

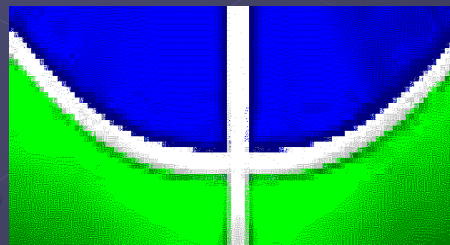
Building magnetic nanostructures from magnetic fluids

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Outline

- The magnetic nanoparticle synthesis
- Nanoparticle surface coating
- Superparamagnetism
- Complex nanoparticulated magnetic systems
- *Ex situ* versus *in situ* template loading & applications
- Closing remarks

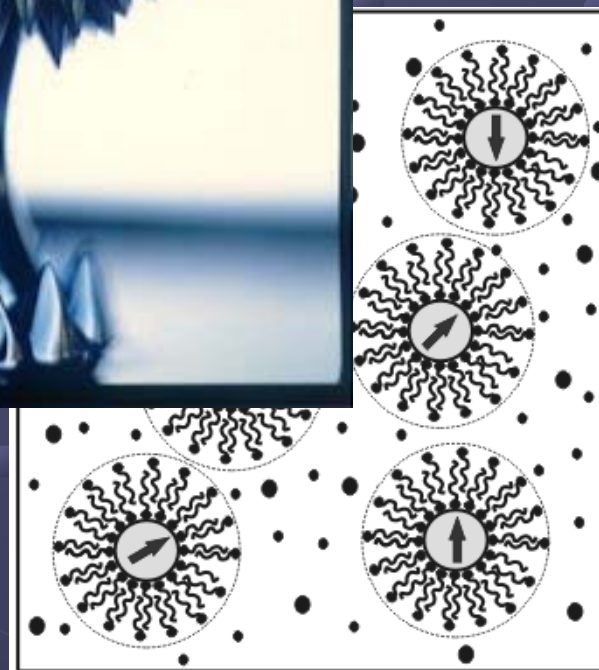
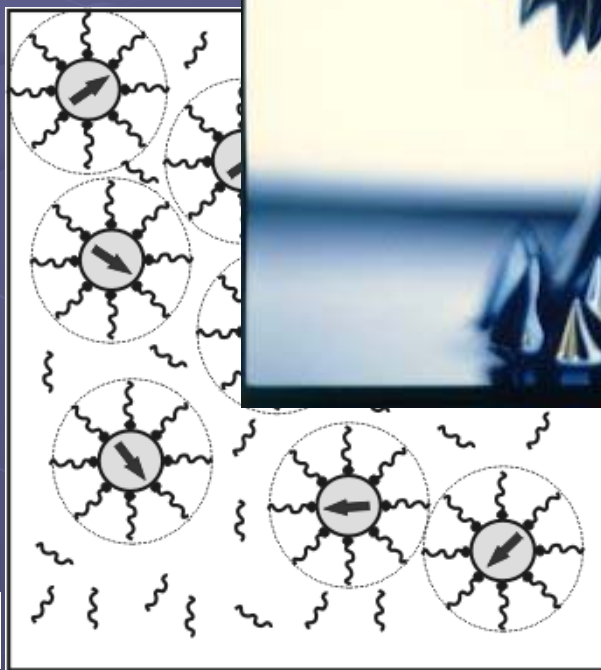
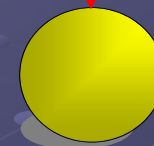
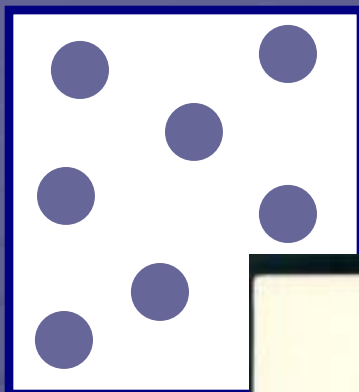


The magnetic nanoparticle synthesis

$$1\text{nm} < d < 20\text{nm}$$

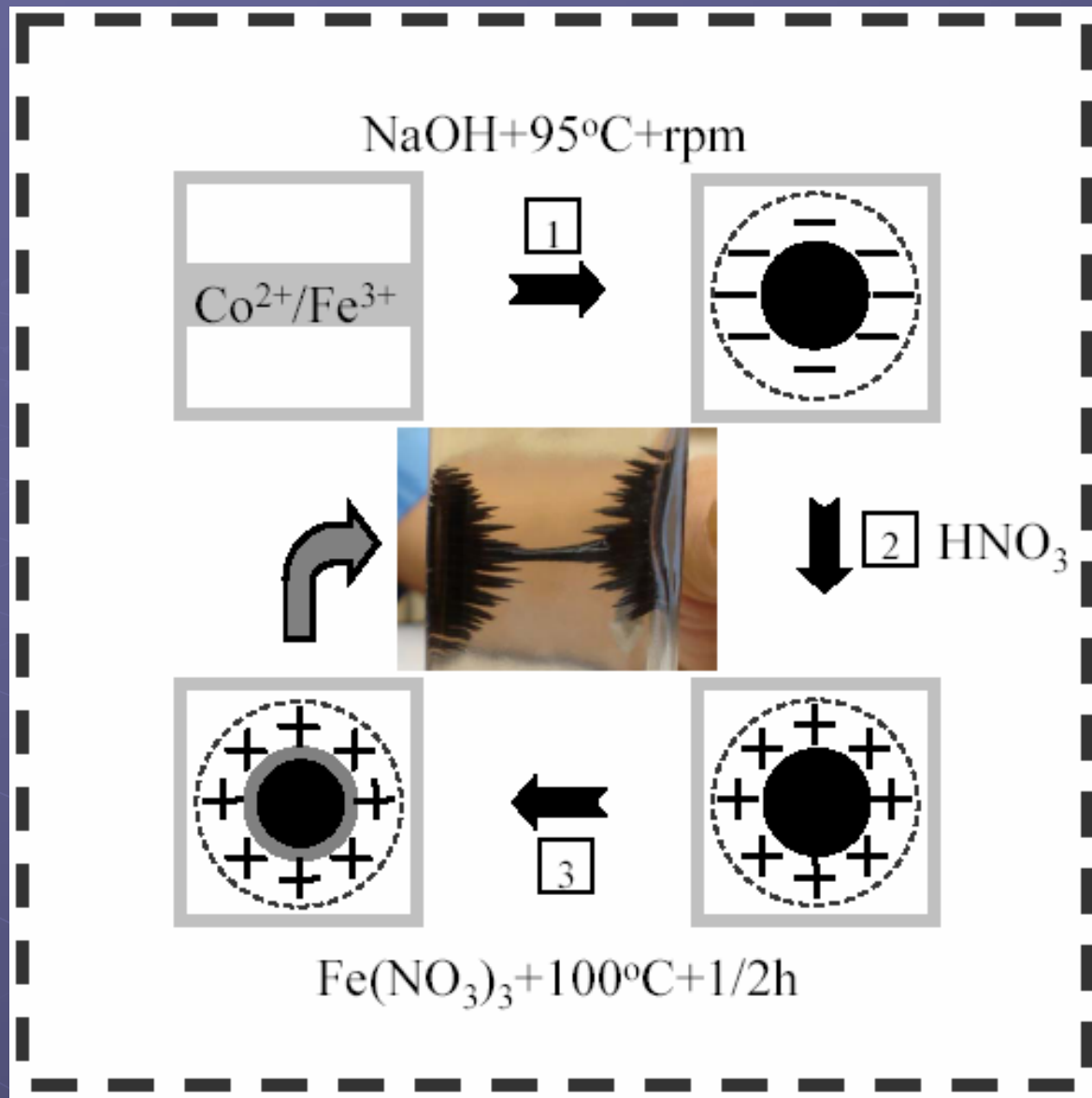
metallic ions Fe^{3+} ,
 Co^{2+} , Ni^{2+} , ...

