Institute for Materials and Processes

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Institute for Materials and Processes
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IMP

- Largest research institute in the School of Engineering
- Home to currently
  - 21 academic staff
  - ~50 research students
  - 10 research staff
- Broad range of research
- Annual research grant expenditure ~ £5M
- Head: Khellil Sefiane
- Deputies: Vasileios Koutsos, Tina Düren

Research interests related to MP1106

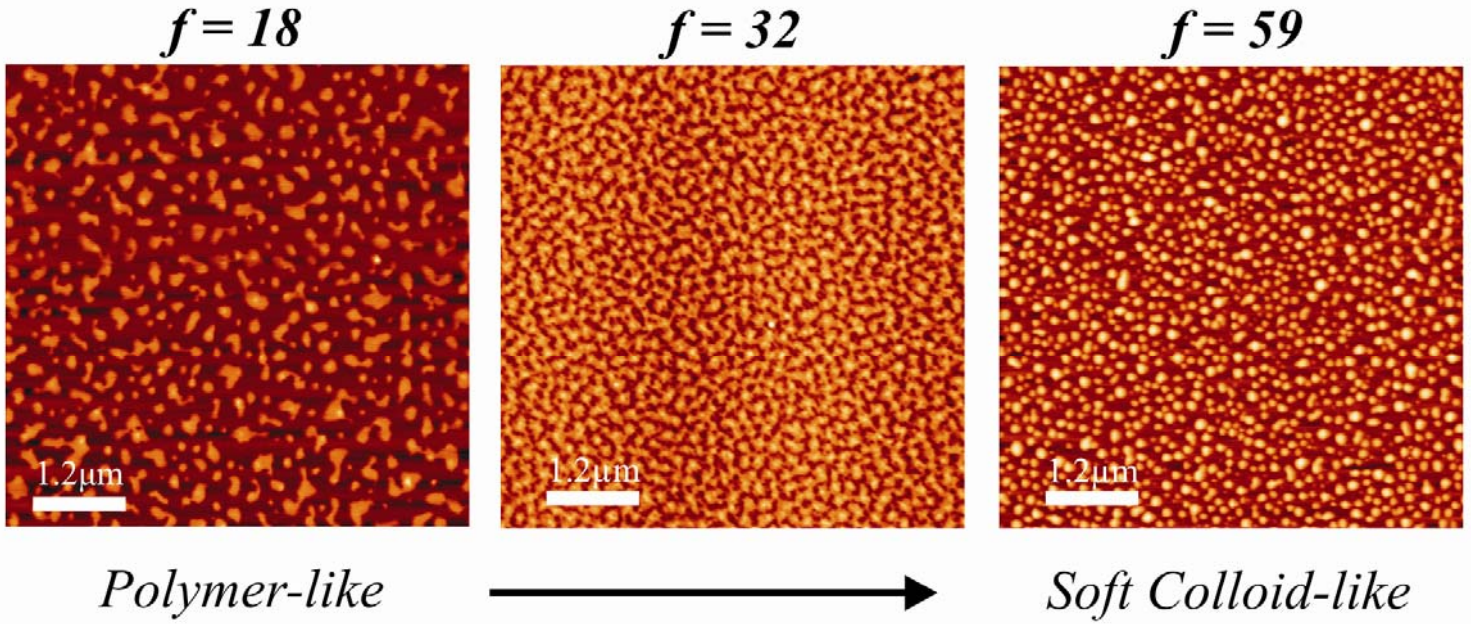
- Complex fluids/Soft materials (nanofluids, polymers)
- Surfaces and interfaces (solid-liquid interface, droplets on surfaces, evaporation, nanopatterning)
- Fluid and particle dynamics

Applications: Industrial (Chemical Industry, Materials) and Biomedical

Equipment and Facilities

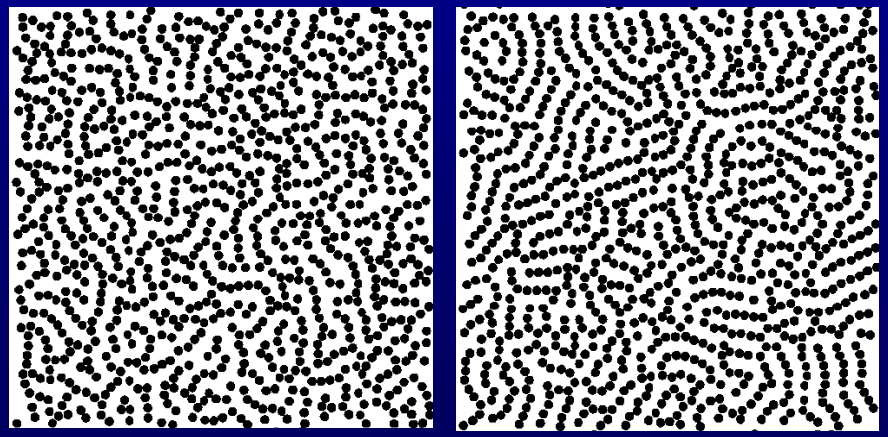
- Sample/materials prep facilities, wet lab (fume cupboards, chemical ovens, furnaces, automated spin-coater, UV-ozone cleaner, ultrapure water etc.)
- Surface and materials analysis (AFMs, contact angle analysers, optical profilometer, Raman spectroscopy, high resolution/fluorescence optical microscopy, mechanical testing, rheometer, tribometer, access to SEM, TEM, XRD, XPS)

Star Polymers on Surfaces



Glynos, E. Koutsos, V. et al. *Macromolecules* 2007, 40, (19), 6947-6958.

