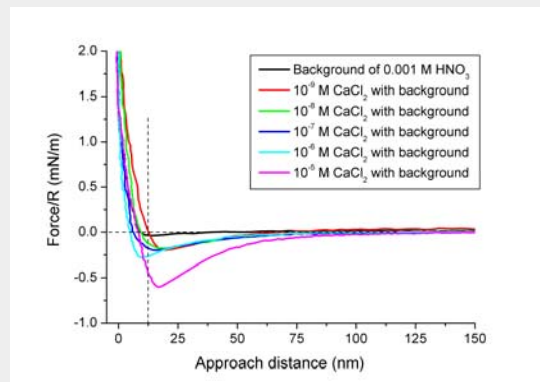
## → Super-paramagnetic nanoparticles as contrast agents for MRI

Super-paramagnetic nanoparticles can be used to enhance the contrast in MRI images. In this project we're investigating the loading of red blood cells with these nanoparticles with Magnetic Force Microscopy (MFM)

# AFM applications – pharmacy & medicine

→ quality/stability/performance of coatings on implants

- Investigation of the delamination of hydroxyapatite coatings on bone implants.
- Dissolution of teeth in soft drinks.



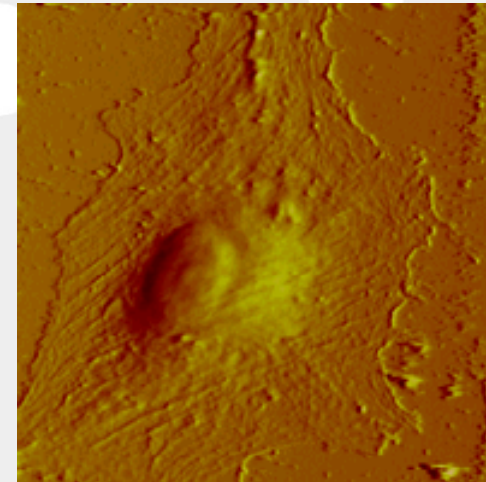
→ ion-selective AFM sensors

In this project we investigate the response of ion-selective polymeric microspheres attached to AFM cantilevers to very low concentration of specific ions in a solution

# AFM applications – pharmacy & medicine

→ Neurotraumas – regeneration of surrounding tissue

- Study of the kinetics of peptide scaffold self-assembly and the effect of pH and concentration. At a later stage we intend to characterise the scaffolds and the growth of the cells on the scaffolds with AFM.
- Drug targetting with nanoparticles

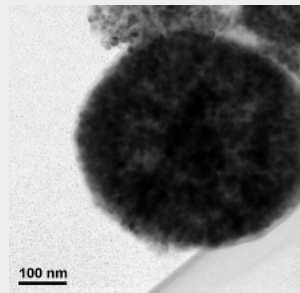


Living glial cell  
(<http://www.veeco.com>)

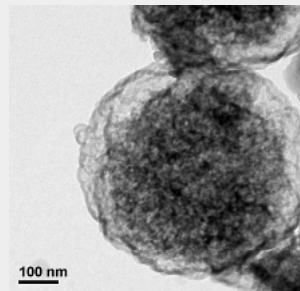
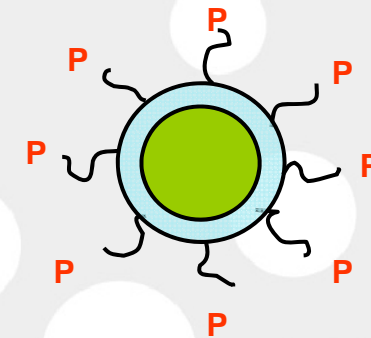
# Polymer-Silica Nano Spheres