cubic ferrite
nanoparticle



hydrophobic

hydrophilic

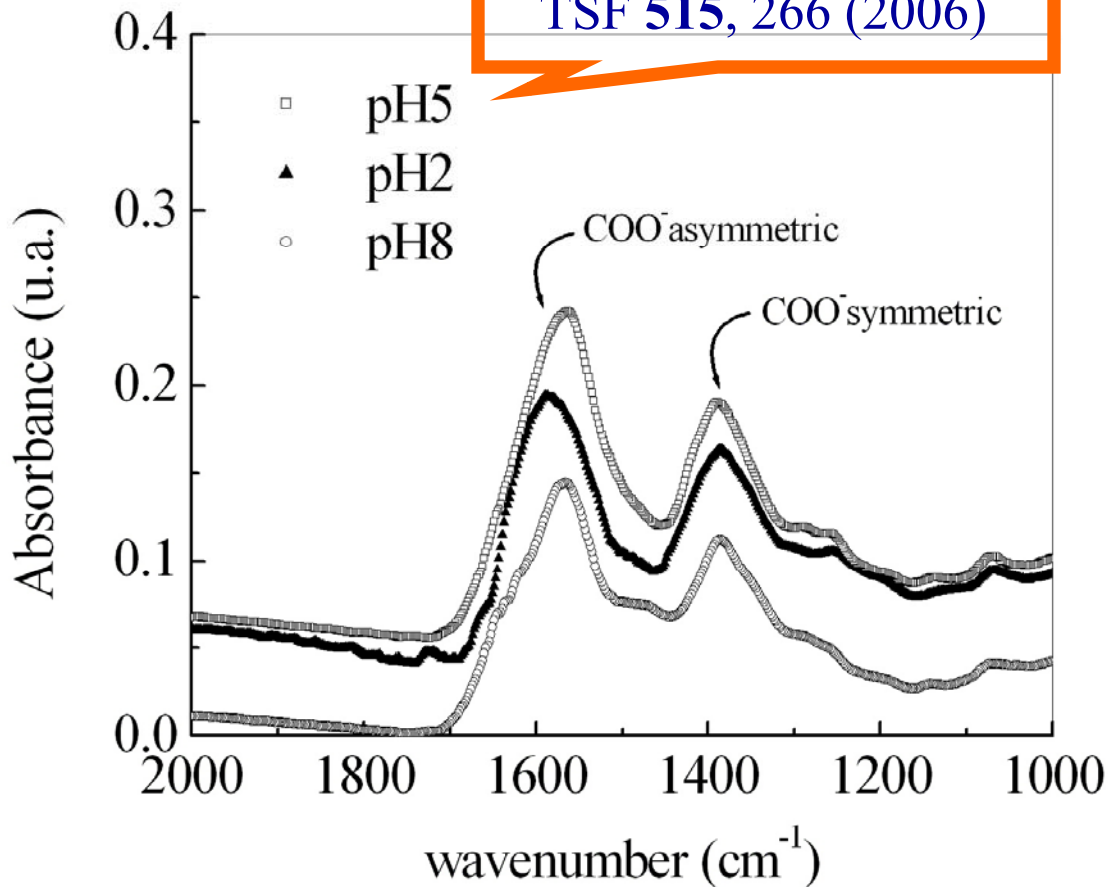


JMMM 225, 37 (2001)

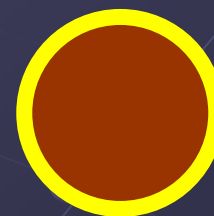
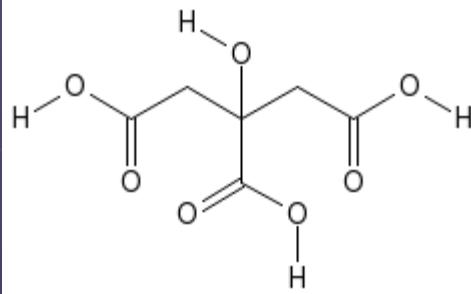


Nanoparticle surface coating

TSF 515, 266 (2006)

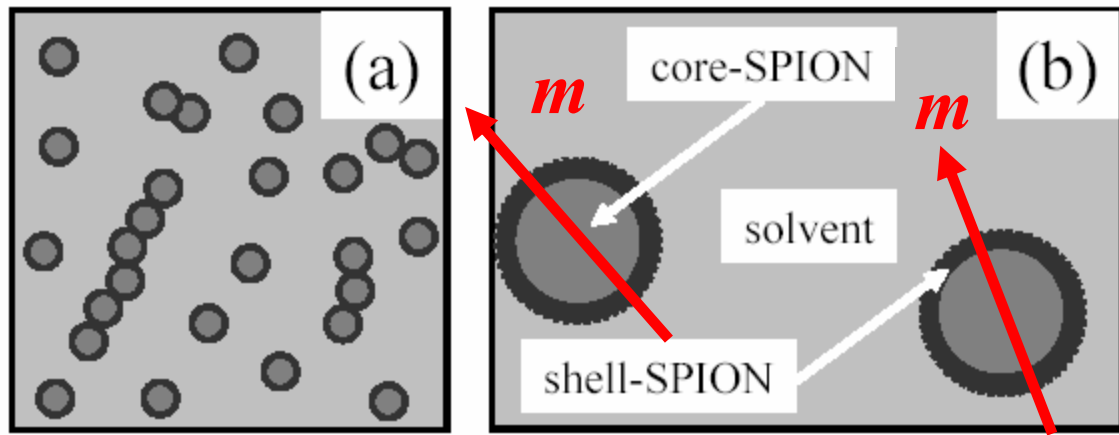


+

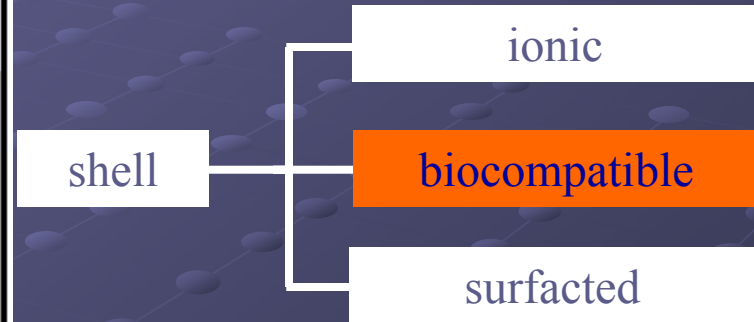


CoFe₂O₄

Magnetic fluid



<18% v.v.