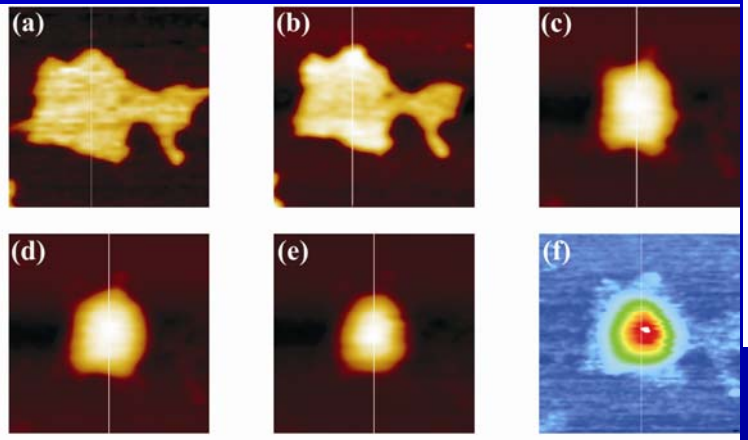
Our adsorbed polymers when in good solvent may behave like a two-dimensional system of repulsive soft spheres; indeed, some of our structures are similar to theoretical predictions of alignment of the particles, worm-like filaments and stripe phases from isotropic repulsive interactions"

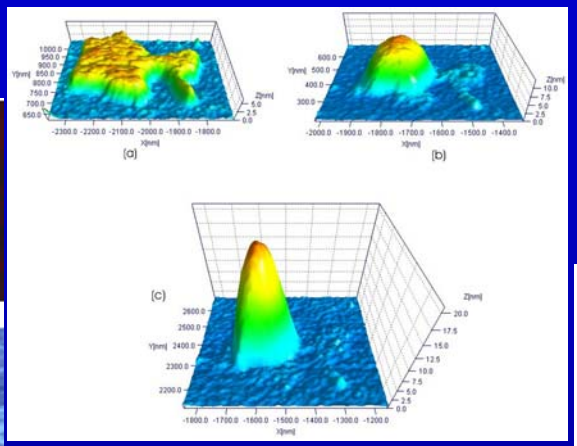


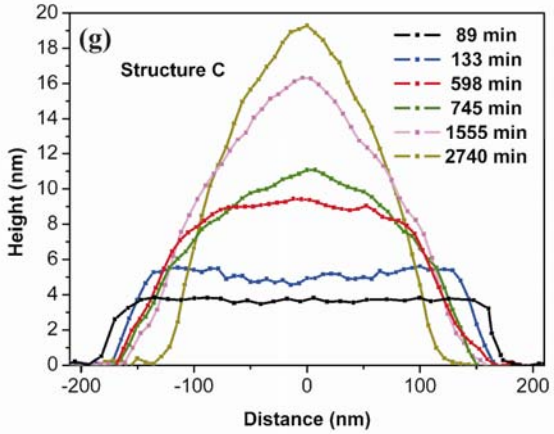
Malescio, G.; Pellicane, G. *Nat. Mater.* **2003**, *2*, 97-100.
Malescio, G.; Pellicane, G. *Phys. Rev. E* **2004**, *70*, 021202.

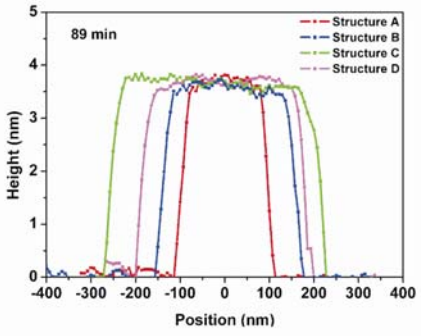
Y. Norizoe,T. Kawakatsu, *Europh. Letters* **2005**, 72 (4) 583–589