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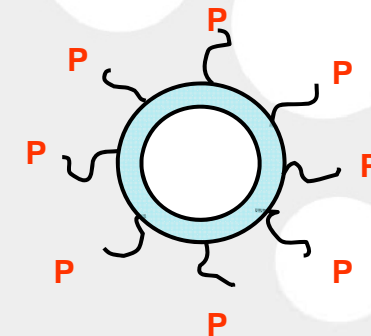
- **Two structures:**
  - Core-Shell & Hollow
  - Porous or nonporous
- **Polymers:**
  - Hydrophobic
  - Hydrophilic
  - T responsive
  - pH sensitive
- **Applications:**
  - Sensing
  - Cell targeting
  - Drug/gene delivery



Core-shell

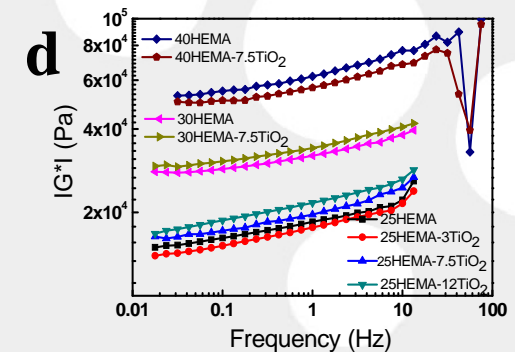
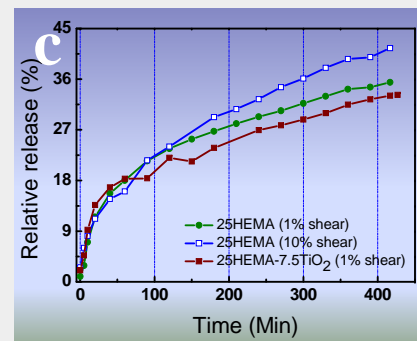
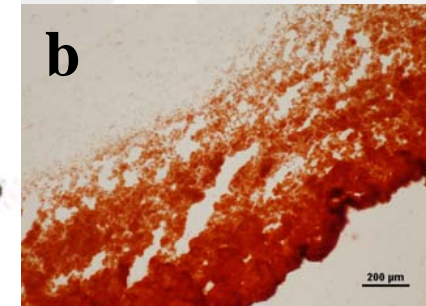
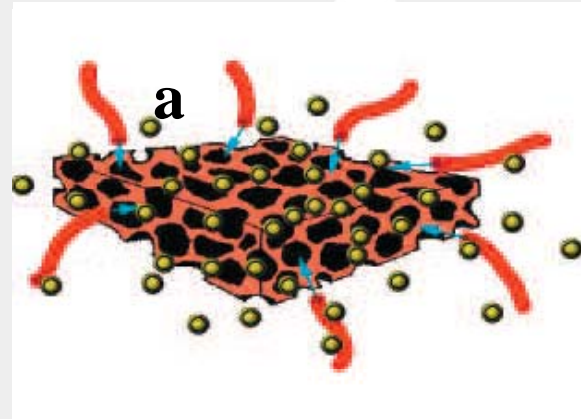


Hollow



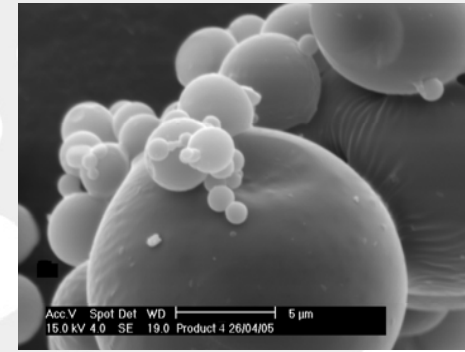
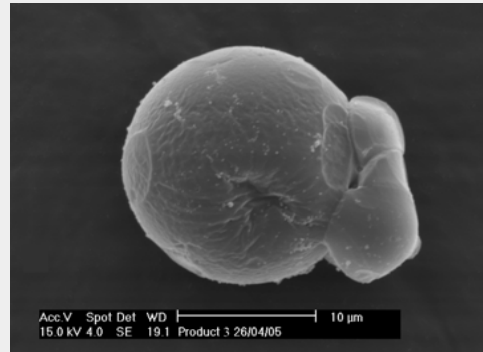
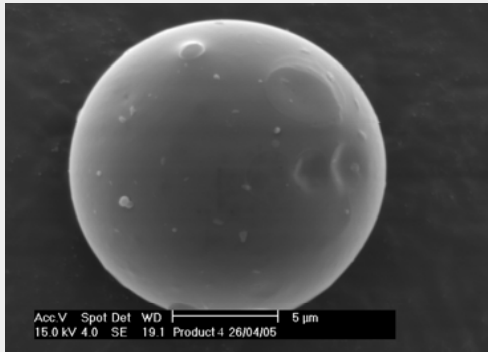
# Nanocomposite Hydrogels