Key Words



① Superparamagnetism

① Magnetic manipulation

② Surface Aspects

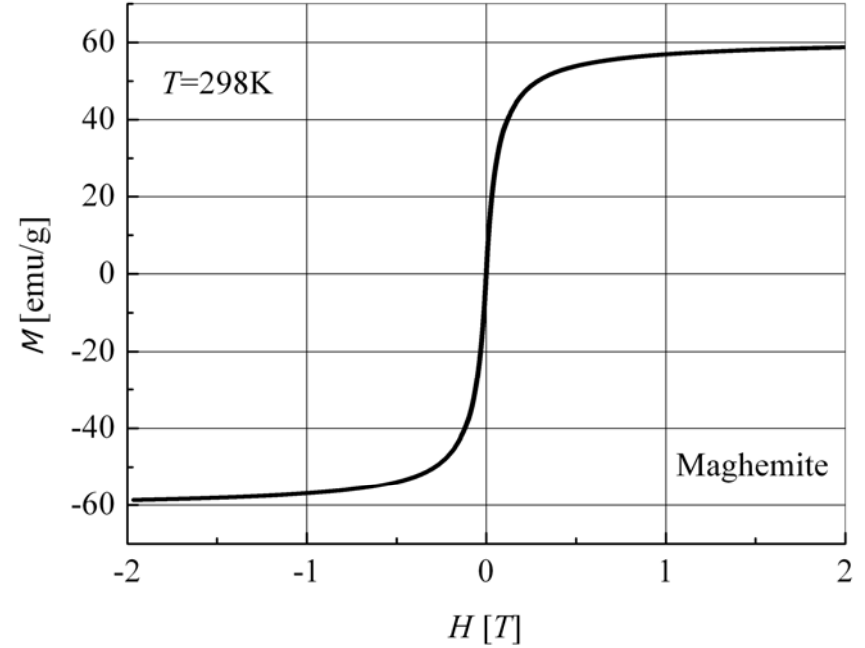
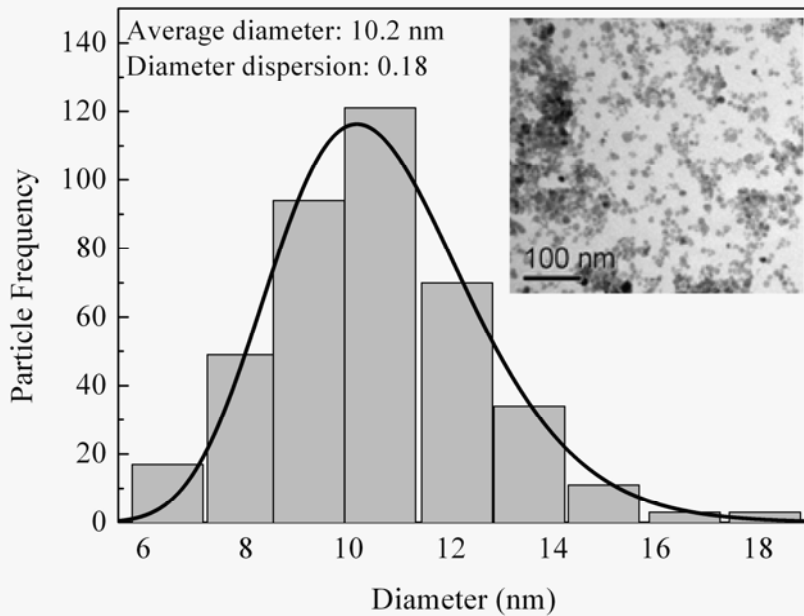
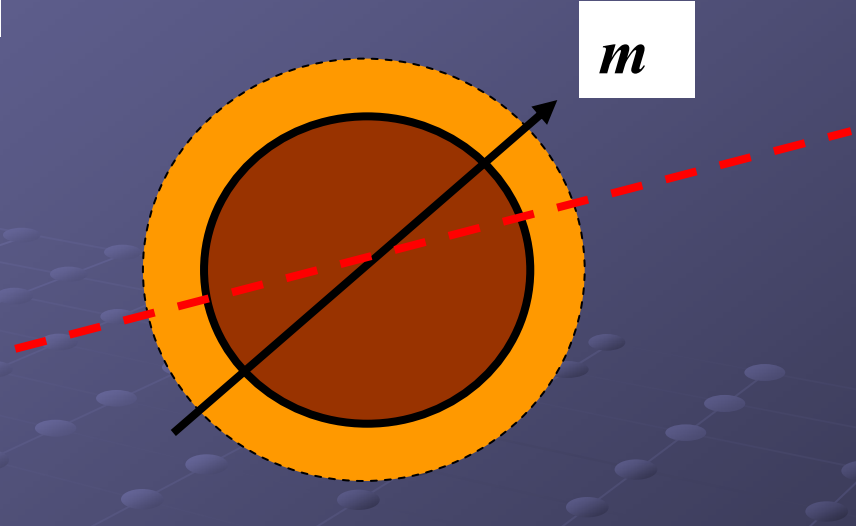
② Hydrophobicity × Hydrophilicity