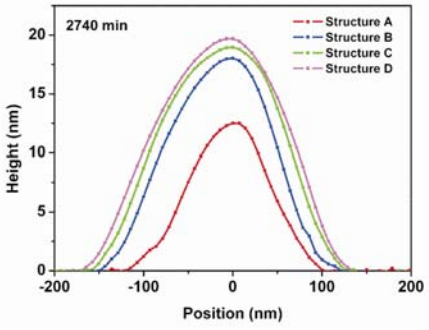
PEO-PI on Mica: droplets changing shape

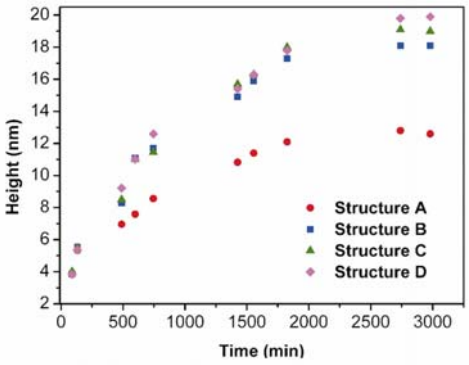


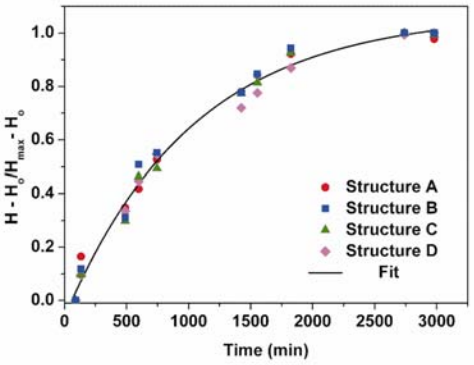






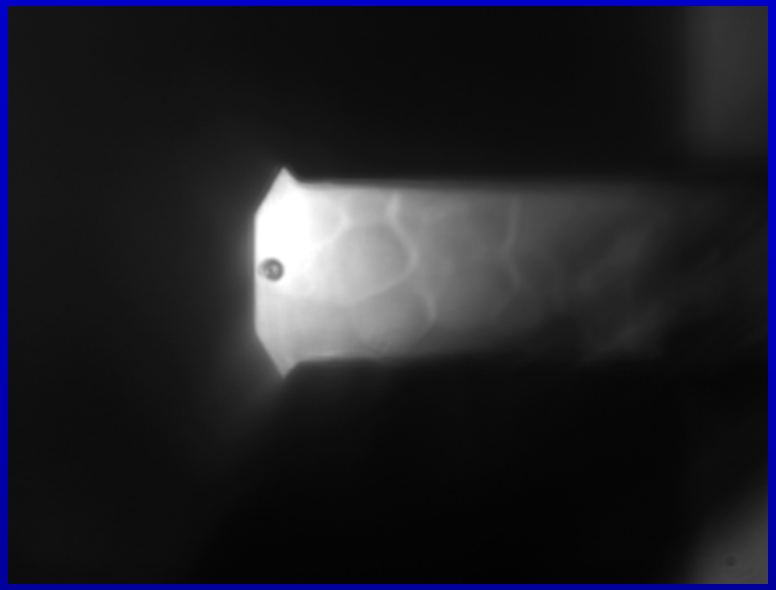


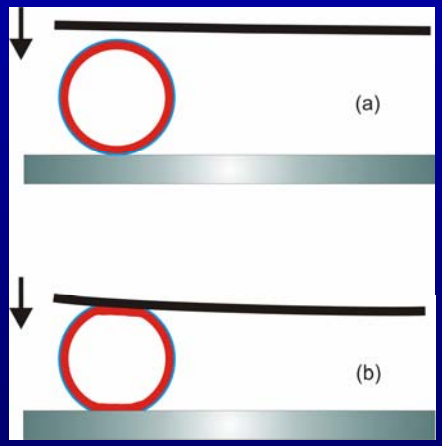


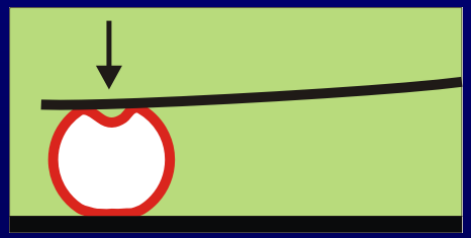


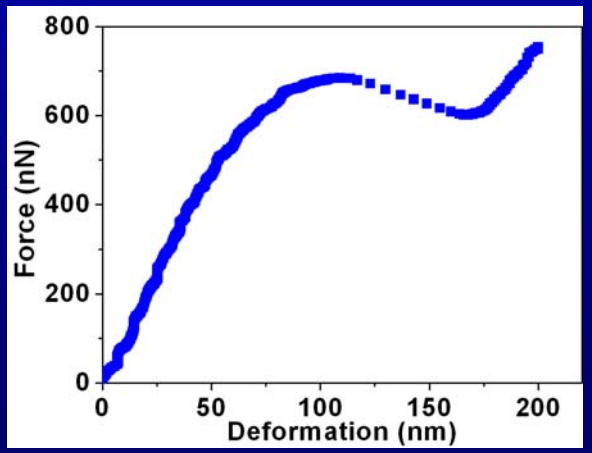
E. Glynos, S. Pispas, V. Koutsos. Amphiphilic Diblock Copolymers on Mica: Formation of Flat Polymer Nanoislands and Evolution to Protruding Surface Micelles. *Macromolecules* **2008**, 41 (12), 4313 - 4320

Nanocompression of (biomedical) Microbubbles









Polylactide-shelled MBs

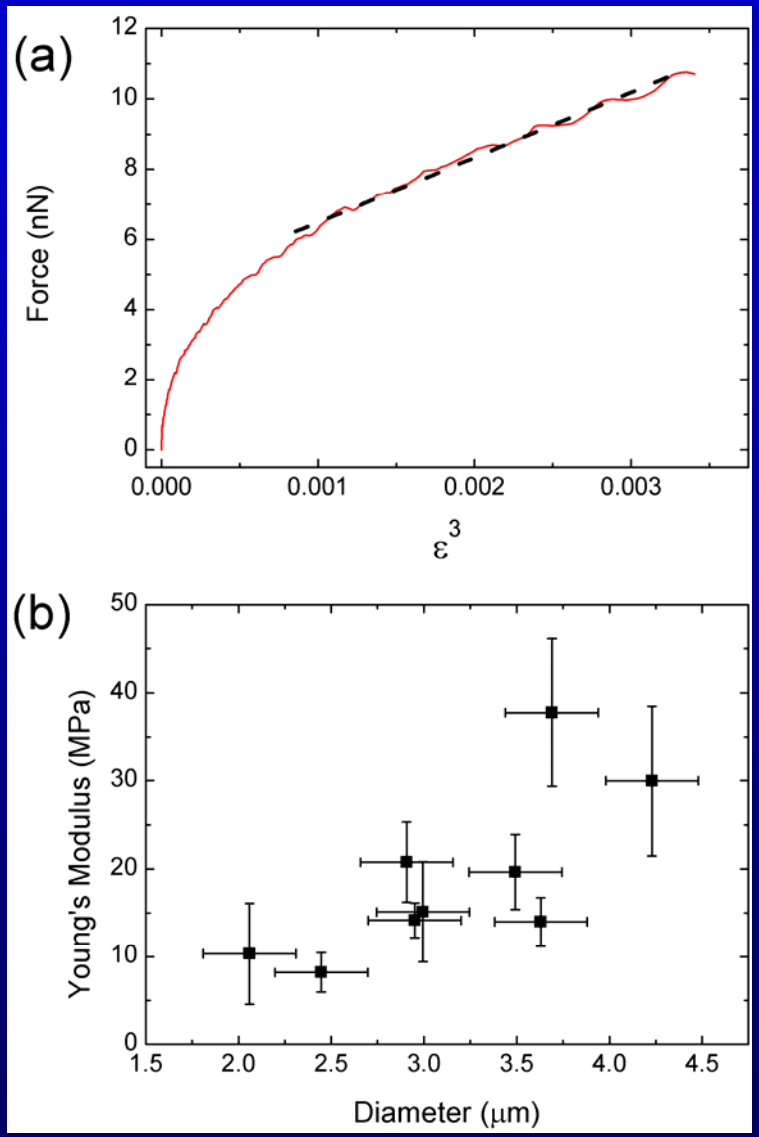
•E. Glynos, V. Koutsos, W. N. McDicken, C. M. Moran, S. D. Pye, J. A. Ross, V. Sboros. Nanomechanics of Biocompatible Hollow Thin-Shell Polymer Microspheres. *Langmuir* **2009**, 25 (13), 7514-7522