- Controlled delivery of steroids, growth factors
- Calcification capacity for orthopaedic applications
- Rheological responses in comparison to human muscles
- Mechanical stimulated drug release from hydrogel scaffolds
- Modelling (in collaboration with Dr S. Wang)



- a) **A composite hydrogel template**  
 b) **A calcified scaffold** *Li, Zheng, Lou. JMMM, 2009*  
 c) **Stimulated release of MB**, *Li & Lou, PCC11 2009*  
 d) **Rheological responses**, *Li & Lou, PCC11-2009*  
 e) **Drug delivery & Modelling**, *Munro, Wang, Lou, Biomaterials 2004; AJP Chem Eng, 2007; Wang & Lou, JIMO, 2009; Optimisation & Eng, 2009.*

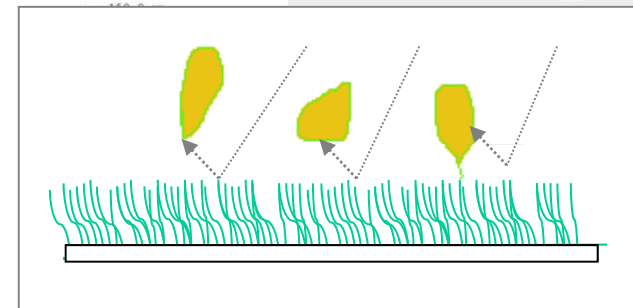
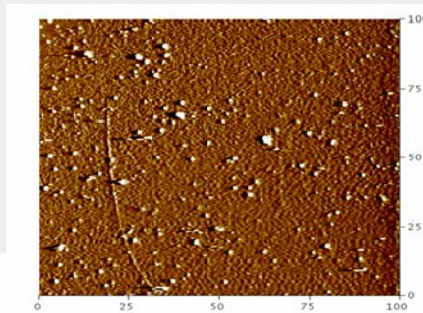
# Biodegradable Particles For ODNs Delivery



*Chirila et al, Biomaterials 2002; Li, Zheng, Li, Lou X, Zheng, Thermochemica Acta. In press 2009; Low, Hellmann & Lou, Micromole & Rapid Commun.*

(ODN = Oligo-deoxynucleotides)