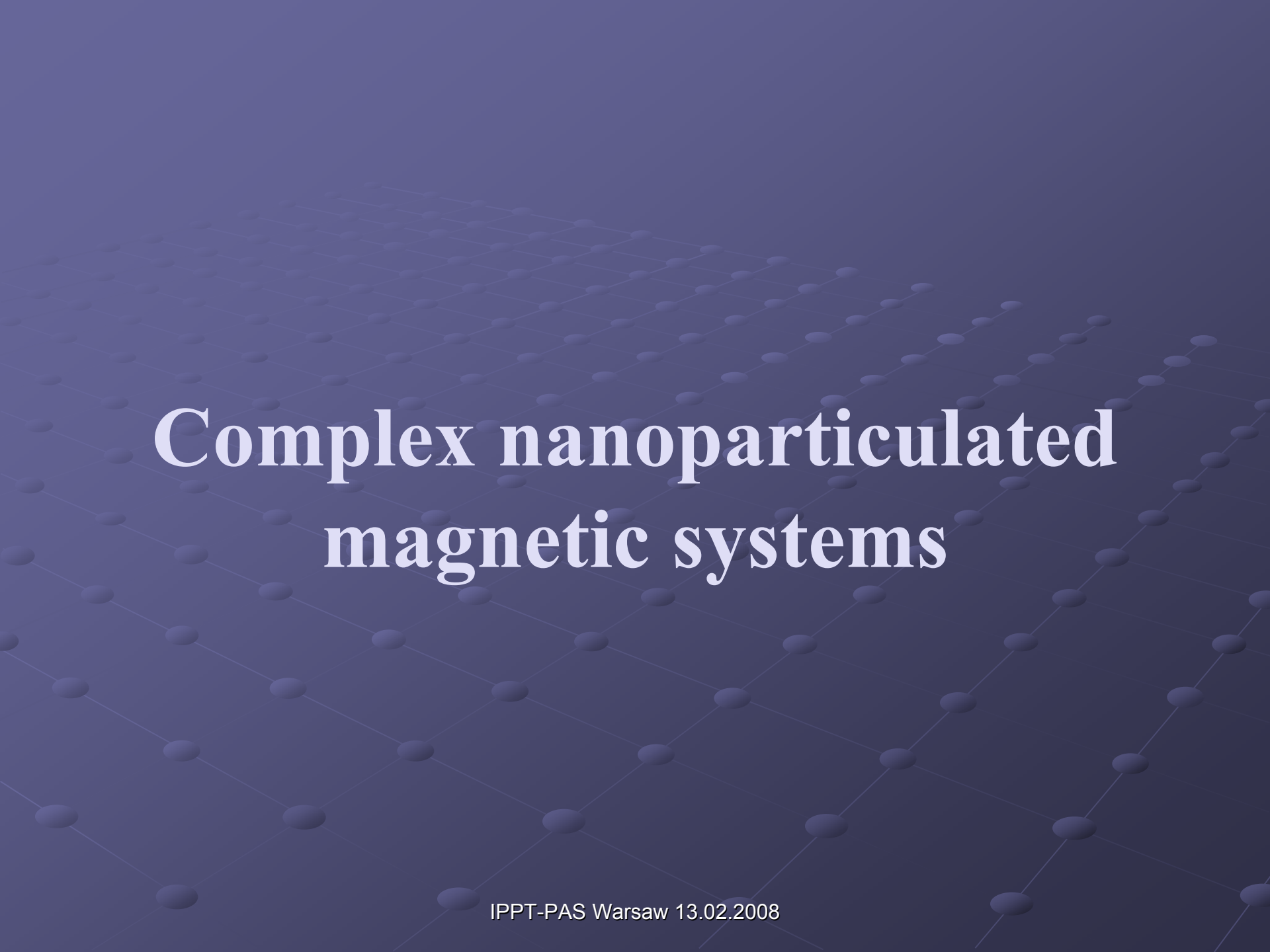
Superparamagnetism

Superparamagnetism

@ $T > T_B$ (blocking temperature)

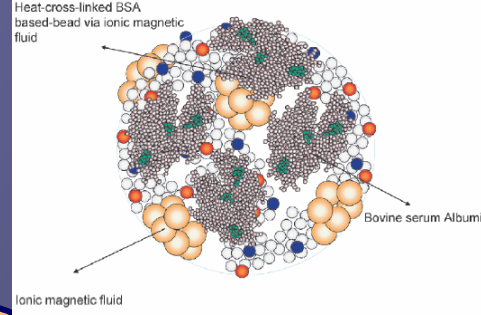
$$\vec{F} = \frac{\chi}{\mu_0} V \vec{\nabla}(H^2)$$



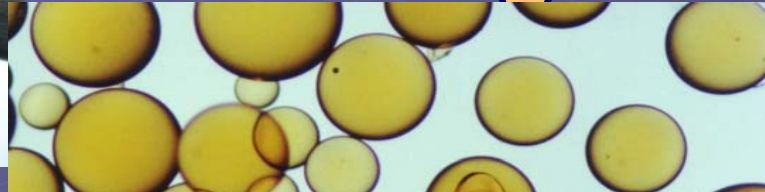


Complex nanoparticulated magnetic systems

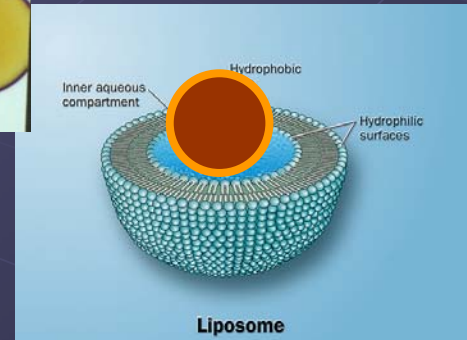
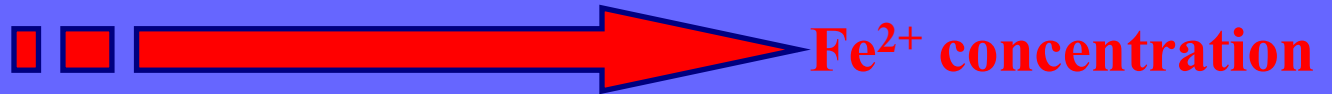
INPI-001639



JNN 6, 2413 (2006)

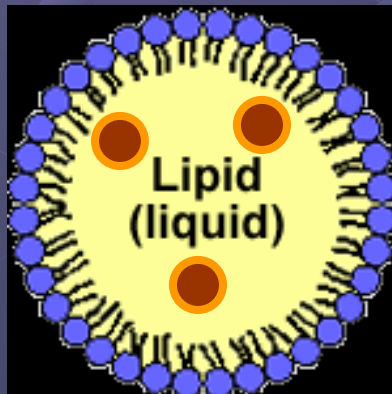


PI-0300855-0




JMMM 272, 2402 (2004)

TM 42, 3596 (2006)



December, 2007



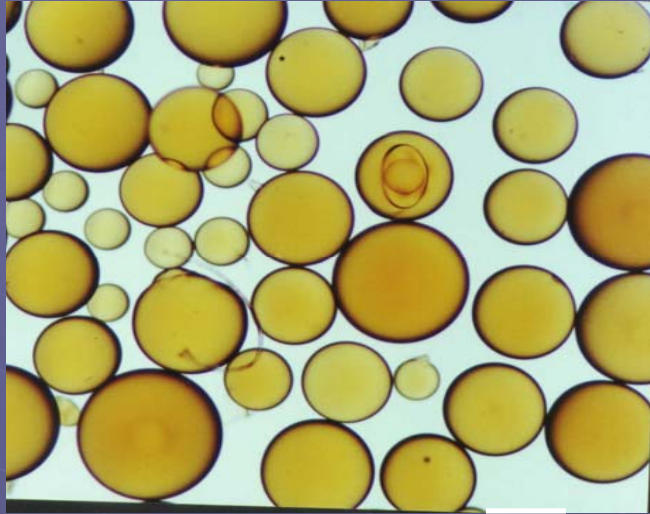


Ex situ versus *in situ*
template loading &
applications

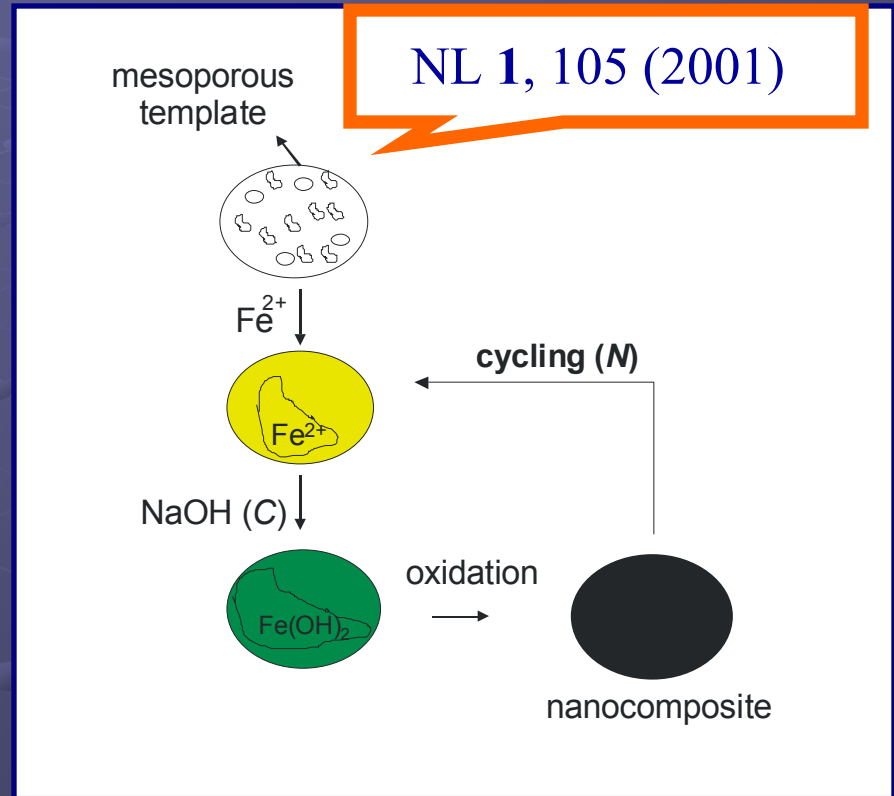
In situ

Species diffusion

(200 μm)



