Chemistry of metal nanoparticles

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Molecular solids
Nanomaterials

Model for Heat Conduction in Nanofluids, Phys. Rev. Lett. 93 (2004) 144301.

Concentration of CO_2 over melting ice oscillates, Phys. Rev. Lett. . 93 (2004) 048304

Dynamics of alkyl chains in monolayer protected Au and Ag clusters and silver thiolates: a comprehensive QENS investigation, J. Phys. Chem. B. 108 (2004) 7012-7020.

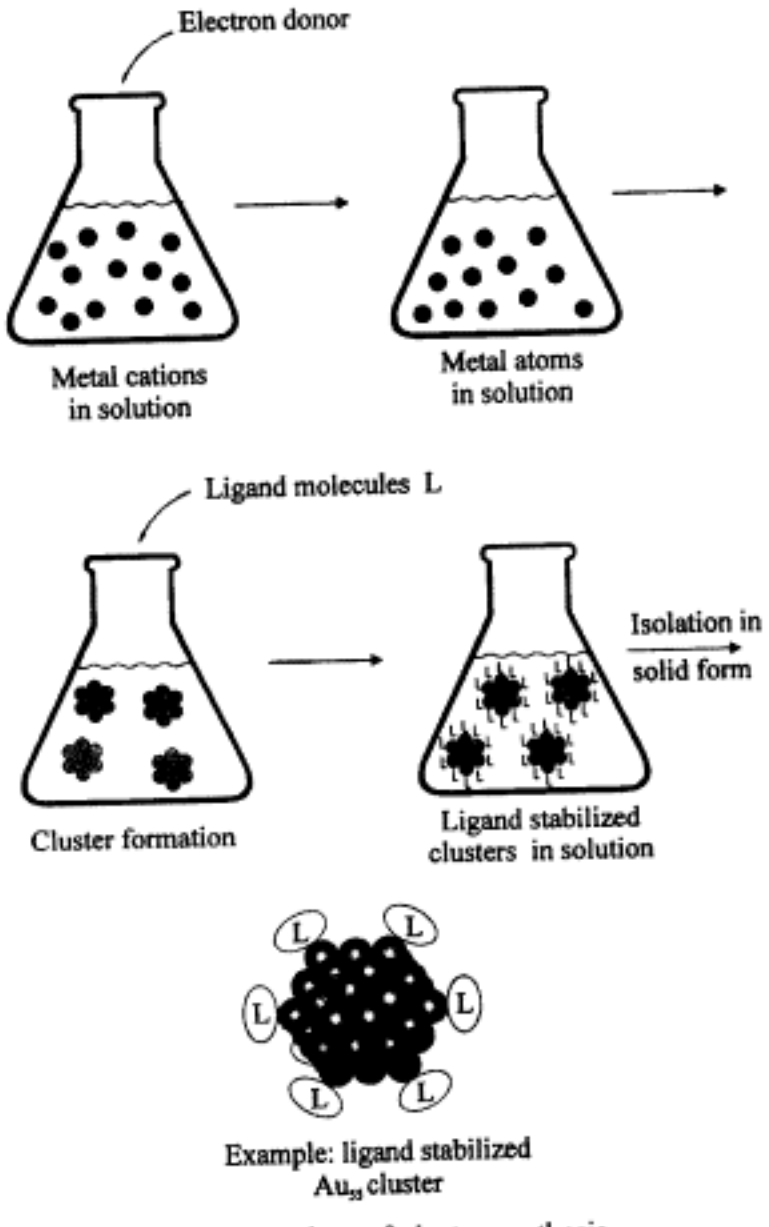
Ciprofloxacin protected gold nanoparticles, Langmuir, 20 (2004) 1909-1914.

Towards Understanding Structure and Phase Transitions of Self-Assembled Monolayers on Two- and Three- Dimensional Surfaces: An Overview of Current Efforts, Int. Rev. Phys. Chem. 22 (2003) 221-262.

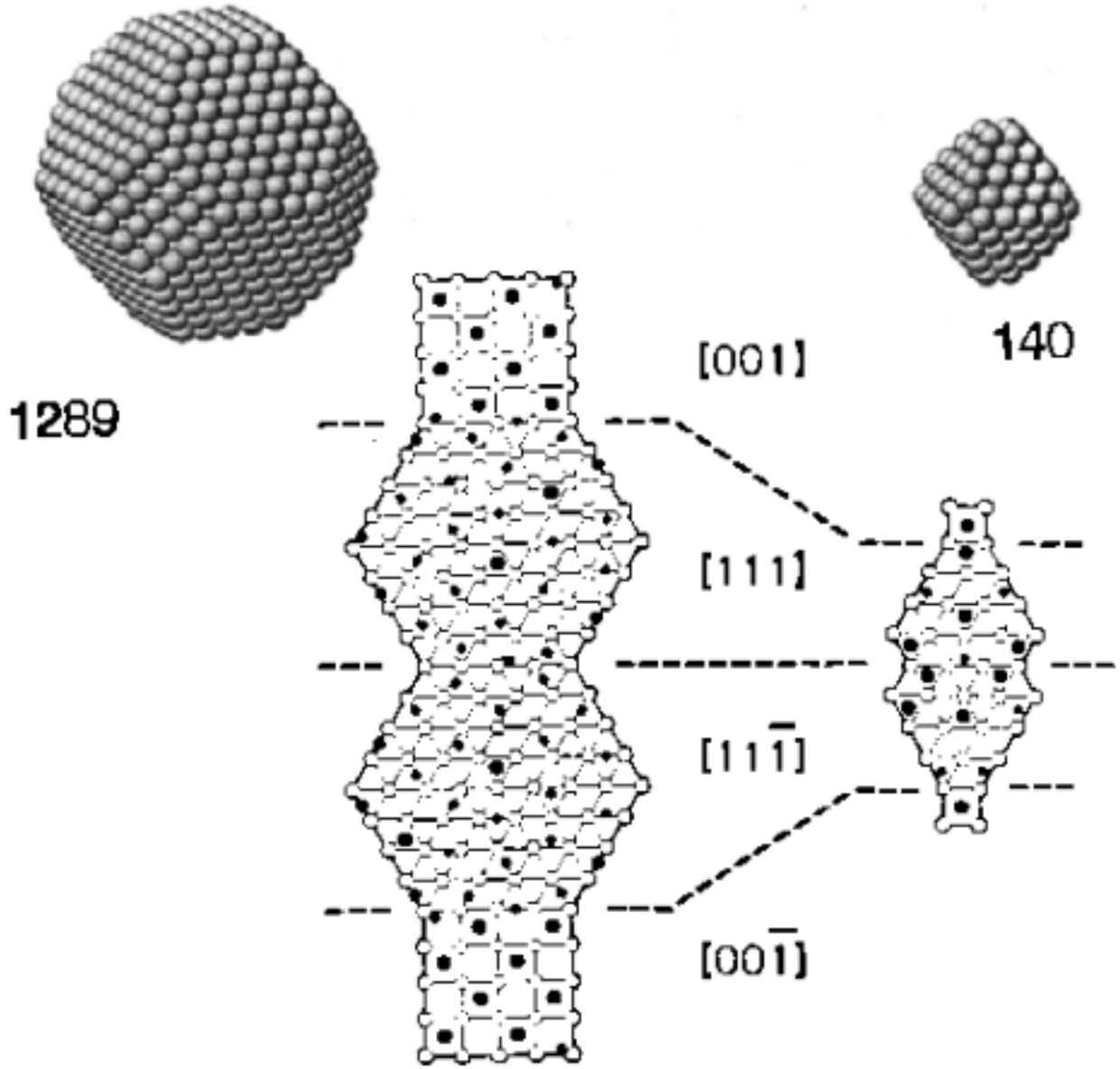
New Materials, chemistry and applications

1. MPCs
2. Core-shell materials
3. Sub-nano particles, clusters
4. Gas phase clusters

Chemical synthesis



Schematic procedure of cluster synthesis.