•E. Glynos, V. Sboros, V. Koutsos. Polymeric thin shells: Measurement of elastic properties at the nanometer scale using atomic force microscopy. *Materials Science and Engineering: B* **2009**, 165 (3), 231 - 234

•V. Sboros, E. Glynos, S. D. Pye, C. M. Moran, M. Butler, J. Ross, R. Short, W. N. McDicken, V. Koutsos. Nanointerrogation of ultrasonic contrast agent microbubbles using atomic force microscopy. *Ultrasound in Medicine and Biology* **2006**, 32 (4), 579-585

•V. Sboros, E. Glynos, S. D. Pye, C. M. Moran, M. Butler, J. A. Ross, R. Short, W. N. McDicken, V. Koutsos. Nanomechanical probing of microbubbles using the atomic force microscope. *Ultrasonics* **2007**, 46 (4), 349-354

Phospholipid-based Microbubbles



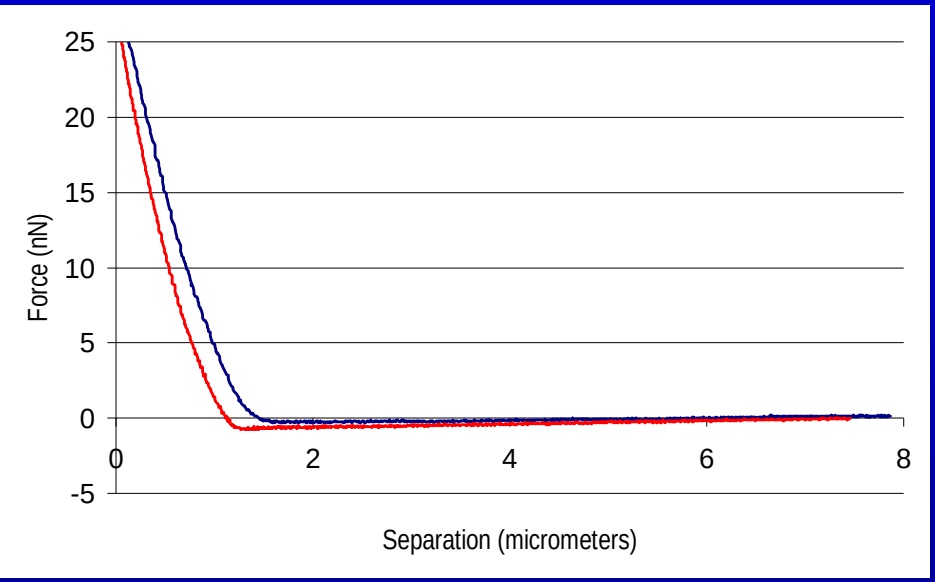
The full form of the elastic membrane theory is composed of a stretching term $F_{stretching} = (2\pi t R_0 E \varepsilon^3)/(1-\nu)$ and a bending term $F_{bending} = (\pi t^2 E \sqrt{\varepsilon})/(2\sqrt{2})$,[35] the ratio of which is given by the equation

$$\frac{F_{bending}}{F_{stretching}} = \frac{t}{R_0}\frac{1-\nu}{4\sqrt{2}}\frac{1}{\varepsilon^{5/2}} \quad (3)$$

$$E = \frac{1-\nu}{2\pi R_0 t}\frac{F}{\varepsilon^3}$$

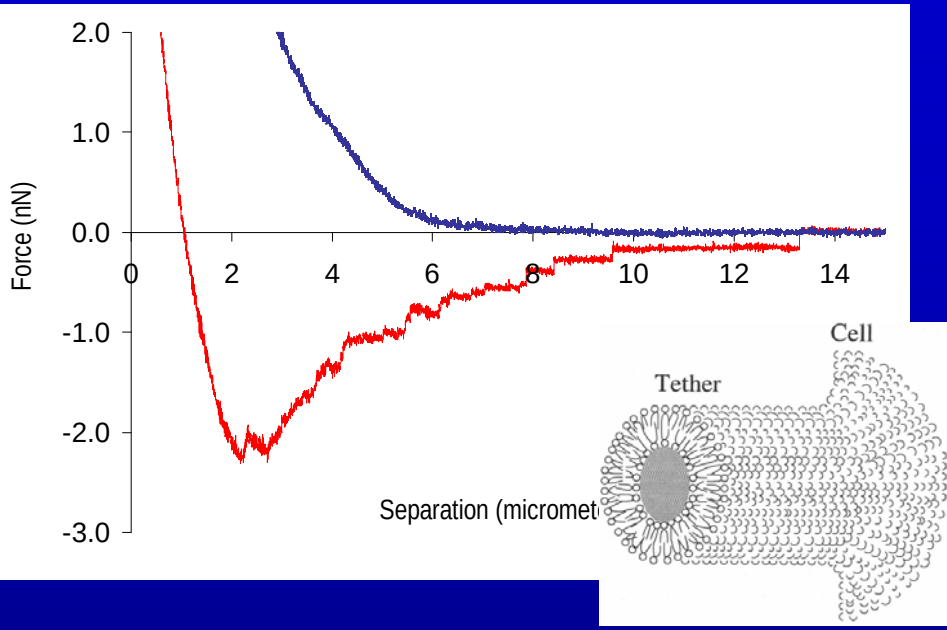
E. Buchner Santos, J. K. Morris, E. Glynos, V. Sboros, V. Koutsos. Nanomechanical Properties of Phospholipid Microbubbles. *Langmuir* **2012**, 28 (13), 5753–5760

MB-cell



F–s curve of an in-house phospholipids MB with an SkHep-1 cell. Approach (blue curve) and retract (red curve) provide some hysterisis due to the viscosity of both MB and cell. Hardly any adhesion is observed when the MB/cantilever system retracts and detaches from the cell.