Styrene-Divinylbenzene

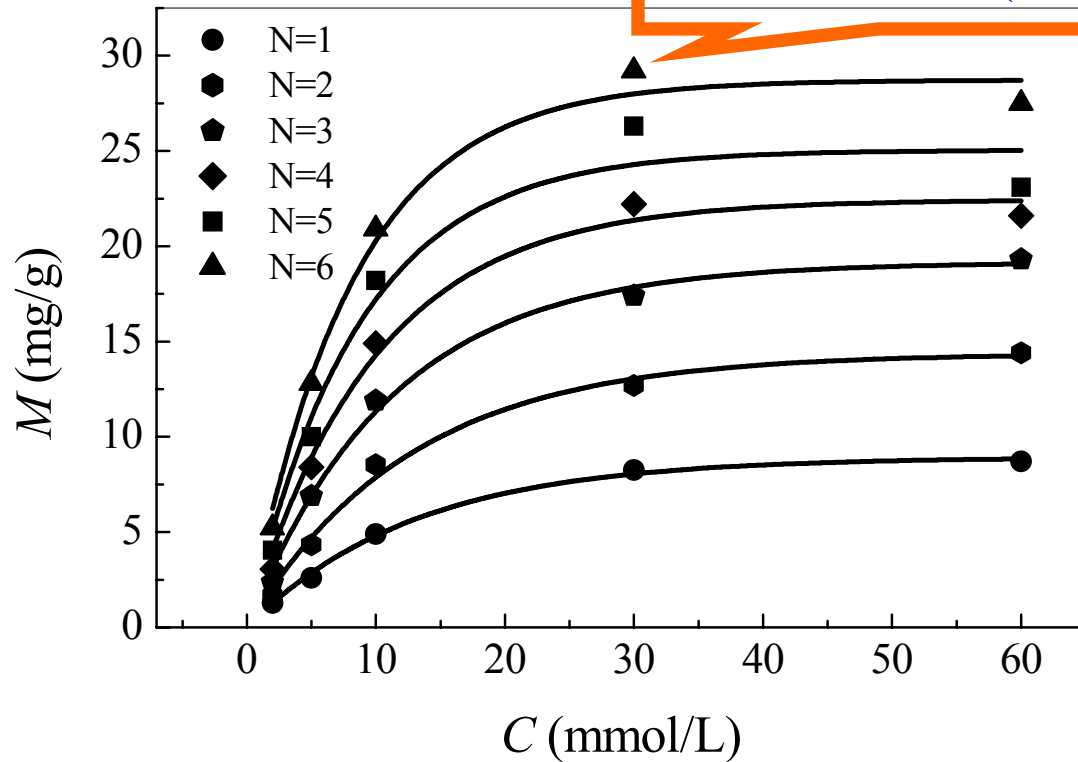


NL 1, 105 (2001)



 Fe^{2+} concentration

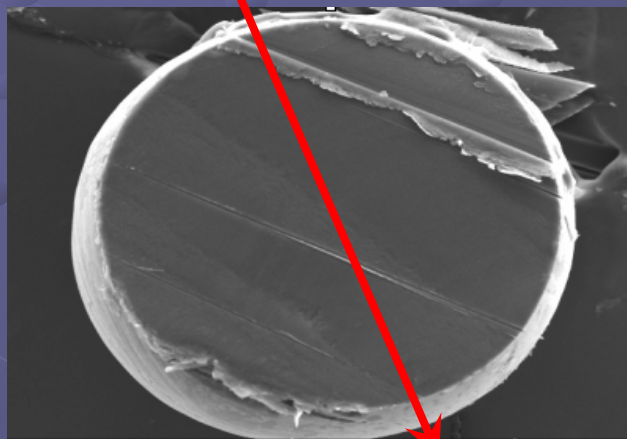
CM 15, 2485 (2003)



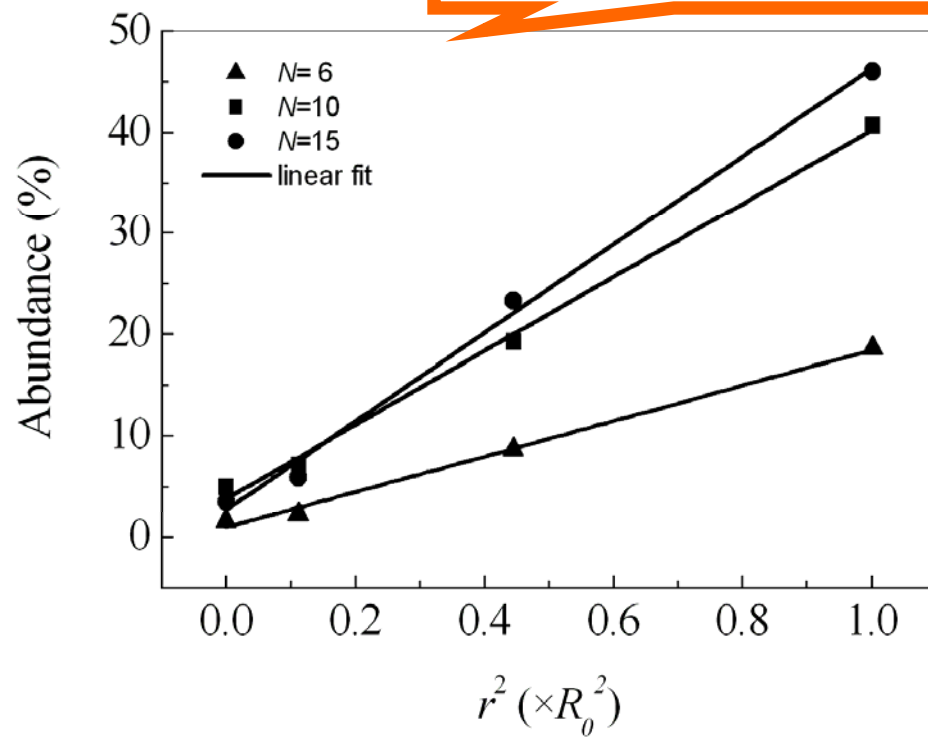
$$\Delta M = (\partial M / \partial C) \Delta C + (\partial M / \partial N) \Delta N$$