1289
140
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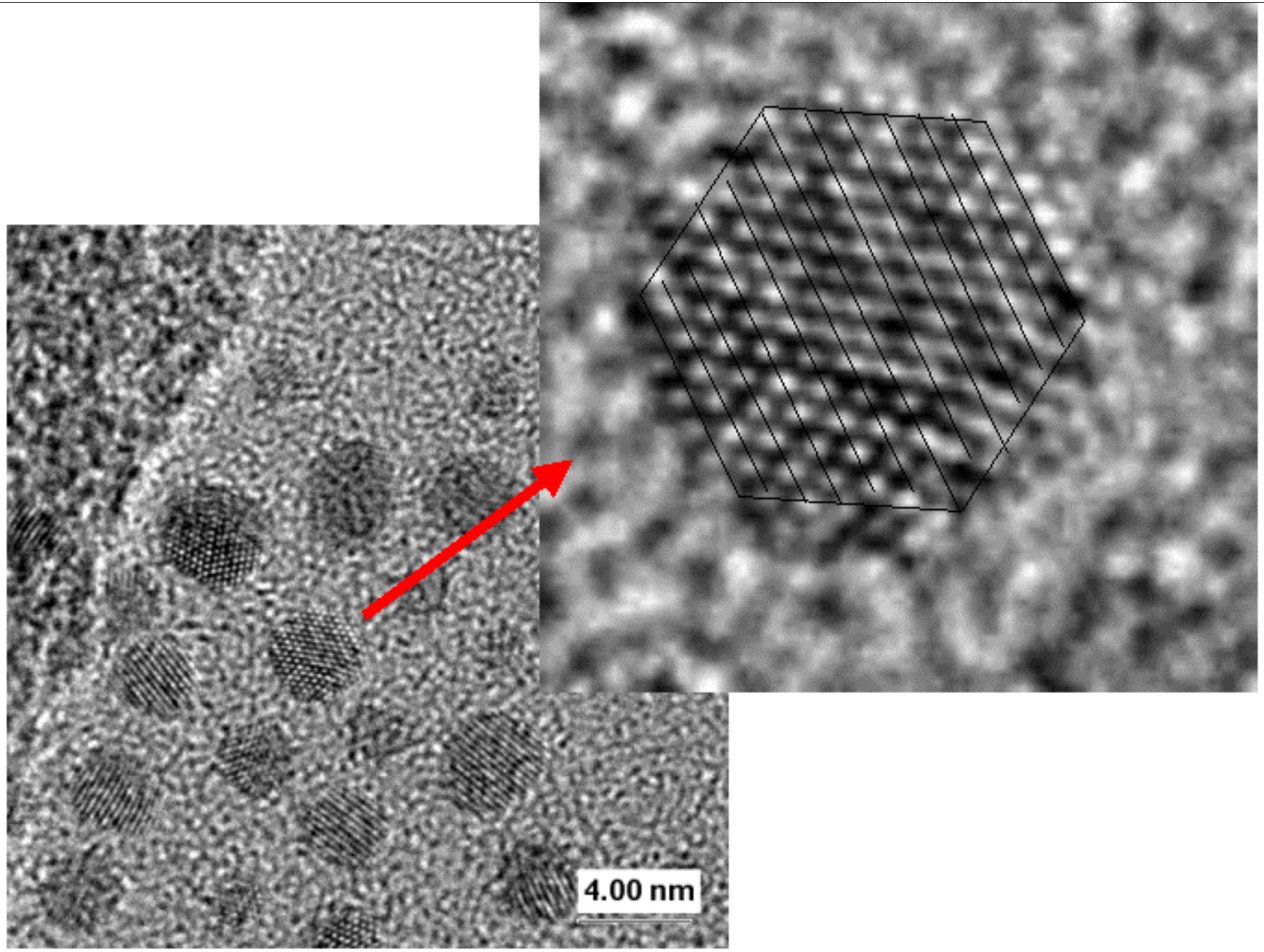
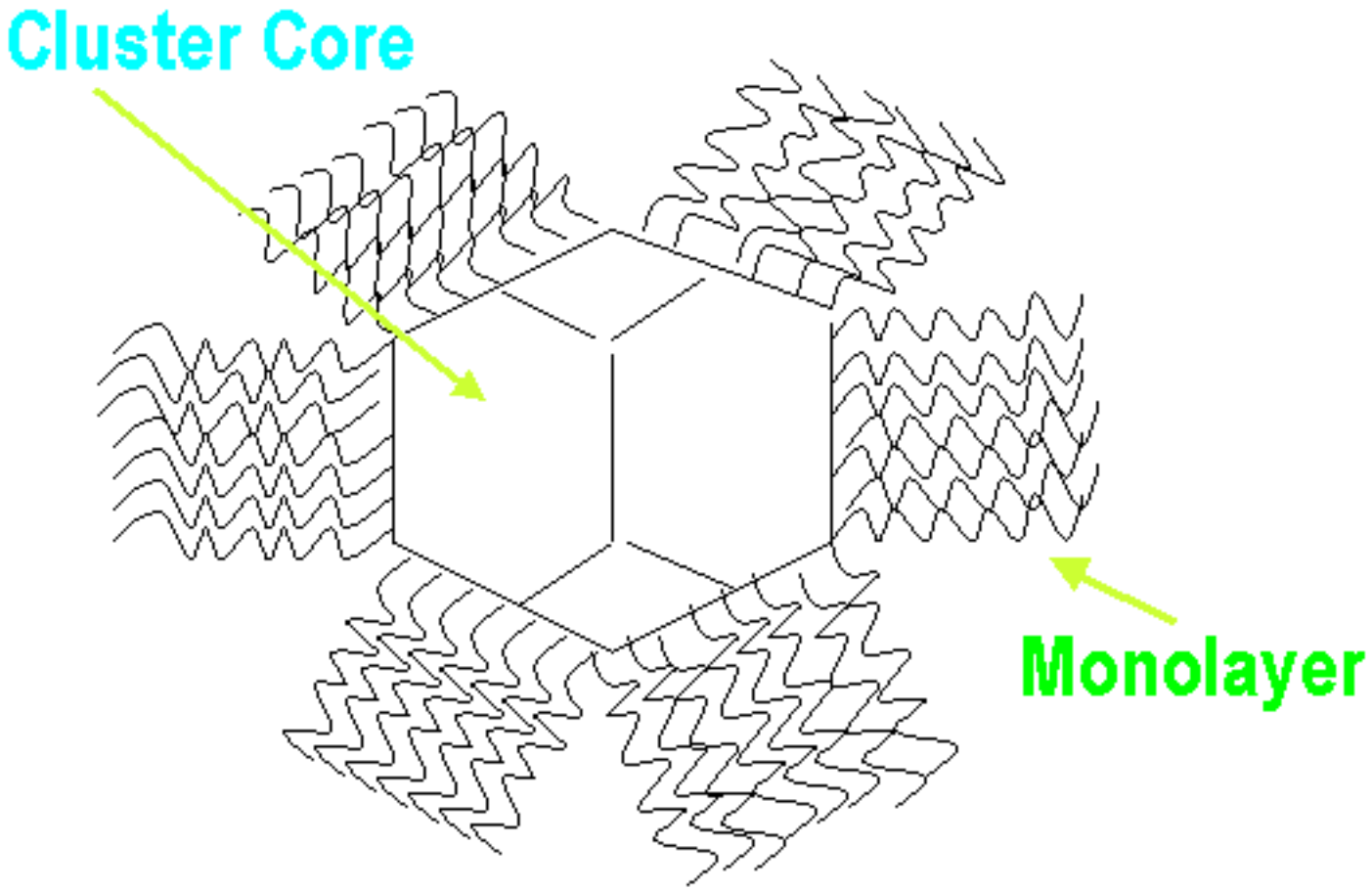
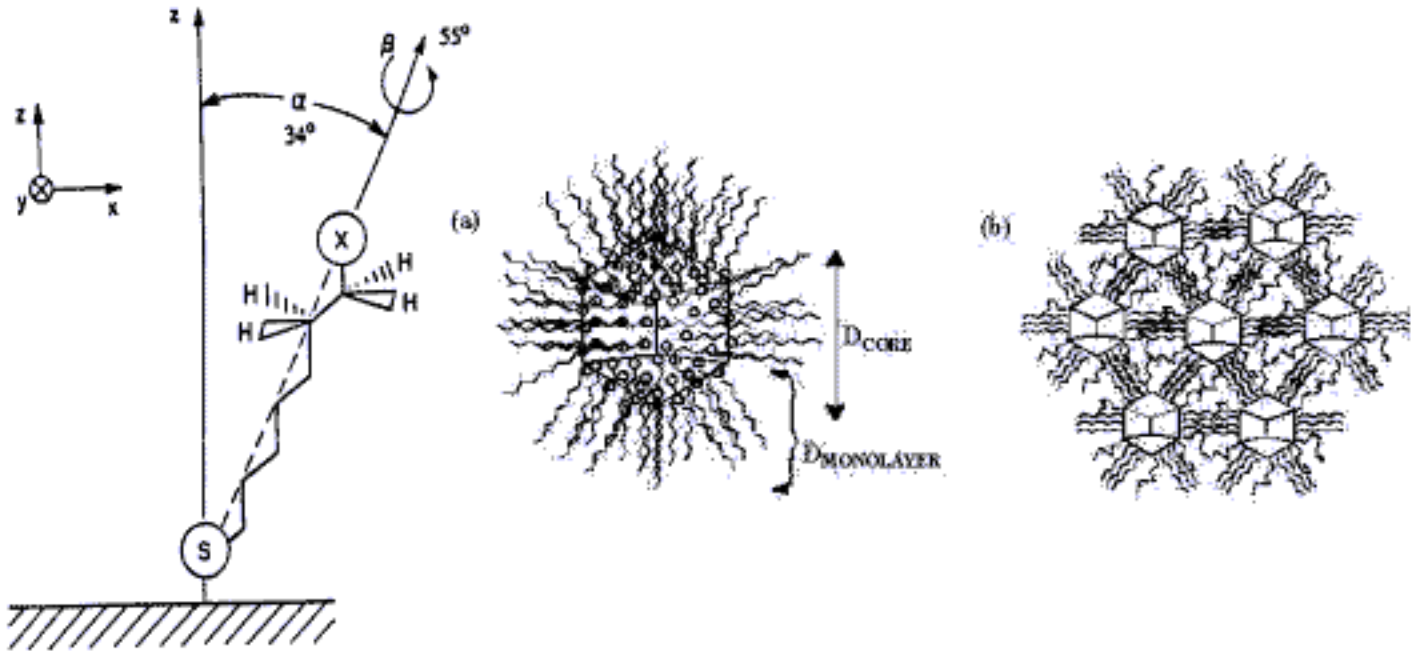
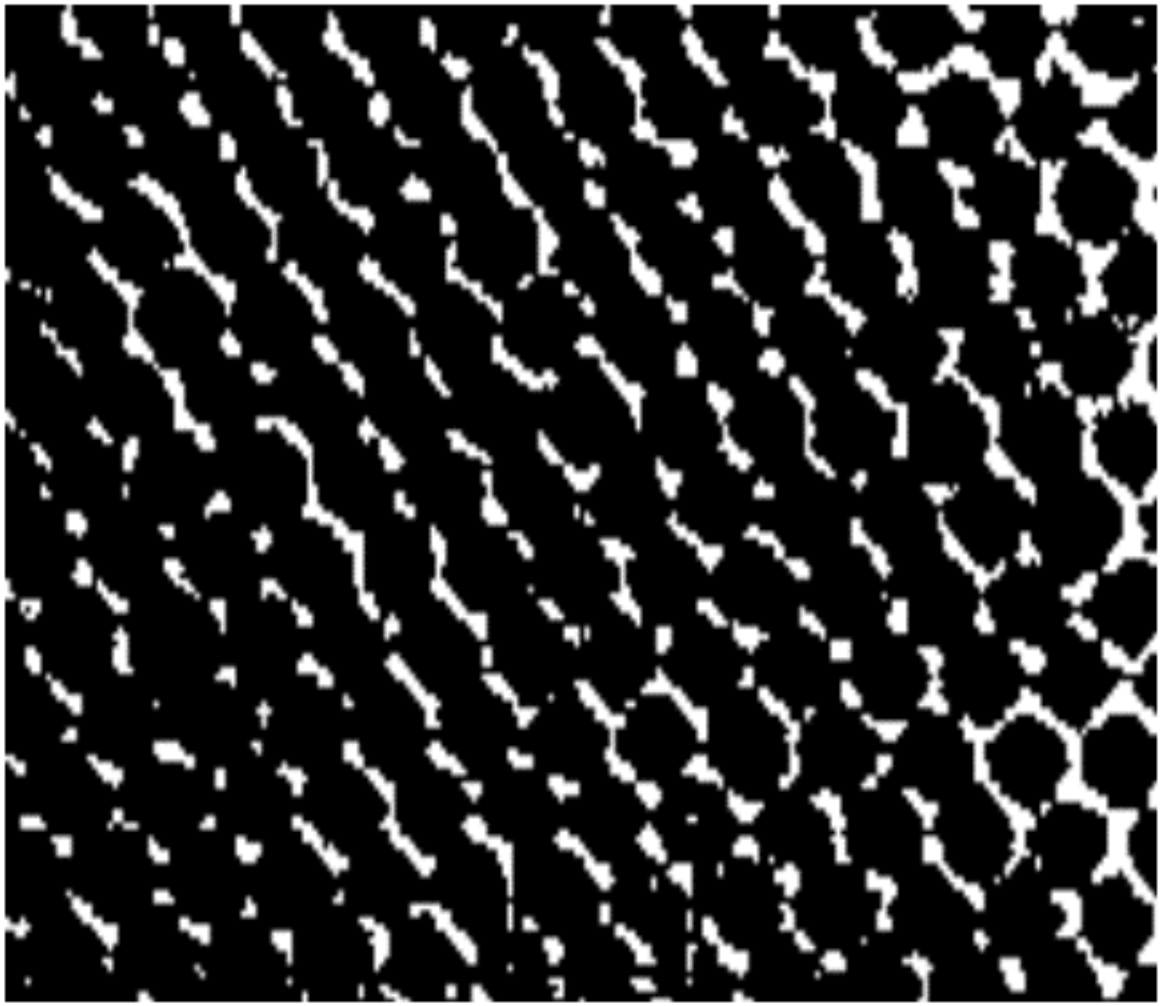