Modified MB-cell



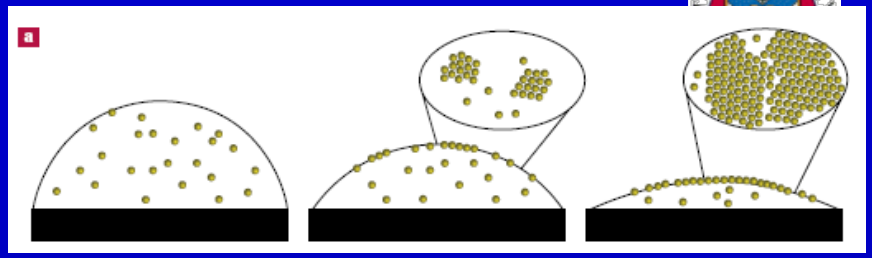
F–s curve of an in-house targeted MB (with biotinylated CD31 antibody) with an SkHep-1 cell. A significant adhesion is registered when the MB/cantilever system retracts. The adhesive force is at ~2 nN while several detachment events are recorded at ~10^2 pN

•V. Sboros, E. Glynos, J. A. Ross, C. M. Moran, S. D. Pye, M. Butler, W. N. McDicken, S. B. Brown, V. Koutsos. Probing microbubble targeting with atomic force microscopy. *Colloids and Surfaces B: Biointerfaces* **2010**, 80, 12-17

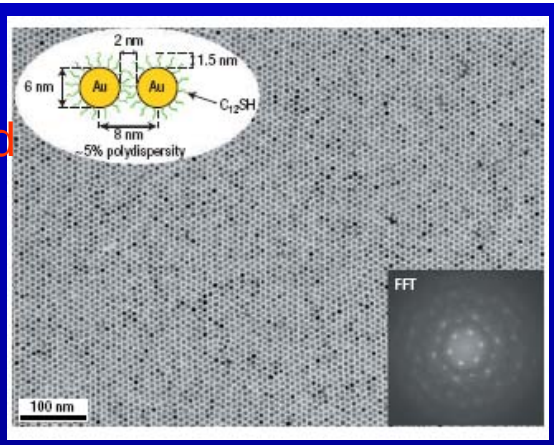
Evaporation of drops and contact lines

- Boiling
- Paints
- Perfume
- Spray dryers
- Micro-electronics
- Printing
- Oil recovery
- Crop spraying
- Disease diagnosis