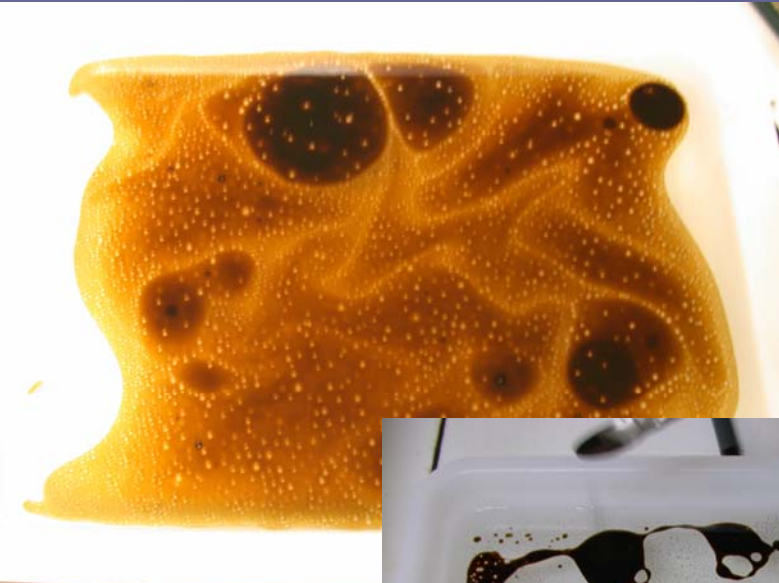
$$M(C, N) = A [1 - \exp(-\alpha C)] [1 - \exp(-\beta N)]$$

SEM-EDX



PSS(a) 201, 898 (2004)





PI-0300855-0

$\text{Mg}_3(\text{Al,Si})_4\text{O}_{10}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$ is an expanding clay material with:

- ① Mg^{2+} cation in the interlayer region to balance the layer charge;
- ② Mg^{2+} cation strongly hydrated separating adjacent layers producing a shrinking and swelling clay;
- ③ Mg^{2+} cation that can be exchanged with other cation when water gets into the interlayer;
- ④ Asbestos free availability.

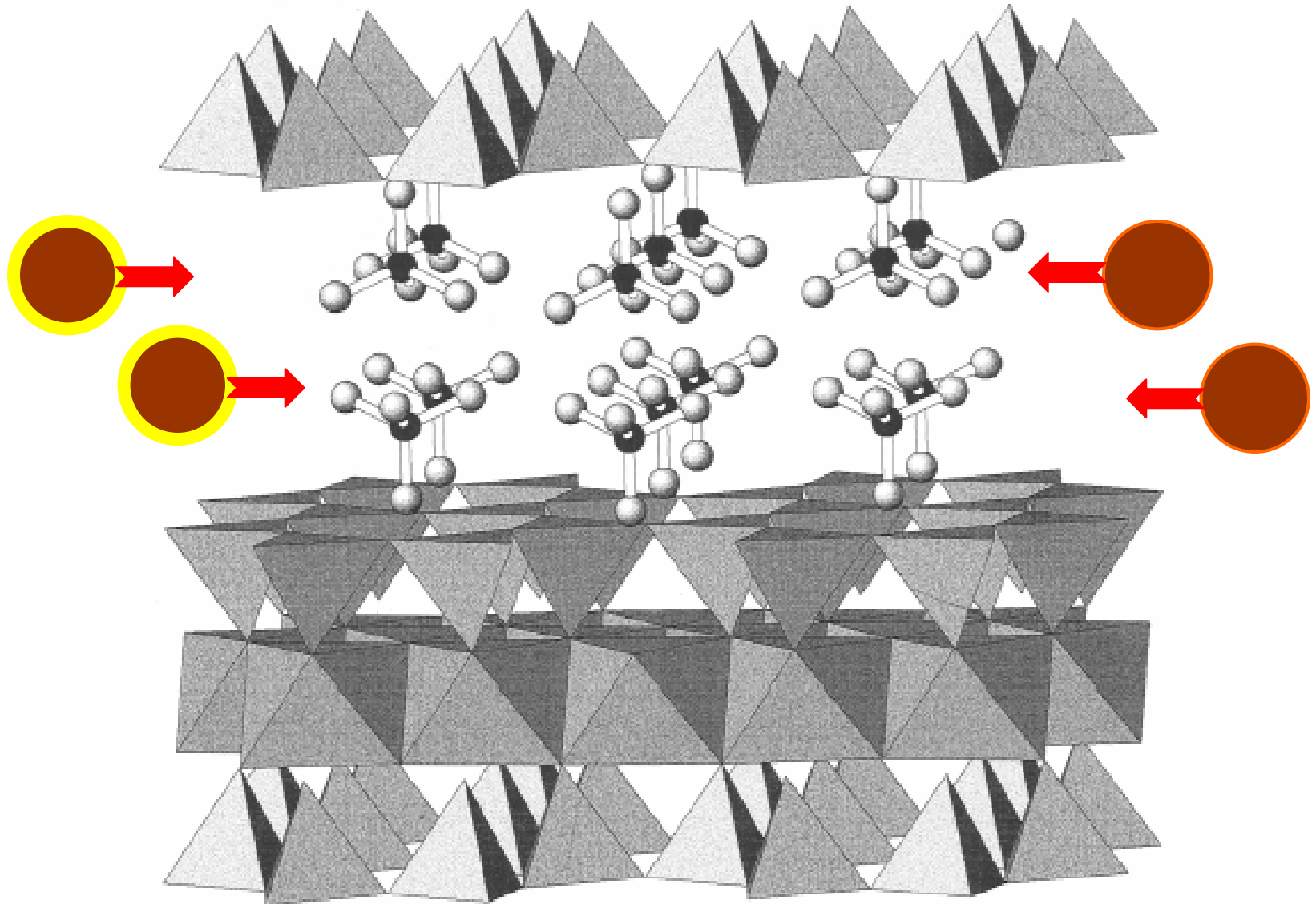
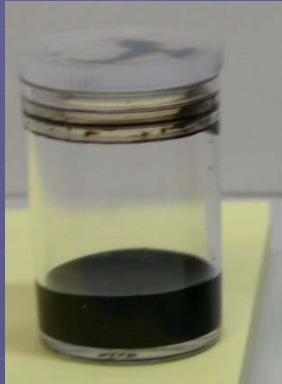


Figure 2. Average structure of TMA-exchanged vermiculite viewed nearly along [100] direction. Note that polyhedral corners are based on oxygen-atom centers. Tetrahedra contain Si, Al and octahedra contain Mg, Fe, Al, Ti, Mn. TMA is depicted as ball-and-stick figures with N at the center and C at the corners. As an average structure, 2 layers of TMA apparently occur in the interlayer, but these sites are only partly occupied (see text).