4.00 nm



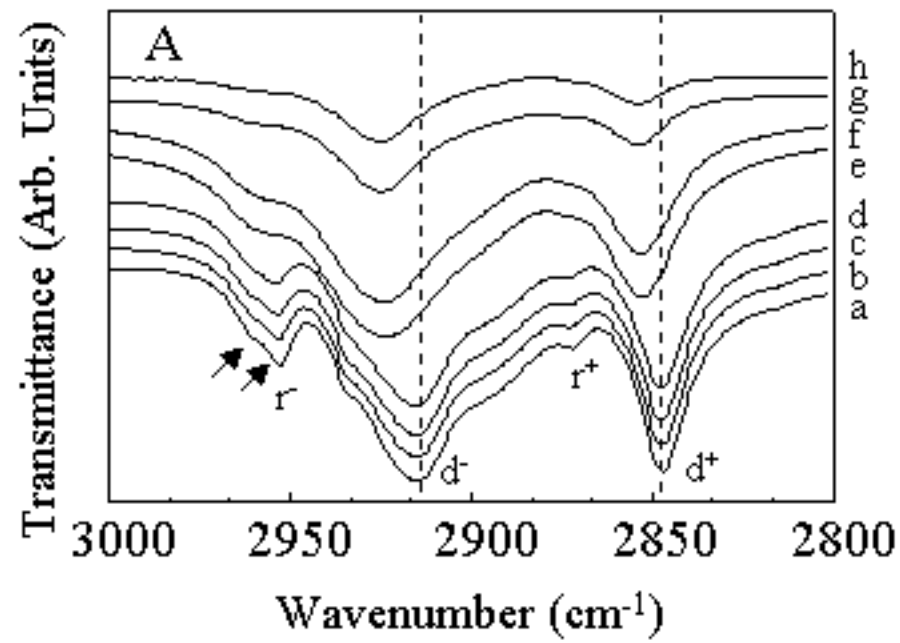
Monolayer protected cluster

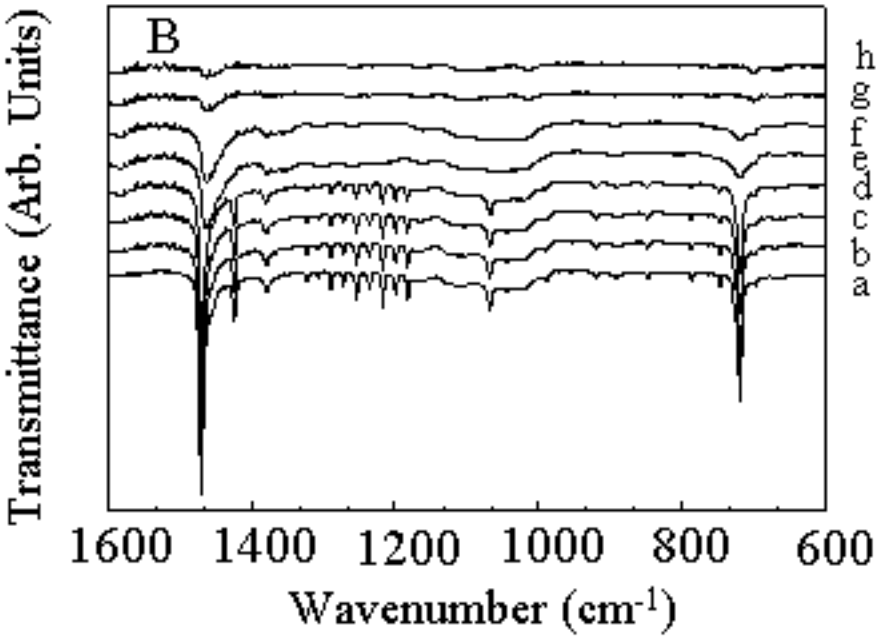


Int. Rev. Phys. Chem. 2003

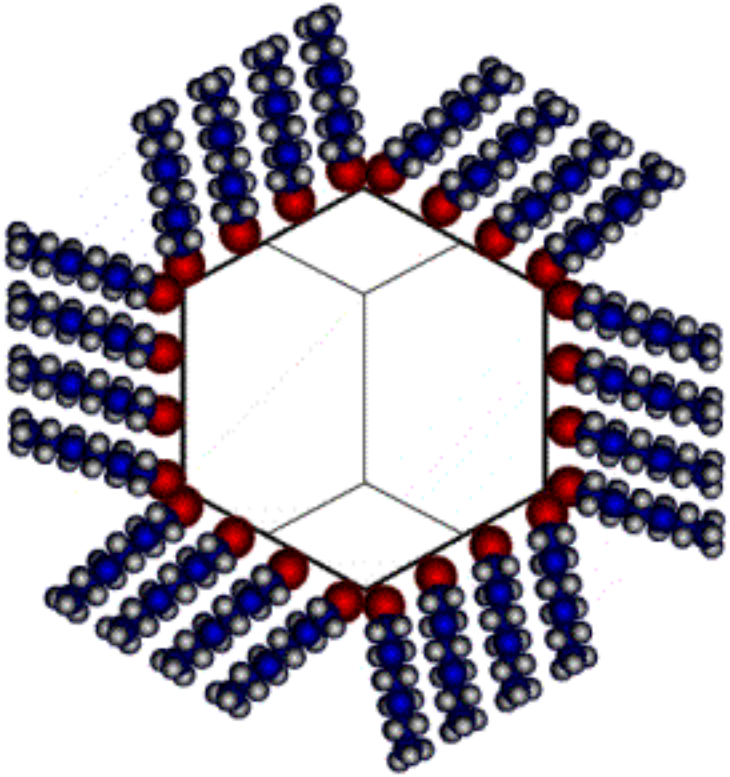


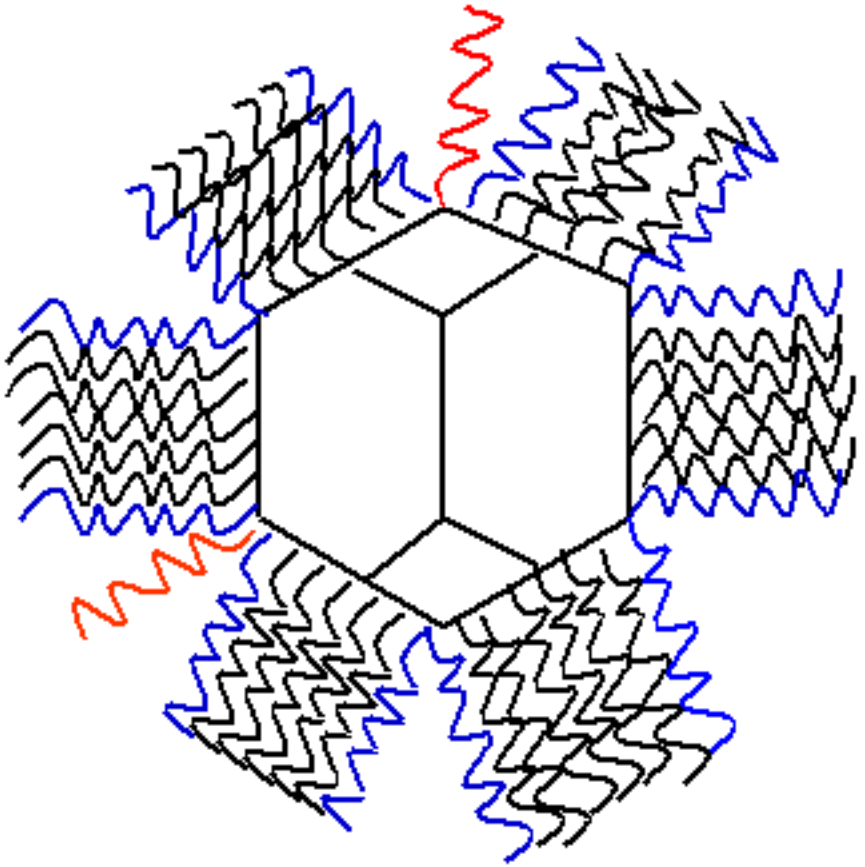
Superlattices of clusters





J. Chem. Phys. 2000, **113**, 9794-9803



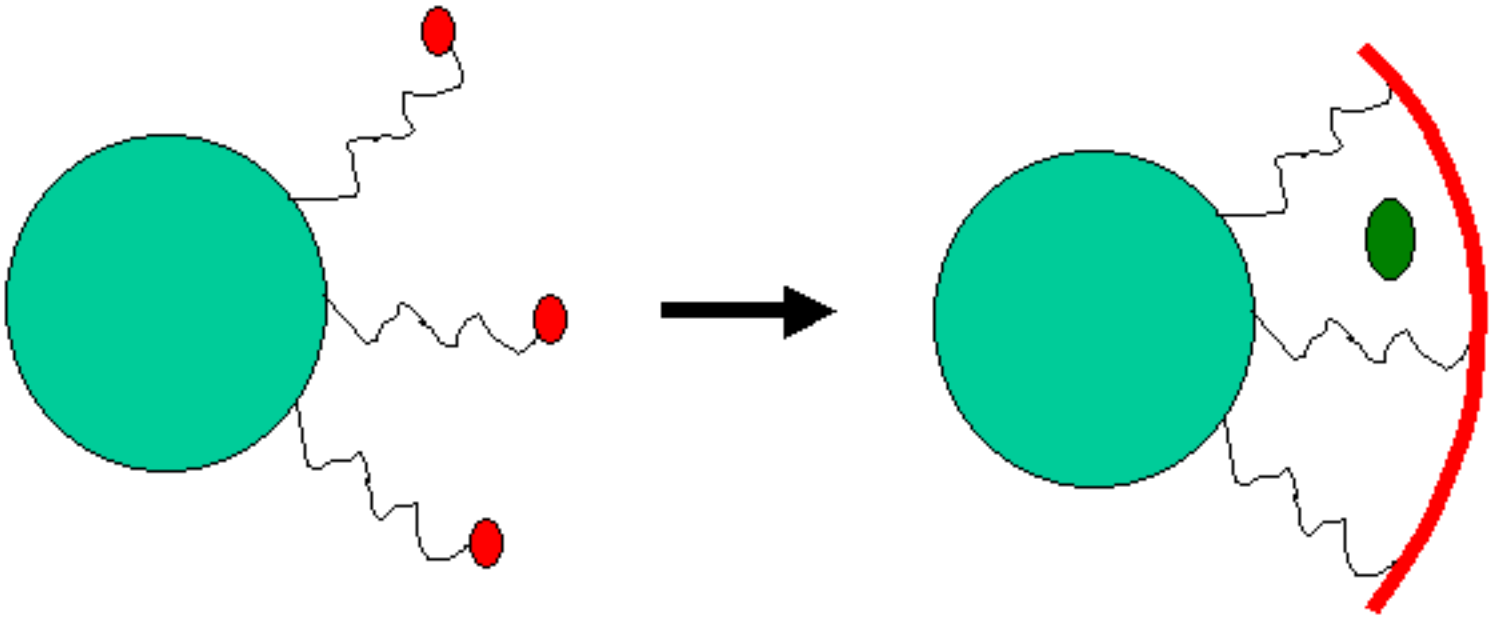


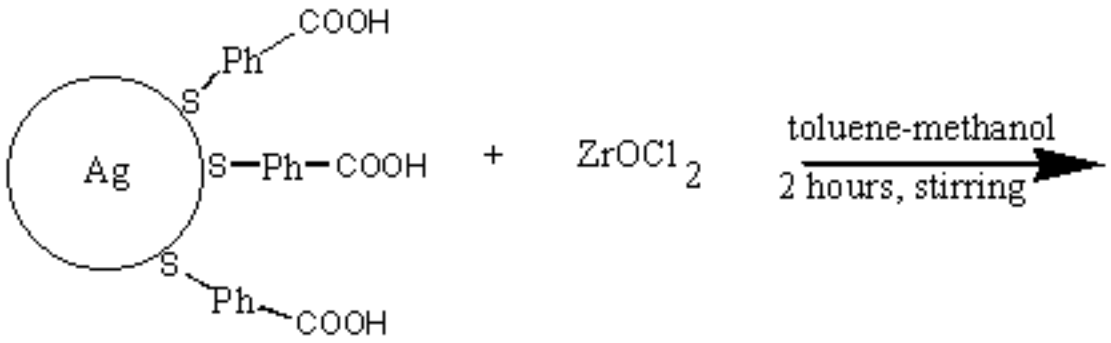
What do we learn?