Bigioni et al., Nature, ‘06

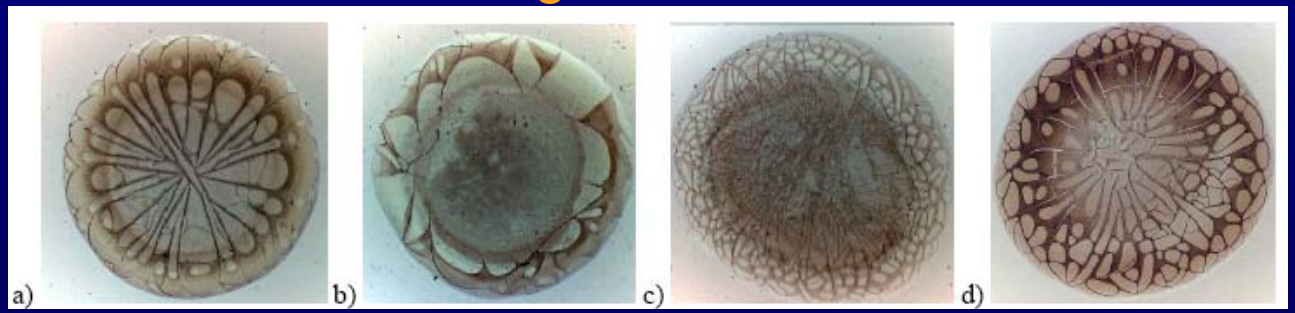


Highly-ordered Nanoparticle monolayers



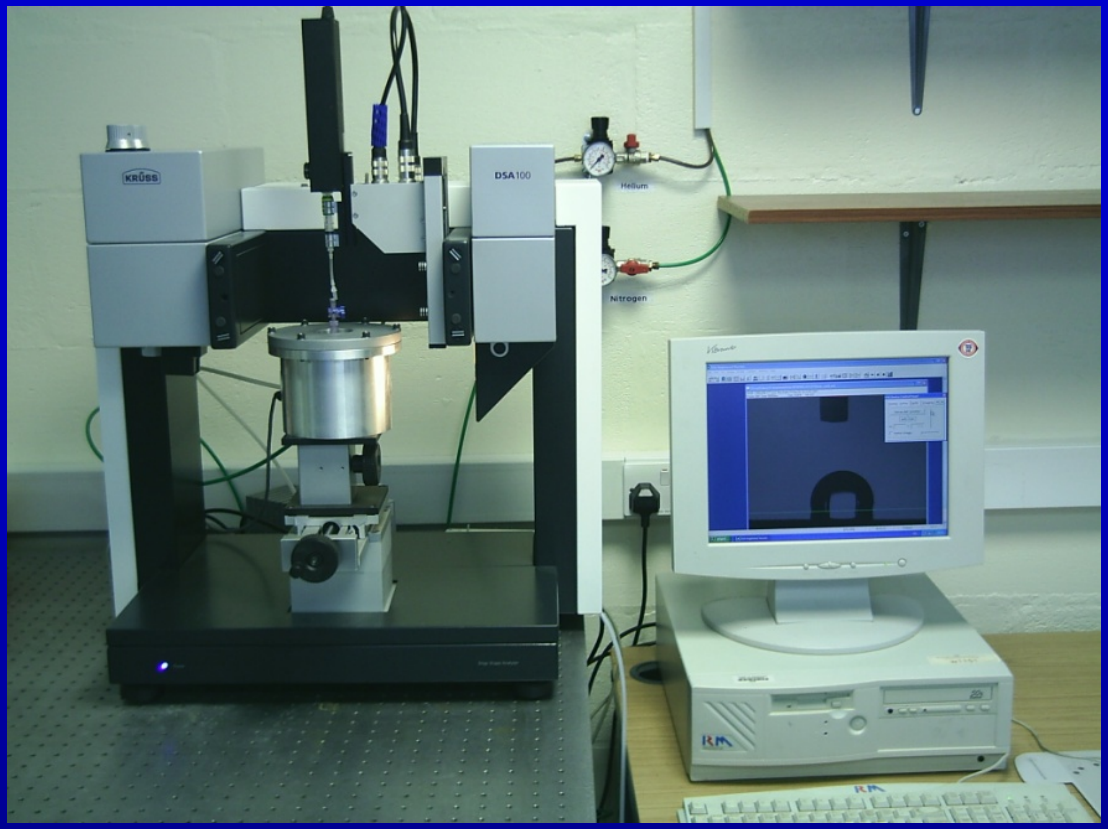
Deegan et al., Nature, ‘97

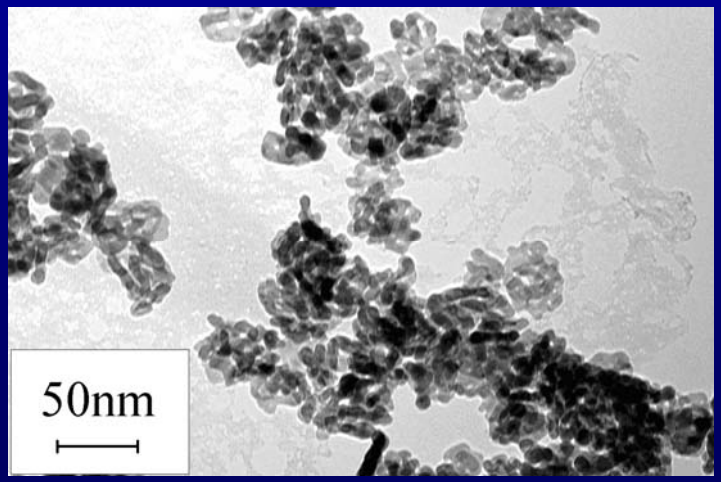
Coffee rings

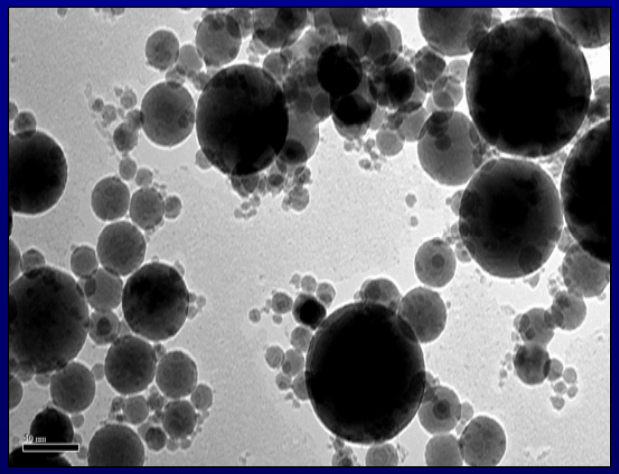


Dried serum drops

(a): healthy (b)-(d): diseased

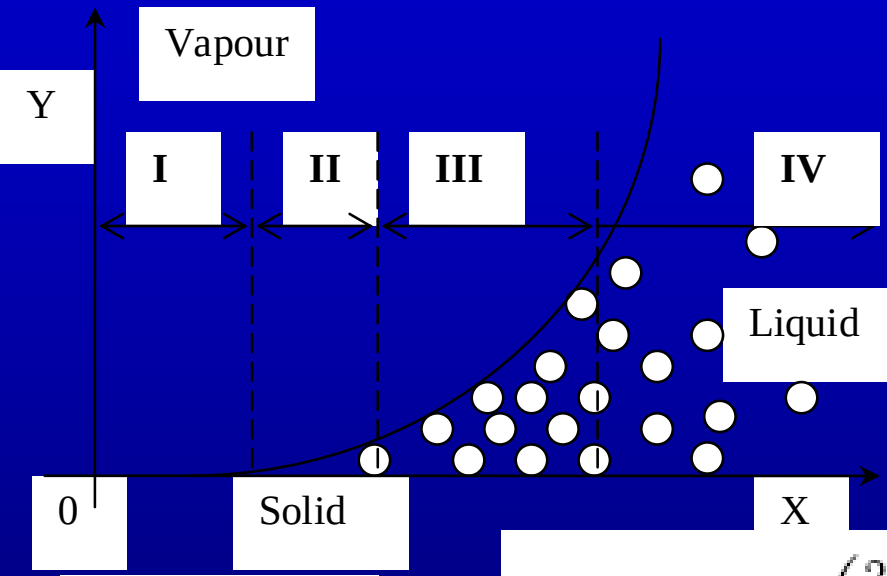




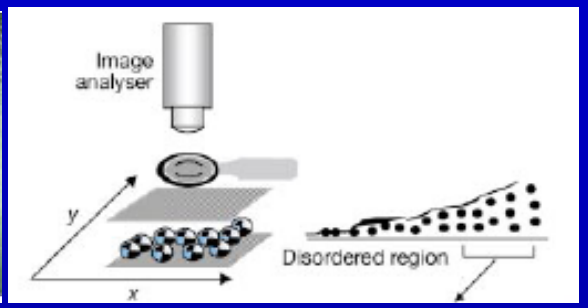


T.E.M. images depicting Al_2O_3 and TiO_2 nanoparticles. Alumina particles are shown to be spherical, whilst the Titania particles are more cylindrical.

microregion model



$$\Pi = \Pi_{vw} + \Pi_{os}$$



Wasan et al., **Nature** 423, 156-159 (08 May 2003)

$$\Pi_{os} = P\cos\left(\frac{2\pi h}{d_1}\right)\exp\left(\frac{d^3}{d_1^2 d_2} - \frac{h}{d_2}\right), \quad h \geq d,$$