Ex situ



INPI-001639

Cell Tagging

ELSEVIER

Journal of Magnetism and Magnetic Materials 272–276 (2004) 2400–2401

Journal of Magnetism and Magnetic Materials
www.elsevier.com/locate/jmmm

Magnetic resonance investigation of magnetic-labeled baker's yeast cells

J.P.M. Godoy Morais^{a,*}, R.B. Azevedo^a, L.P. Silva^a, Z.G.M. Lacava^a, S.N. Bão^a,
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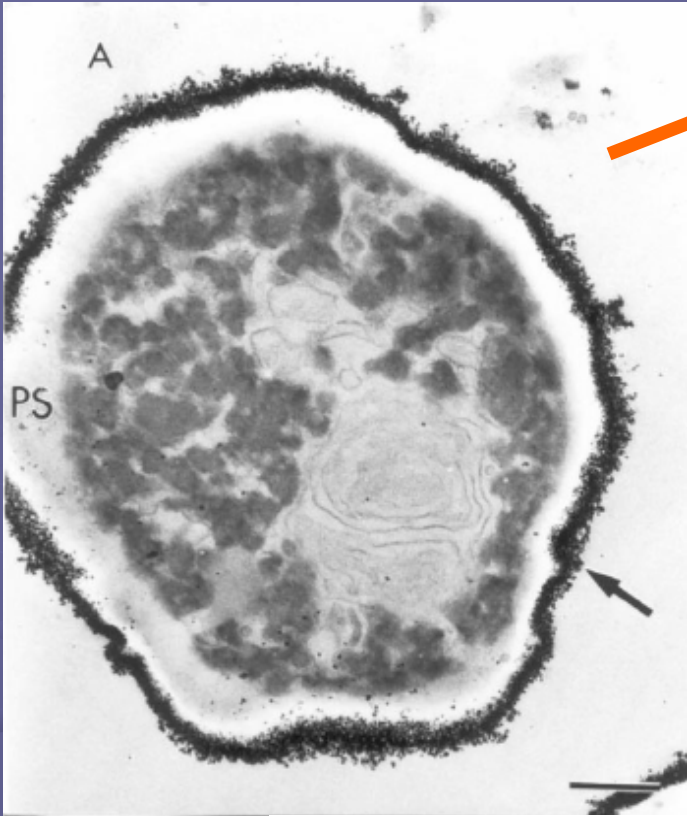
Journal of
Nanoscience and Nanotechnology
Vol. 7, 1–3, 2007

Interaction of Erythrocytes with Magnetic Nanoparticles

Maria A. G. Soler^{1,*}, Sônia N. Bão², Gustavo B. Alcântara¹, Victor H. S. Tibúrcio²,
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Universidade de Brasília, Brasília-DF 70910-900, Mexico

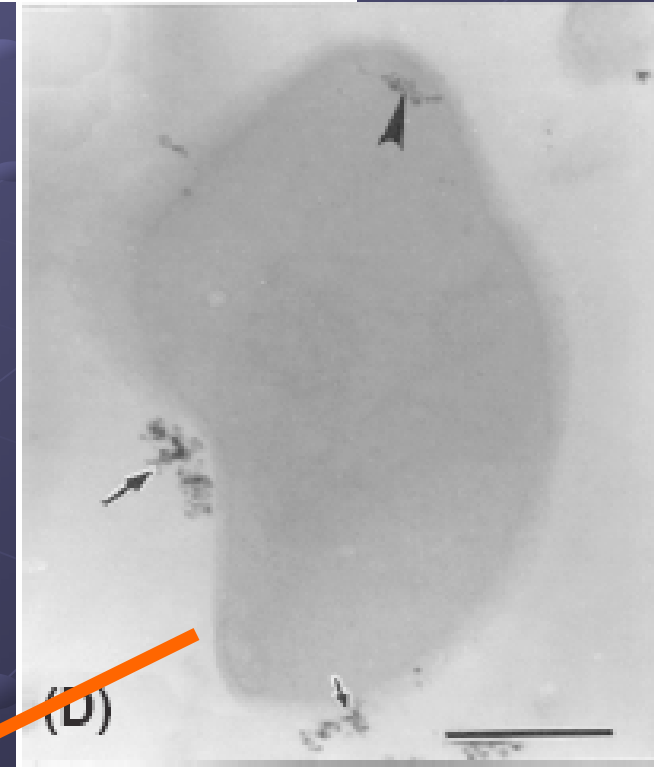
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JMMM 272, 2400 (2004)

Erythrocytes

Saccharomyces



JNN 7, 1069 (2007)

Control cell

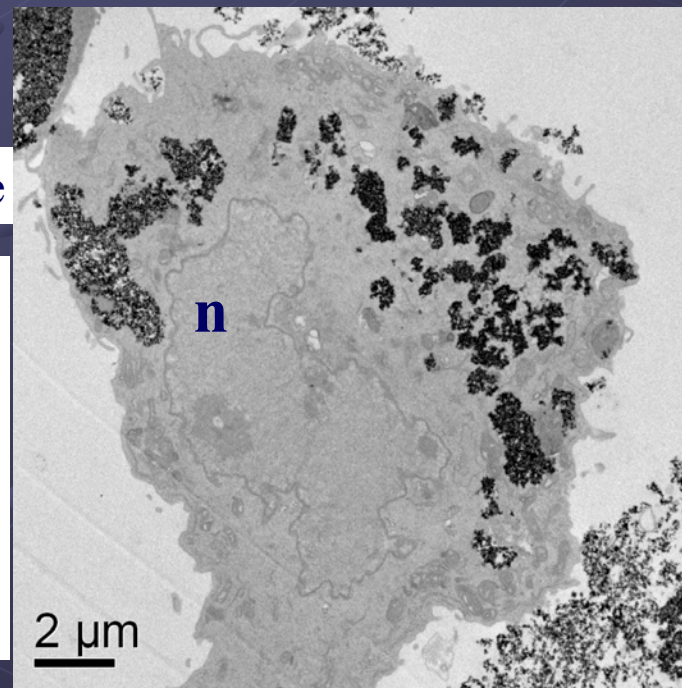
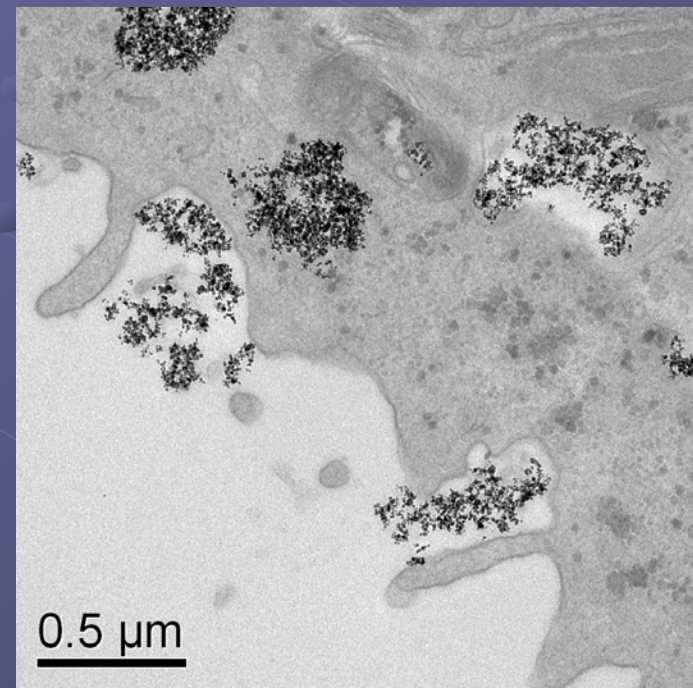
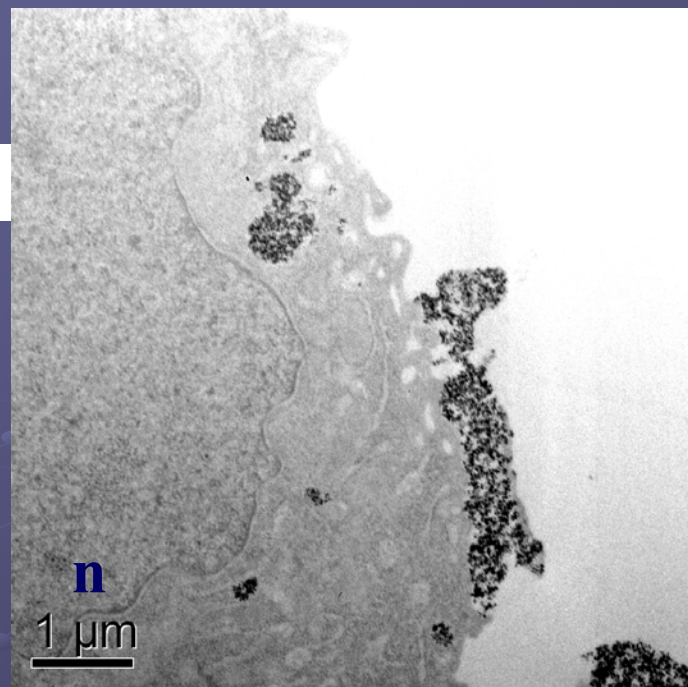
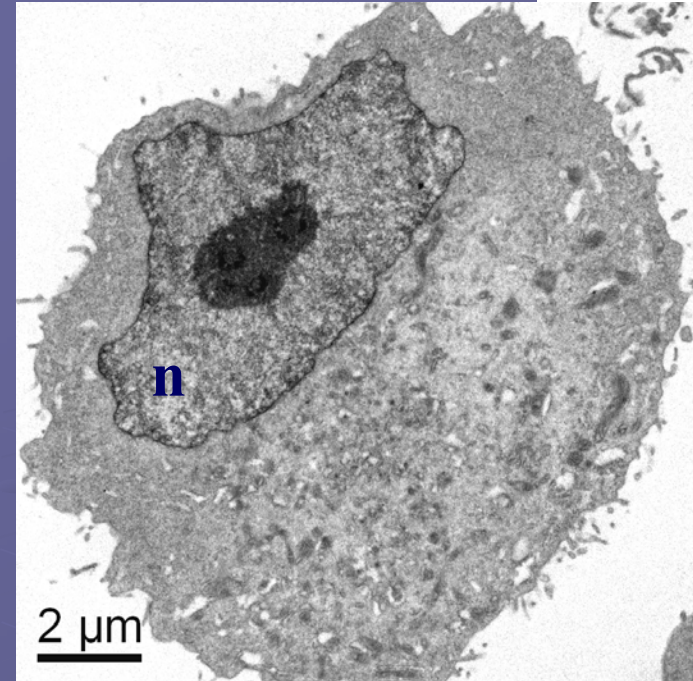
DMSA-maghemite