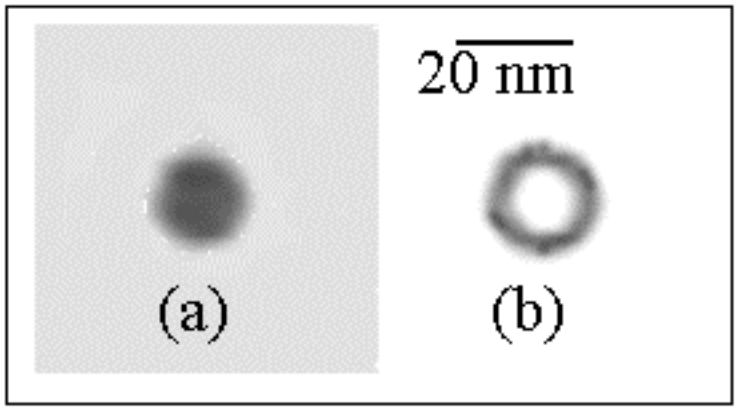
J. Phys. Chem. B. 2002, **106**, 3960-3967

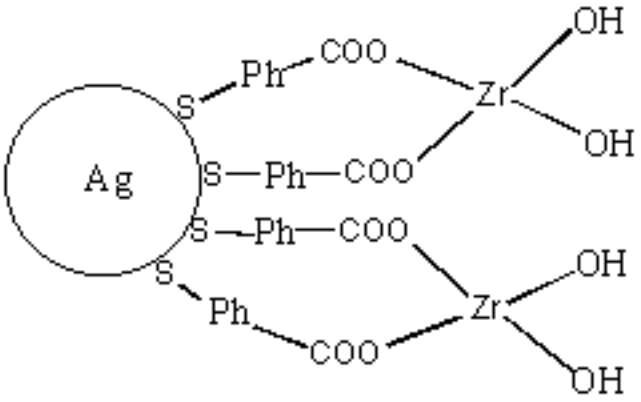
J. Chem. Phys. 2003, *J. Phys. Chem. B* 2004

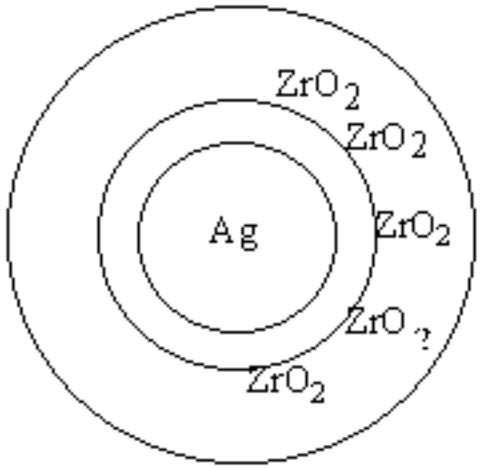
Monolayer chemistry to materials

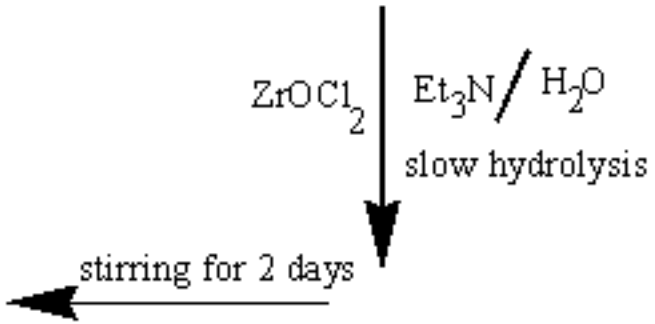




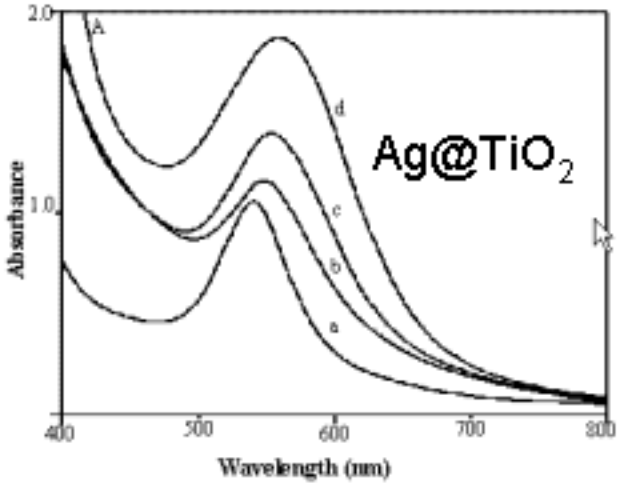


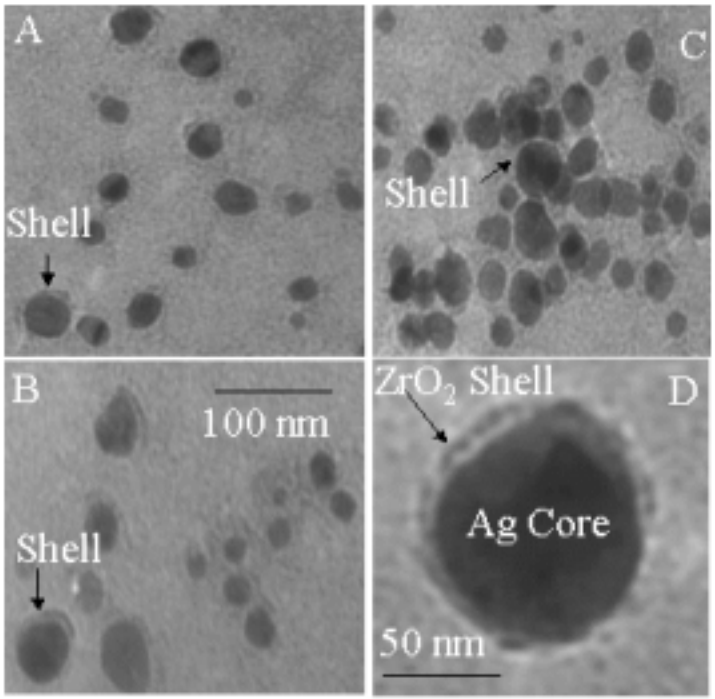






J. Mat. Chem. 2002

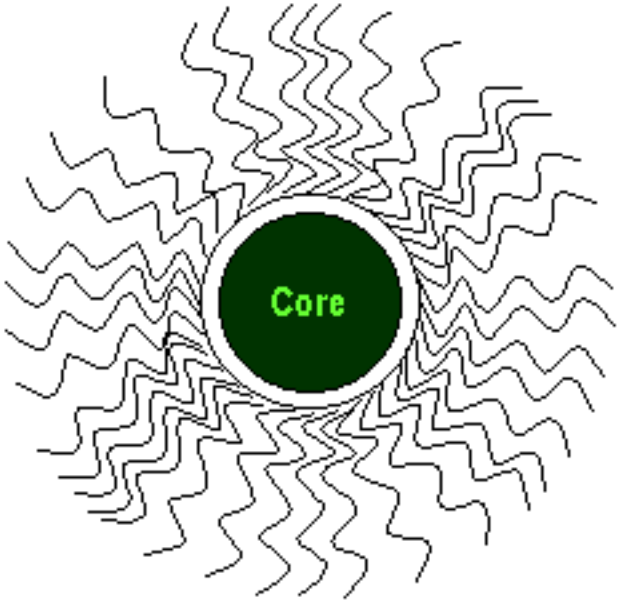


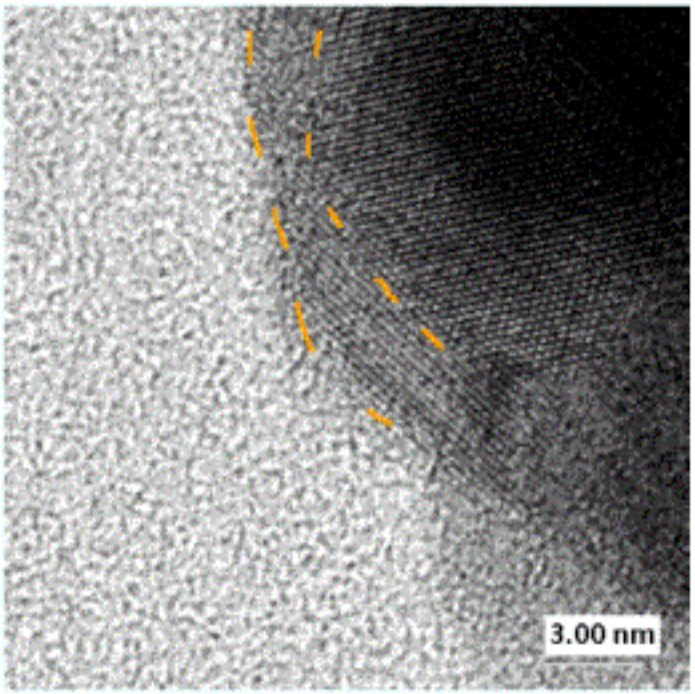


$$3\ HCONMe_2 + 2\ AuCl_4^- + 3H_2O \rightarrow\ 2Au_0 + Me_2NCOOH + 6H^+ + 8\ Cl^-$$