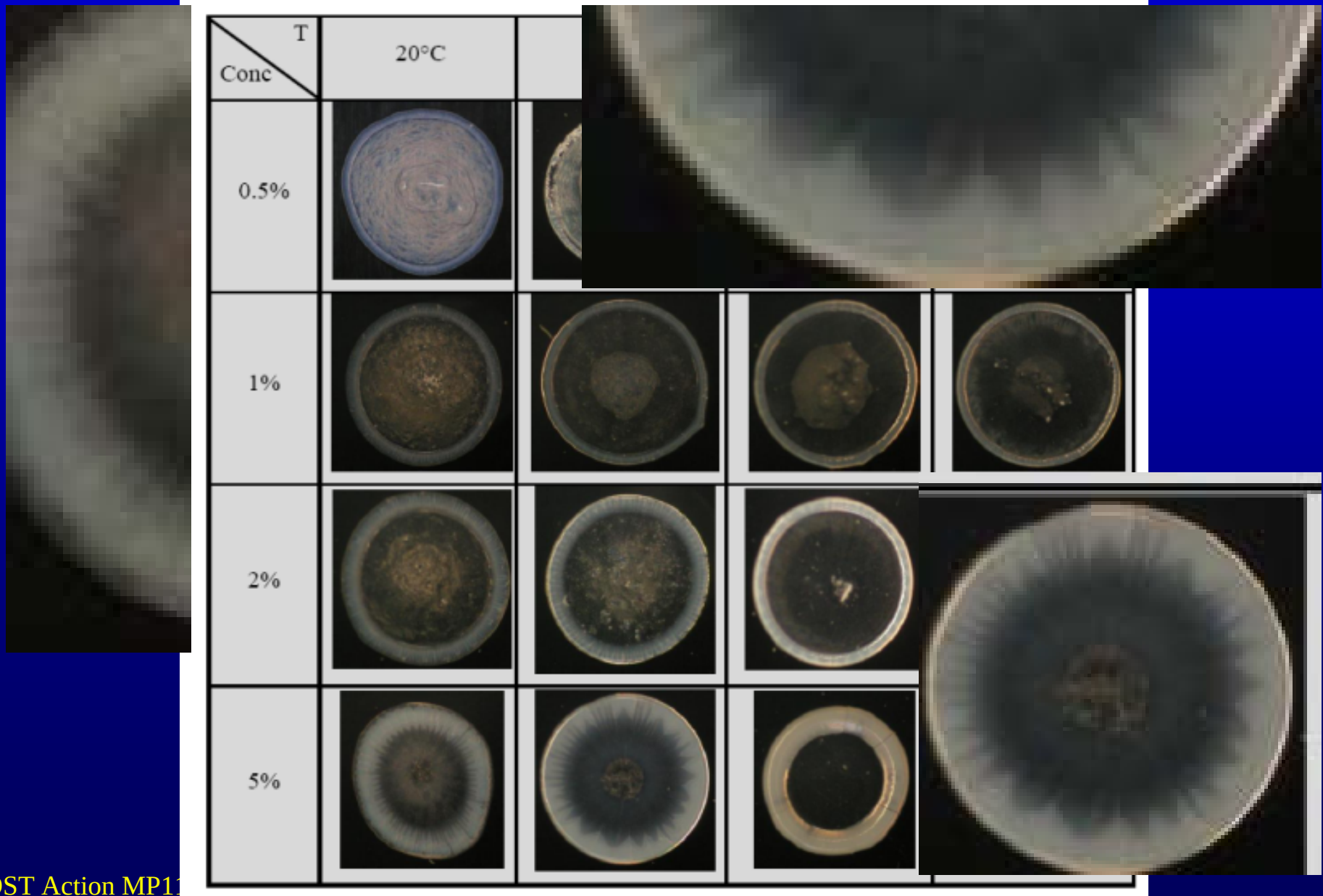
$$\Pi_{os} = -P, \qquad 0 < h < d,$$

$$\Pi_{vw} = \frac{A}{6\pi h^3}.$$

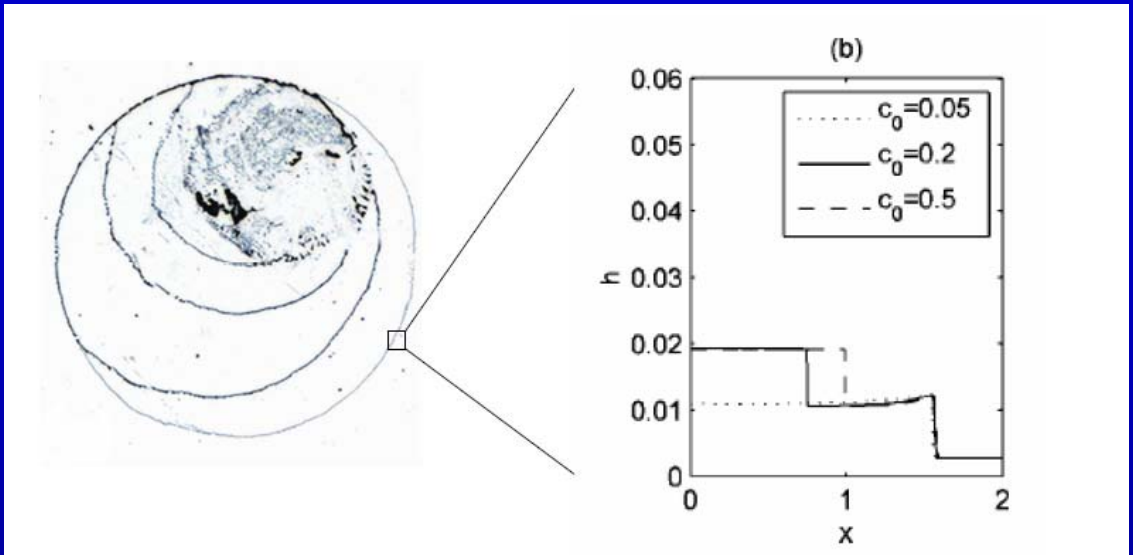
R. Craster, O.K. Matar, K. Sefiane, Langmuir, 25, 2009

The enhanced wetting capability could be an important mechanism for boiling heat transfer using nanofluids

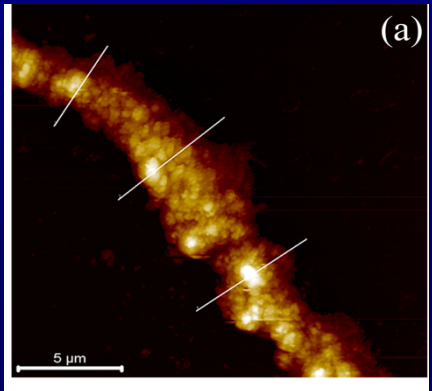
PATTERNS AND SELF-ORGANISATION OF PARTICLES

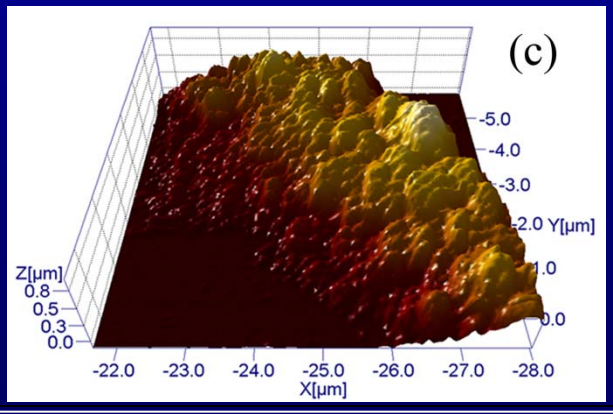


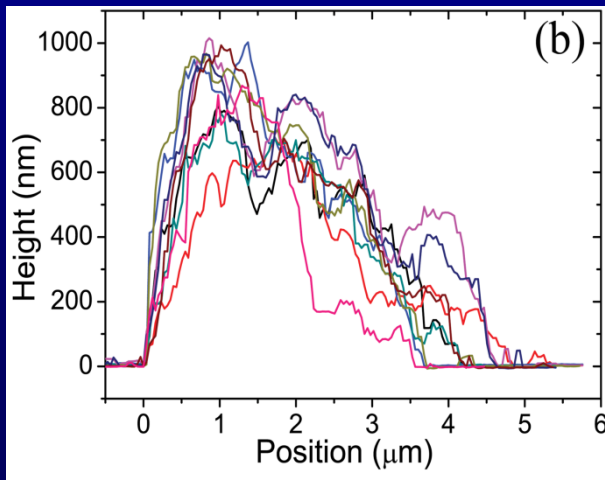
Nanoparticle Deposits



Nanoparticle deposits near the contact line of pinned volatile droplets: Size and shape revealed by atomic force microscopy







A. Askounis *et al.*, Soft Matter, 2011.

Topics for Research Proposal

#1 Topic

Title: Self-assembly at solid-liquid and liquid-liquid interface: fabricating smart patterns using green processing

Promotion text: Self assembly of functional soft matter systems (polymer solutions, nanofluids, complex fluids, complex macromolecules, complex functional nanoparticles) on solid substrates to create smart/responsive nano/micropatterns/templates in large areas using green (enviornmentally friendly solvents and components, efficient use of materials, almost no waste products) processing.
Applications: e.g. lab-on-a-chip

Duration: 3-5 years

Expertise required: Very wide: chemistry, physics, materials science, engineering

Facilities/equipment required: Very wide: synthesis/materials/fabrication/experiments/theory

Topics for Research Proposal

#2 Topic

Title: Nanoparticles at liquid interfaces (solid-liquid, liquid-liquid)

Promotion text: to study their behaviour for biomedical and environmental reasons

Duration: 3-5 years

Expertise required: wide

Facilities/equipment required: wide

Topics for Research Proposal

#3 Topic

Title: Controlling the phase separation of polymer blends/quantum dots thin film Systems for flexible PVs and LEDs.

Promotion text: New area for us but we have very good preliminary results

Duration: 3 years

Expertise required: Chemistry/Physical Chemistry of Polymers/Thin films/ Device testing

Facilities/equipment required: synthesis, sample preparation, characterisation, devices, testing

Thank you for your attention