## Bioactive Surfaces for Tissue Engineering and Medical Implants: Protein-Hydrogel Interactions

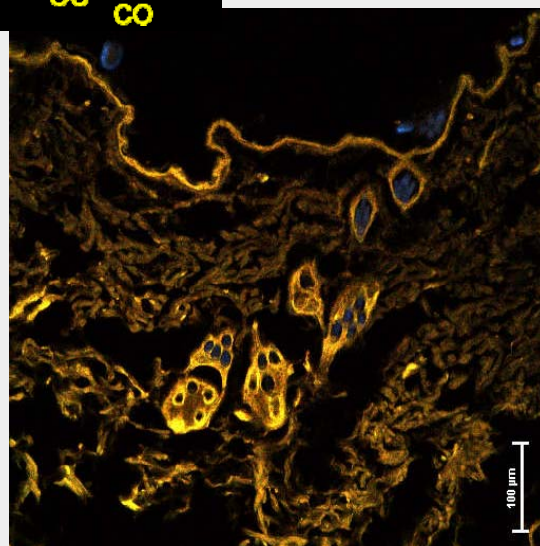
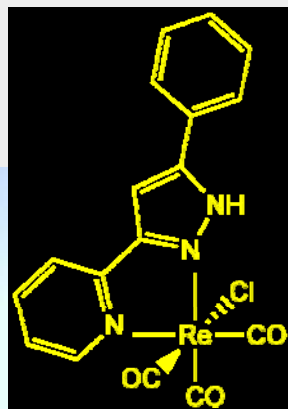
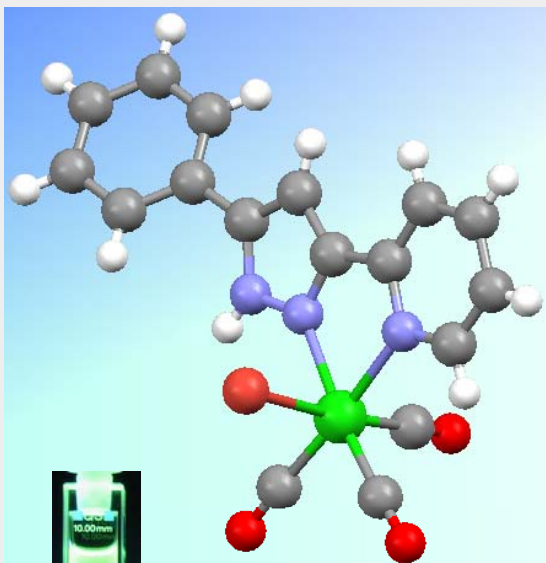


*Hicks, Morrison, Lou et al, Expert Review of Medical Devices 2006, Lou et al, Biomaterials, 2004; Hicks, Corford, Lou et al, Eye 2003;*

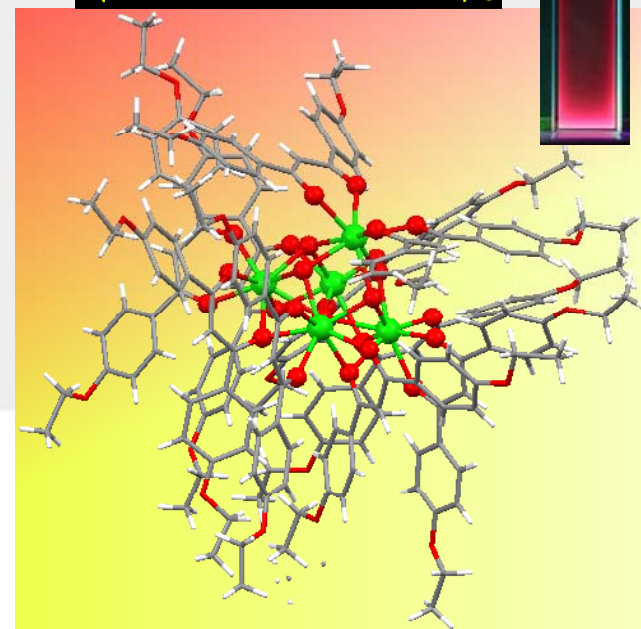
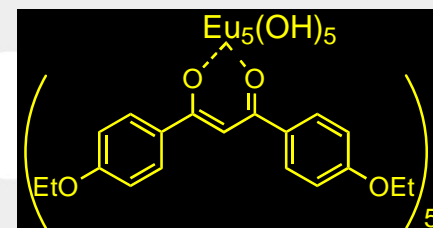
*Su, Grenik, Becker & Lou. How proteins interact with porous pHEMA.*

# Synthesis and Application of Phosphorescent Metal Complexes

Dr Max Massi,  
Department of Chemistry



Biological Labels for  
Optical Imaging



# Contacts

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