…and $Au@ZrO_2$, $Ag@ZrO_2$

Langmuir 2003

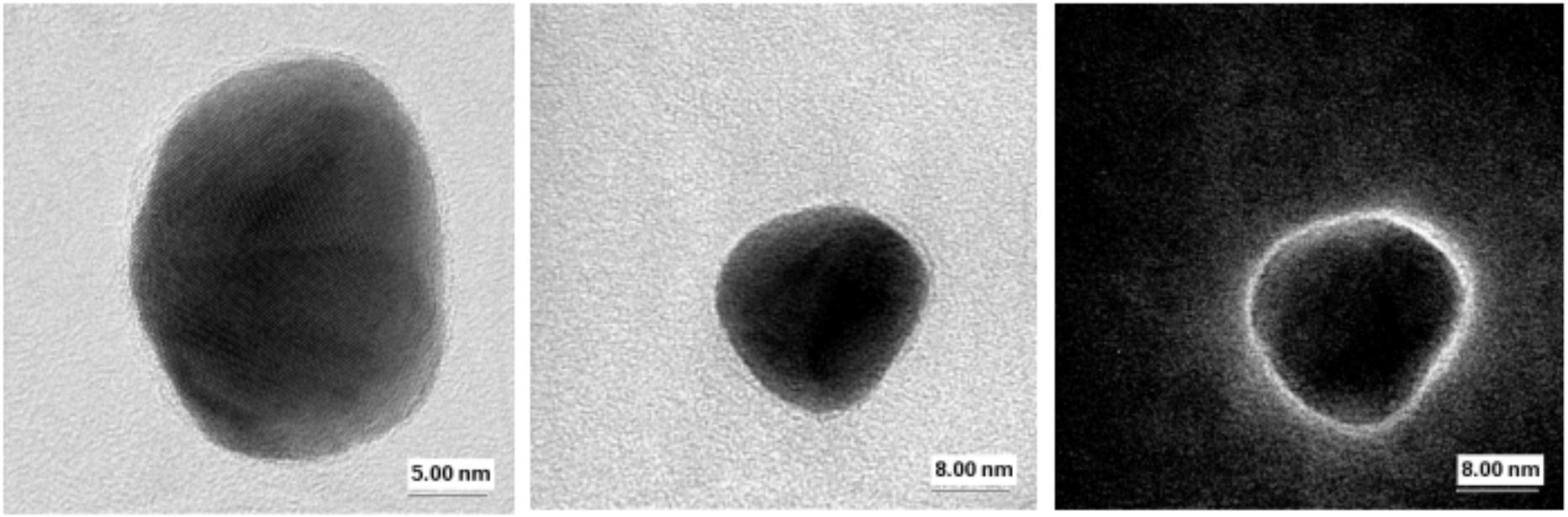




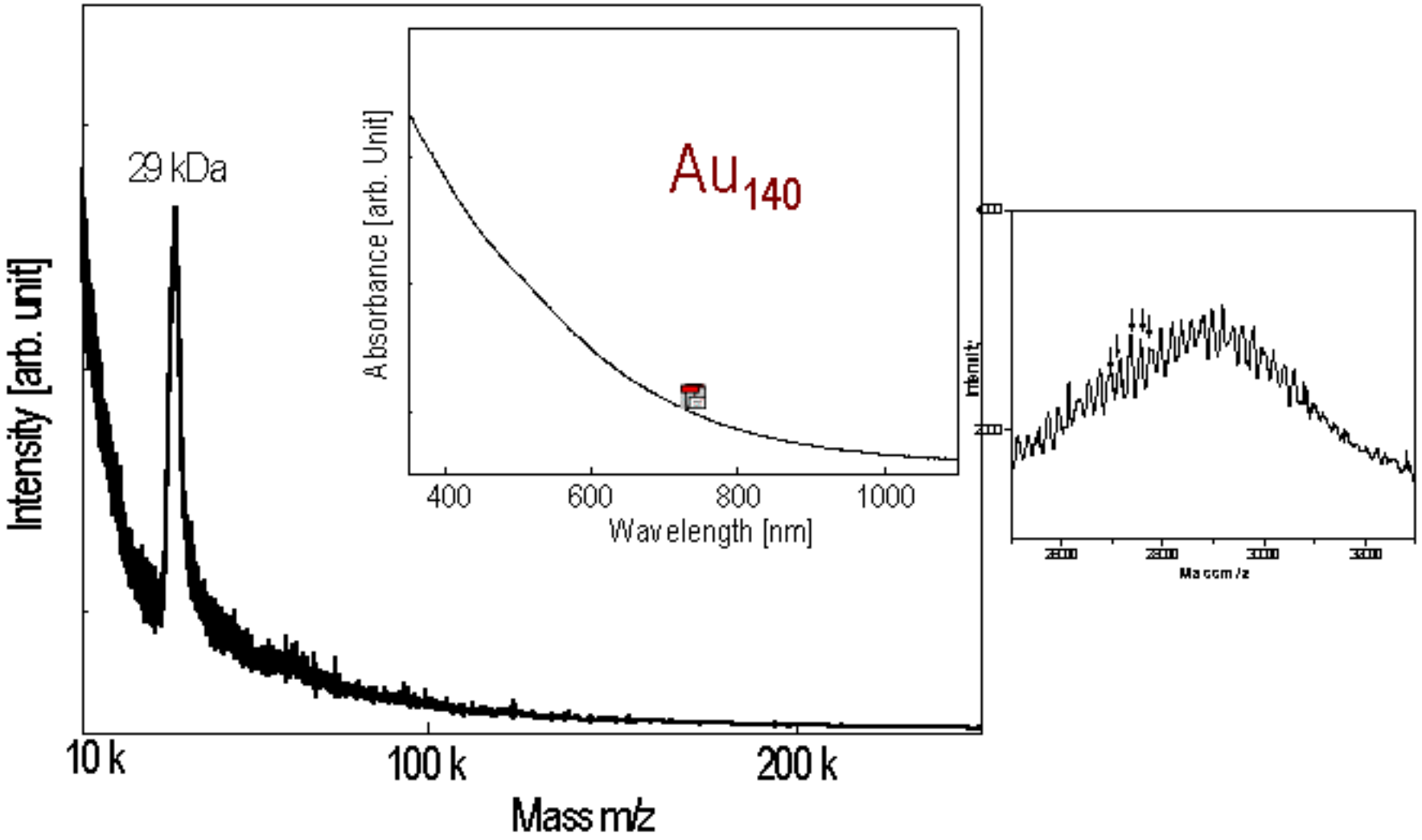
Tunable parameters

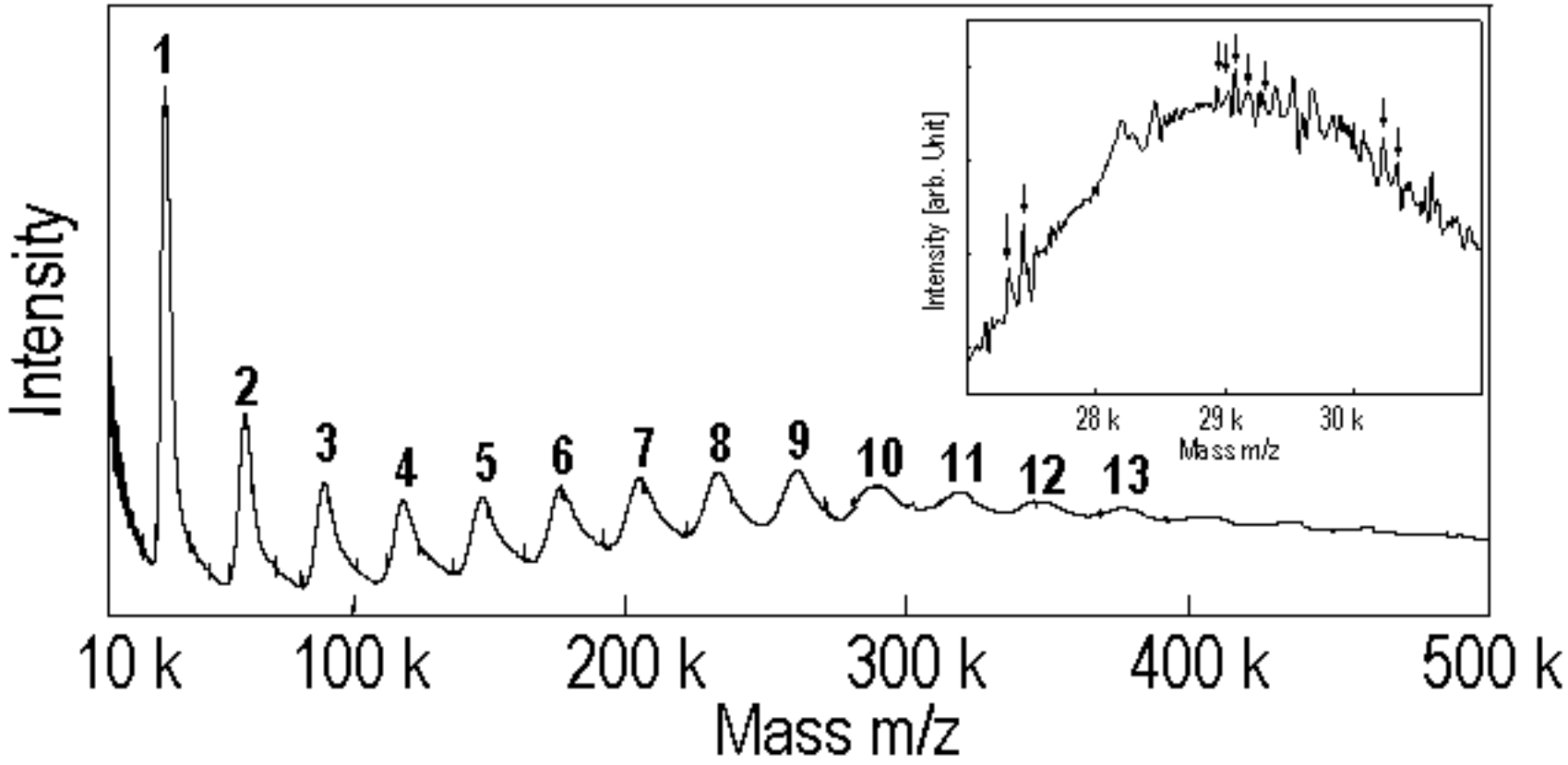
Freely soluble M@ZrO_2@XR

J. Mat. Chem. 2004a, b



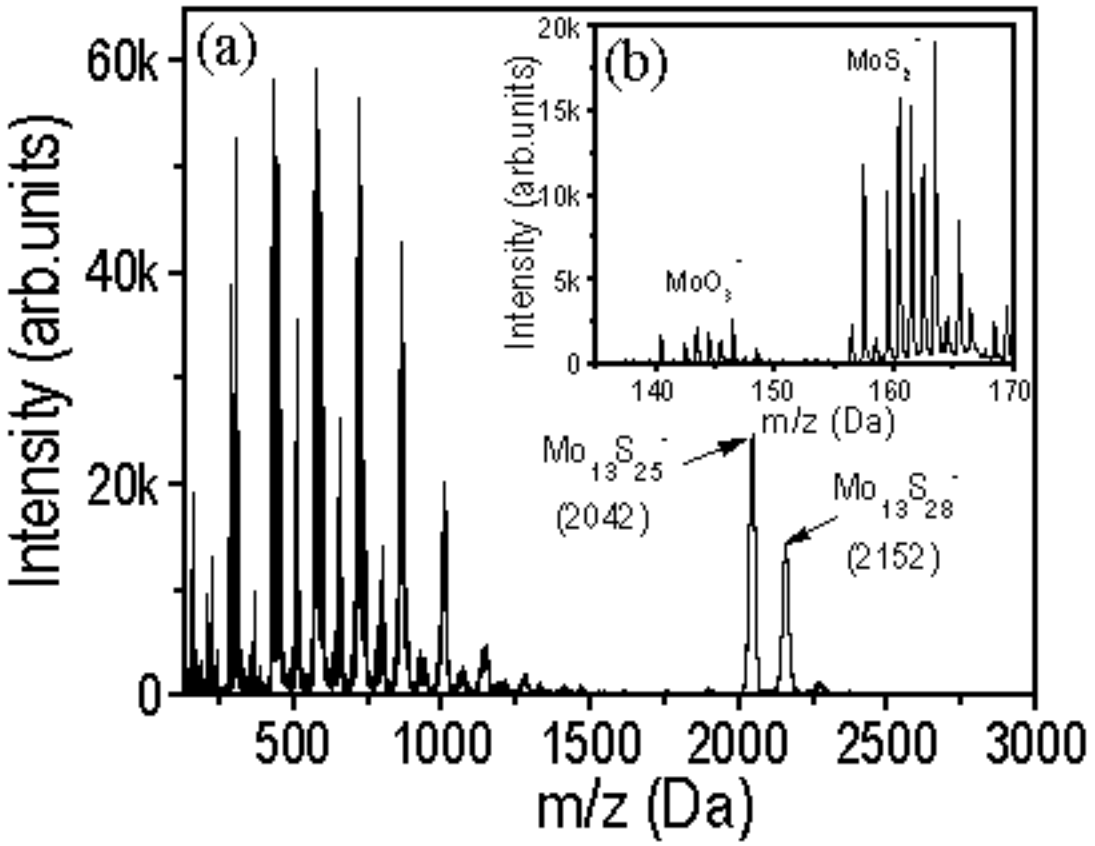
Ian MacLaren


29 kDa
Intensity [arb. unit]
10 k
100 k
200 k
Mass m/z
Au140
Absorbance [arb. Unit]
400
600
800
1000
Wavelength [nm]



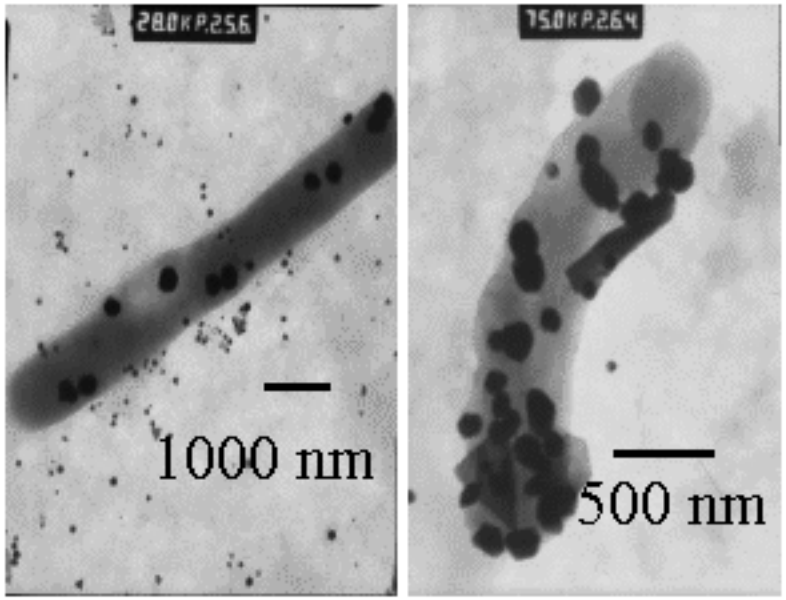
DLDI-TOF MS Au@hexanethiol cluster

Chem. Phys. Lett. 2004



MoS_2 magic clusters

Novel synthetic routes



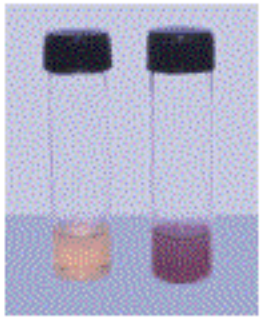
Biosynthesis

Crystallites of gold and silver grown with common *Lactobacillus* strains

Growth happens by exposing bacteria to metal ions

Nearly 30% of the dry bacterial mass is metals

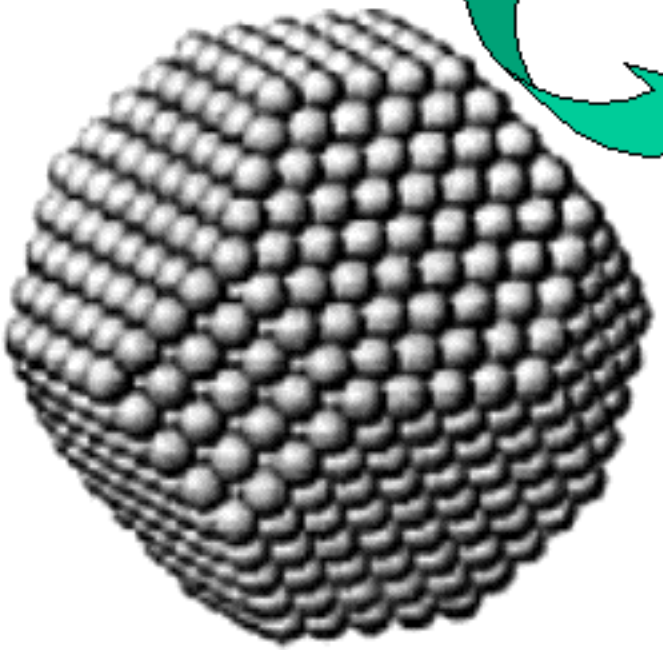
Application in extraction



Free bacterial (left) and metal colloid (right) solutions

New chemistry

Excess chloride in the solution



CCl_4

$C + 4Cl^-$

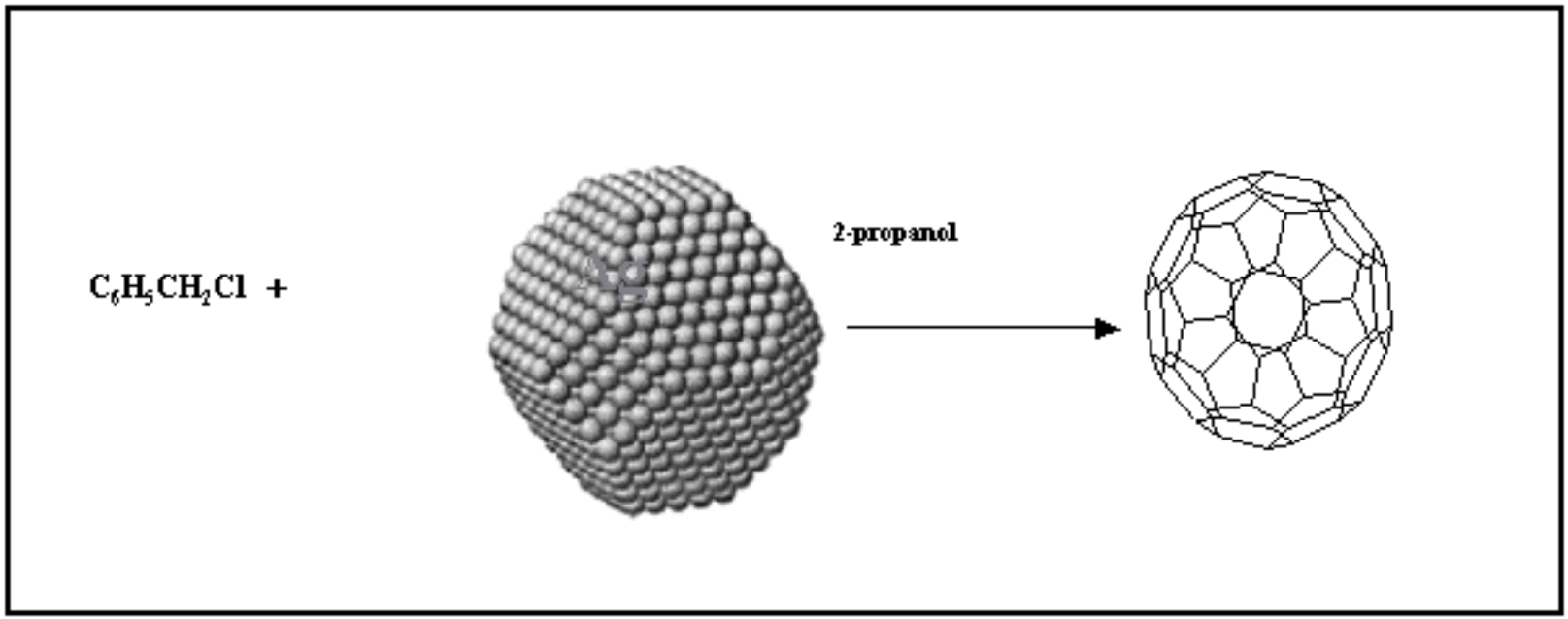
$Ag^+ + e$

$CH_3CHOHCH_3 \rightarrow CH_3COCH_3 + 2H^+ + 2e$

$4Ag + CCl_4 \rightarrow 4AgCl + C \quad \Delta H = 4 \times -127.01 + 128.2 = -379.84$ kJ/mol

Does not happen in the bulk

2003



2004

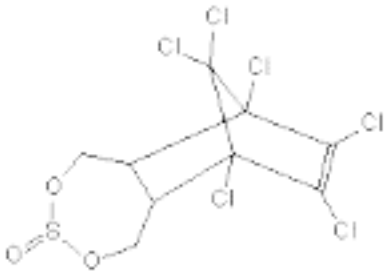
Applications

Environmental applications

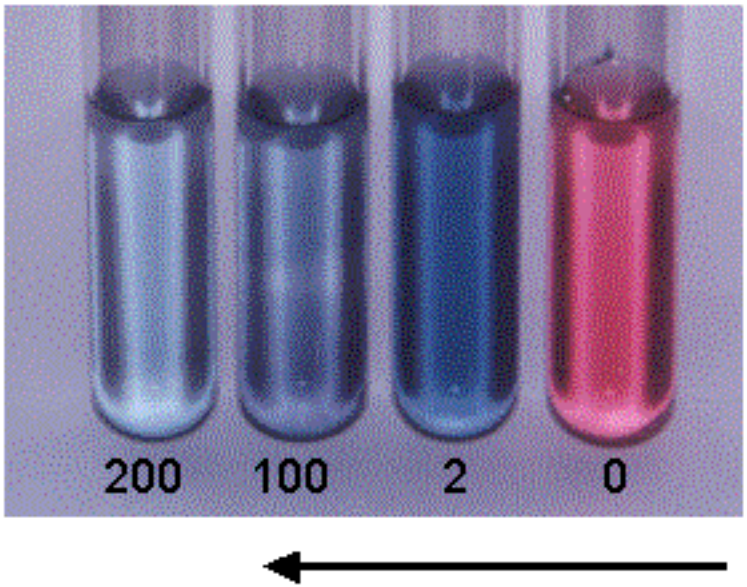
Detection and decontamination

Color of gold nanoparticles with endosulfan

Example



Endosulfan



Endosulfan concentration in ppm

Color changes with pesticide concentration

Good response at lower concentrations

Down to 0.1 ppm

Adsorbed pesticides can be removed from solution

Pesticide removal

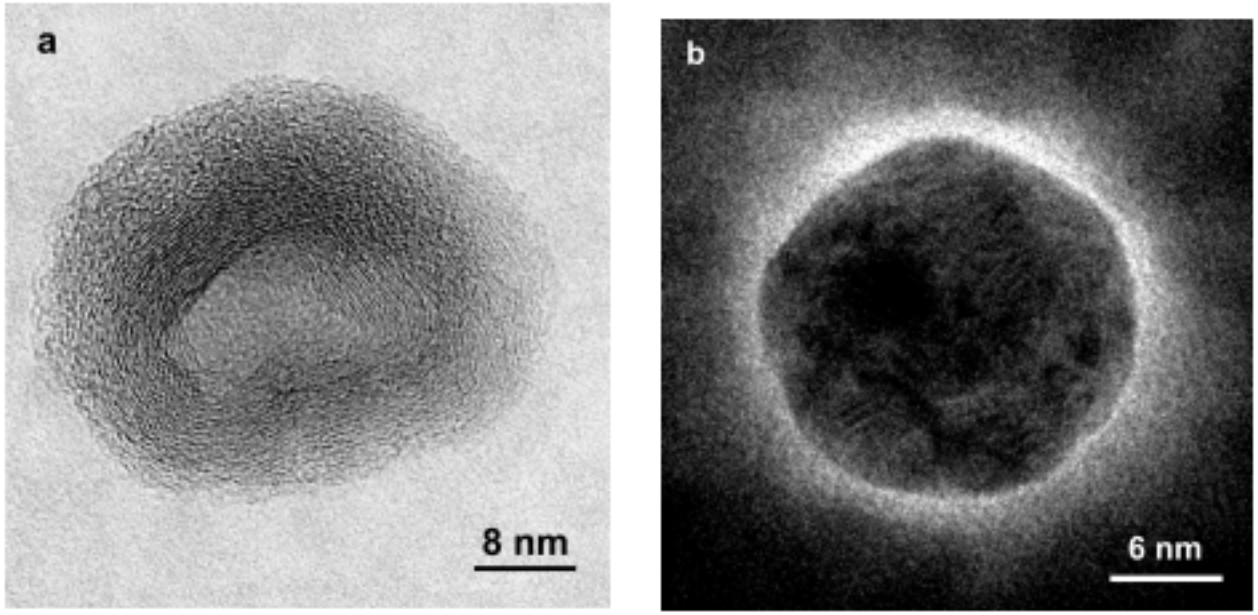
Indian Patent filed

International patent in process

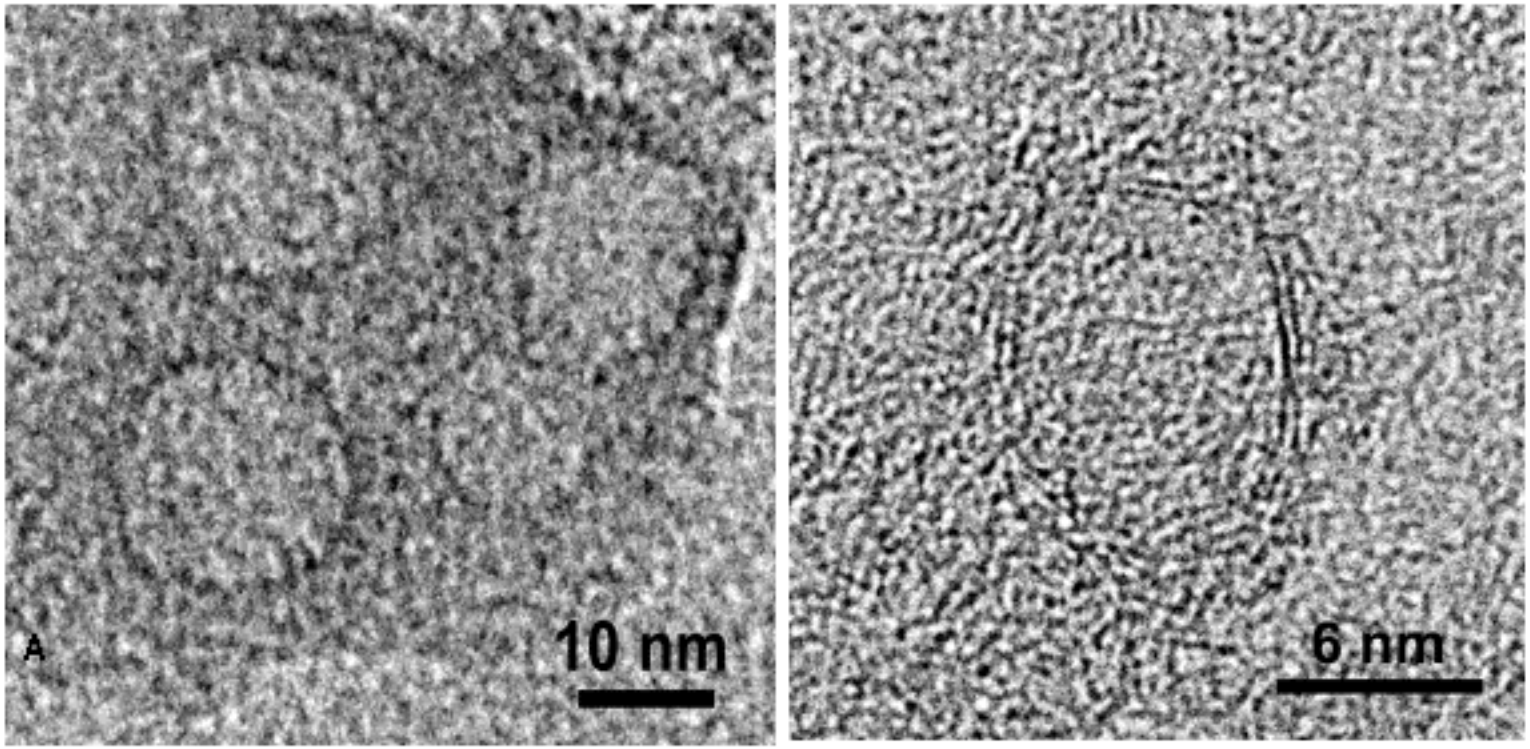
Technology being commercialized

2003

Molecular bottles



Carbon 2004



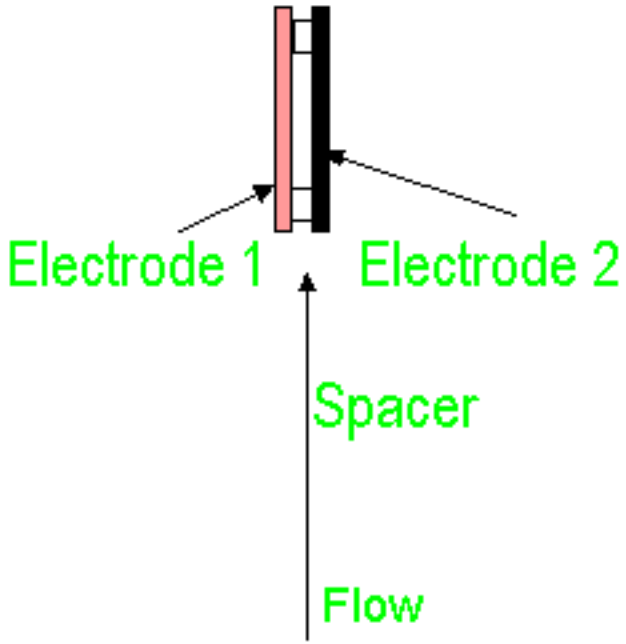
Ciprofloxacin@SiO_2

J. Mat. Chem. 2003

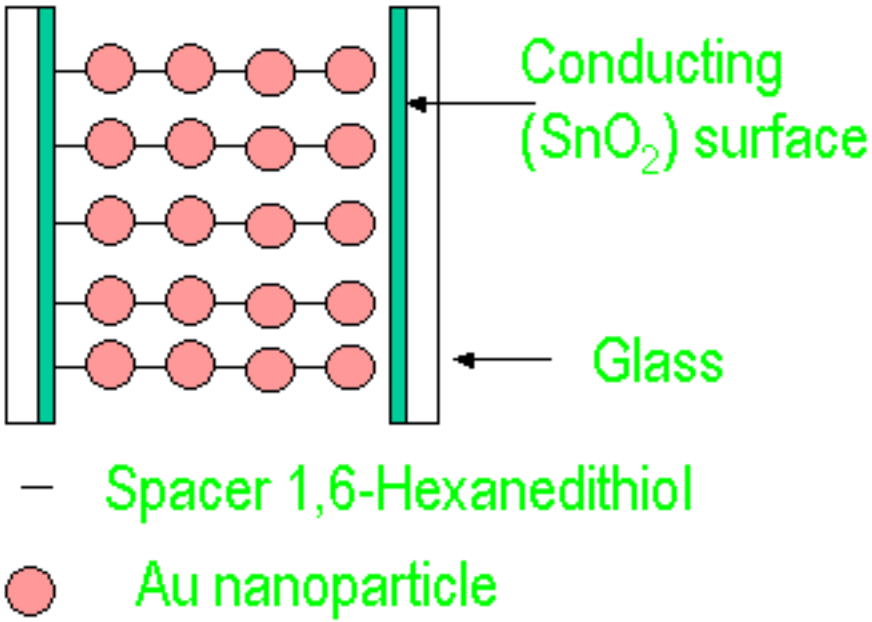
Sensors

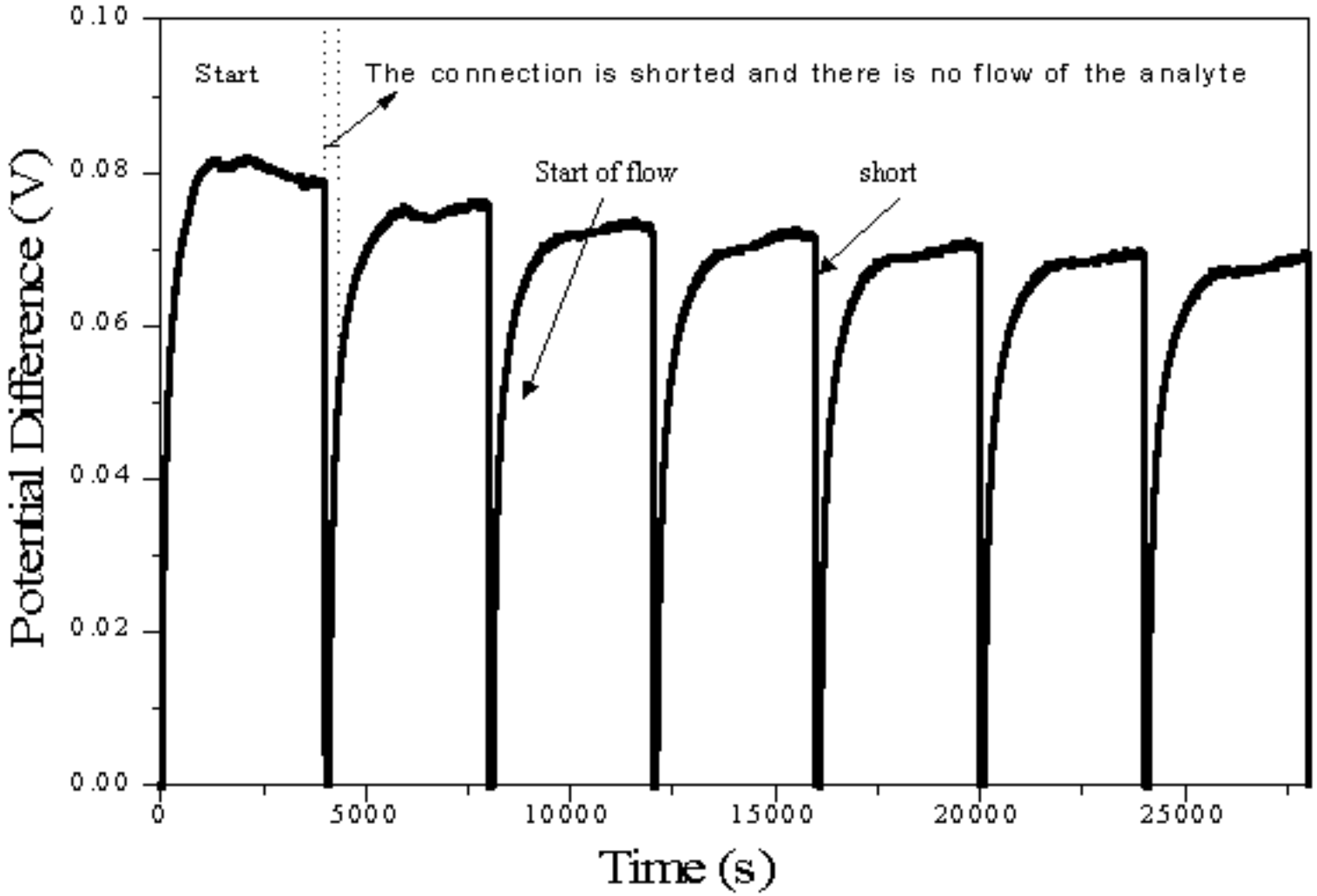
Flow induced potential in nanoparticle arrays

Sensor device (side view)



Schematic Representation



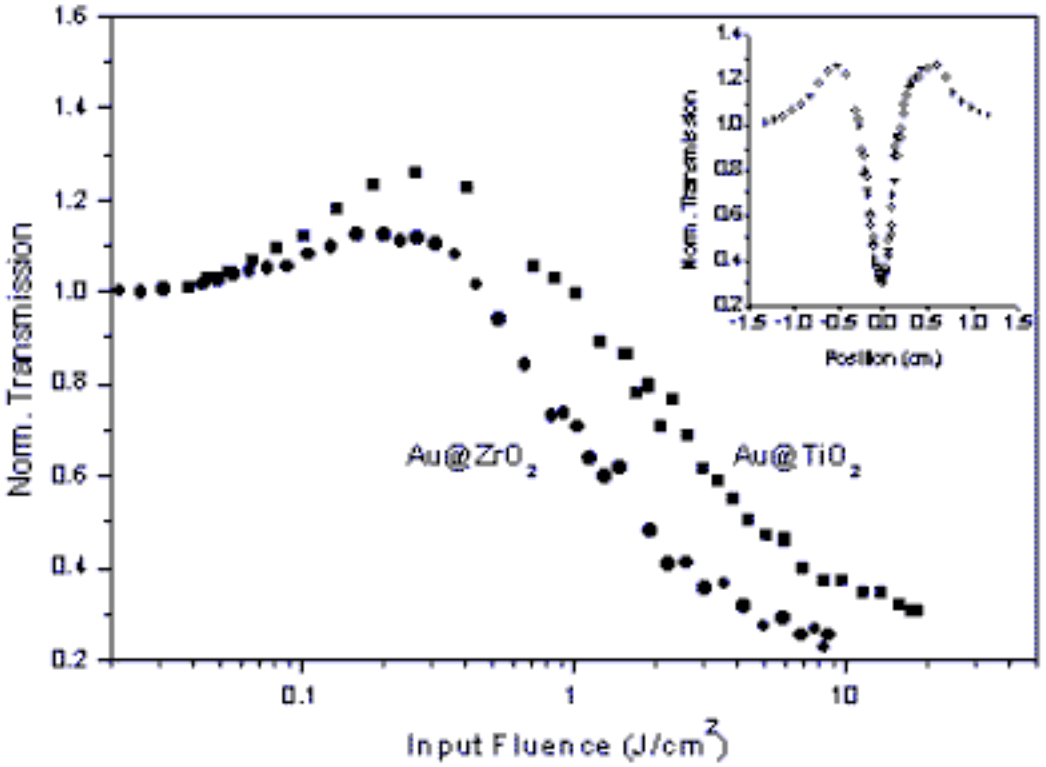


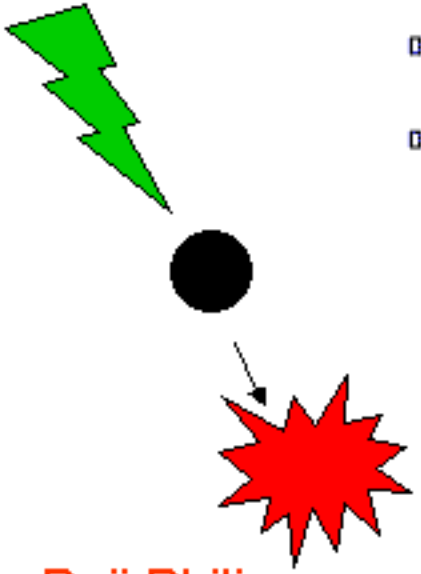
Plot of potential difference versus time for a flow rate of 500 cc/hr.

Jayadeb Chakraborti

Unpublished

Optical limiting



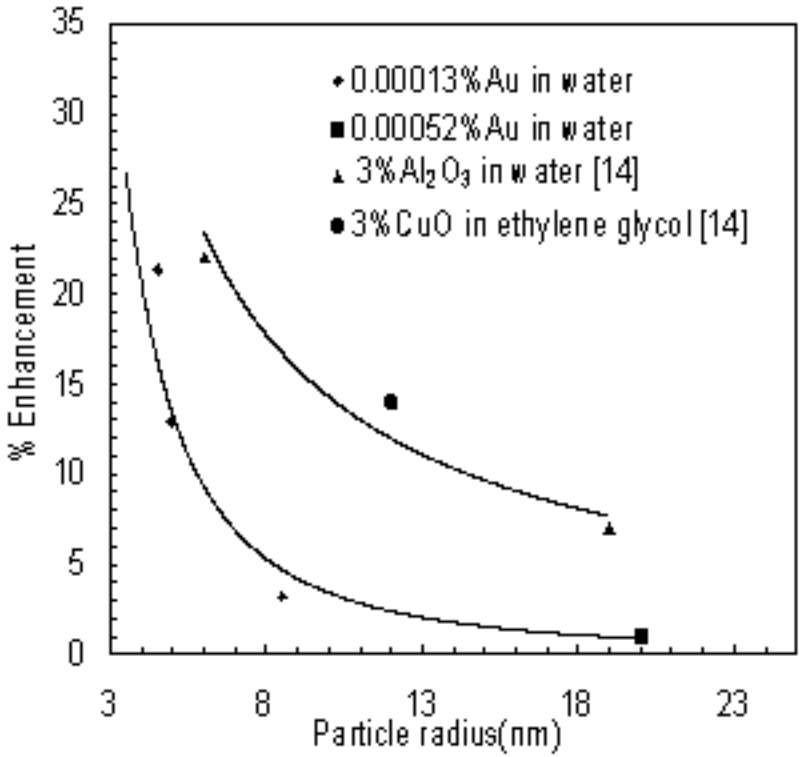


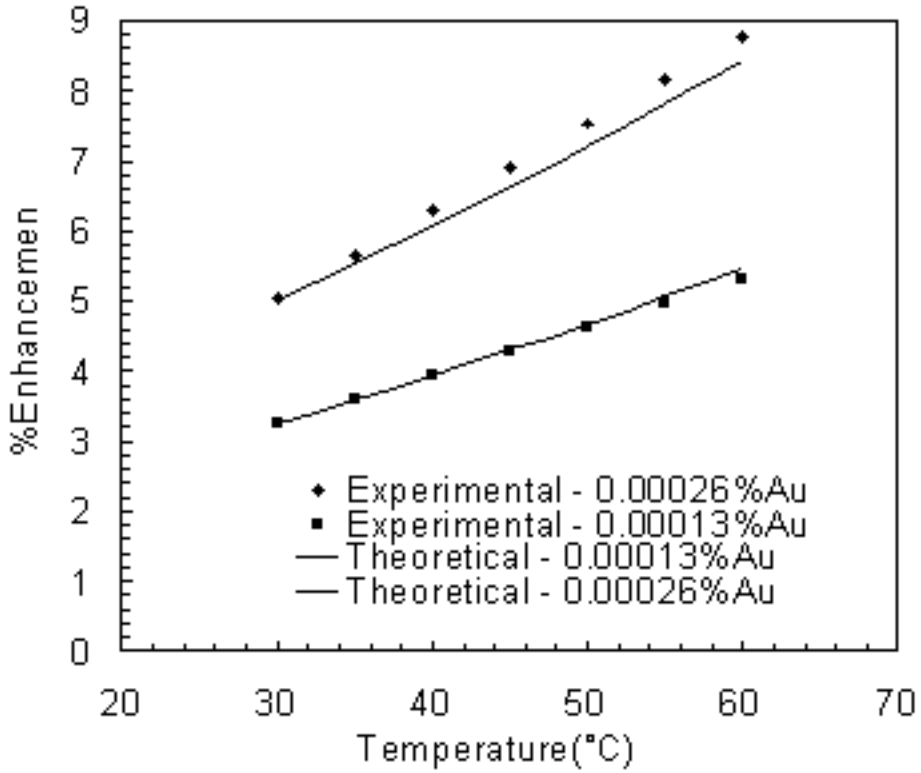
Reji Philip

Optical Limiting

Chem. Phys. Lett. 2004

Thermal conductivity of nanofluids





S. K. Das
T. Sundararajan

Phys. Rev. Lett. 2004

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Interuniversity Consortium for DAE Facilities
Council of Scientific and Industrial Research

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