JNN (in press)

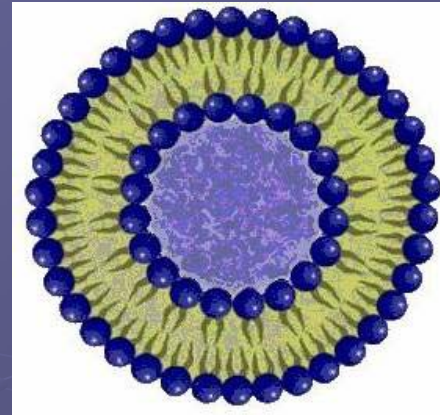
Citrate-maghemite

Laurate-maghemite

**Human
Melanoma
Cells**

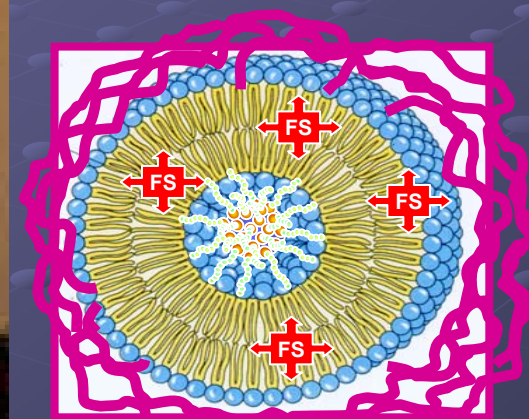


Magnetoliposome

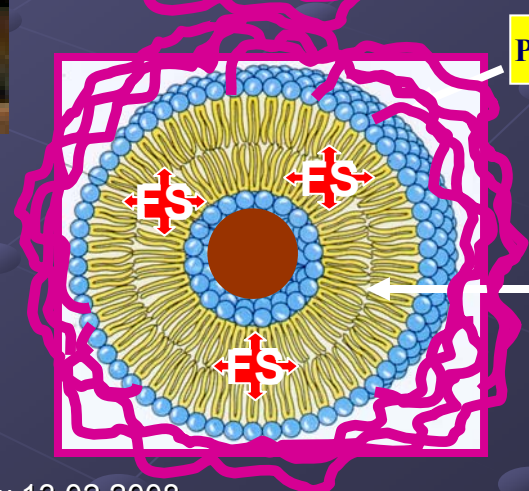


Liposome

HRAN - Brasilia



LTC-liposome



PEG-Derivative

Lipidic structure

Magnetoliposome

JAP 97, 10Q906 (2005)

Closing Remarks

Brazilian Nanobiomagnetism Network

Network Team

- ➔ 40 Professors (7 Full & 33 Associate + Assistant)
- ➔ 160 Students (Pos-Docs, Graduate & Undergraduate)

Brazilian Nanobiomagnetism Network Achievements

ISI Web of Knowledge ISI Access the new version! Web of Science GO

Web Of Science Results Analysis

Results Analysis
1,389 records. TS=(magnetic-fluid or magnetic-fluids or ferrofluid or ferrofluids)

Rank the records by: Analyze: Set display options: Up to 2500 records. Show the top 1 Minimum record

Author Country/Territory Document Type Institution Name

ANALYZE Rank results by t

1945-1998

Use the checkboxes below to view the records.
Note: The number of records displayed may be greater than if the original set contained more records than the number o

VIEW RECORDS

Field: Institution Name	Record Count	
<input type="checkbox"/> UNIV PARIS 06	78	5.
<input type="checkbox"/> TOHOKU UNIV	68	4.
<input type="checkbox"/> UNIV WALES UNIV COLL N WALES	50	3.
<input type="checkbox"/> KEIO UNIV	41	2.
<input type="checkbox"/> UNIV COLL N WALES	36	2.
<input type="checkbox"/> YARMOUK UNIV	34	2.
<input type="checkbox"/> ACAD SCI USSR	25	1.
<input type="checkbox"/> UNIV DUBLIN TRINITY COLL	25	1.
<input type="checkbox"/> RUSSIAN ACAD SCI	24	1.
<input type="checkbox"/> EXXON RES & ENGN CO	23	1.

Web Of Science Results Analysis

Results Analysis
2,340 records. TS=(magnetic-fluid or magnetic-fluids or ferrofluid or ferrofluids)

Rank the records by: Analyze: Set display options: Up to 2500 records. Show the top 10 Minimum record

Author Country/Territory Document Type Institution Name

ANALYZE Rank results by th

1999-2008

Use the checkboxes below to view the records.
Note: The number of records displayed may be greater than if the original set contained more records than the number o

VIEW RECORDS

Field: Institution Name	Record Count	% of 2340
<input type="checkbox"/> UNIV BRASILIA	152	6.4957
<input type="checkbox"/> UNIV PARIS 06	114	4.8718
<input type="checkbox"/> UNIV FED GOIAS	59	2.5214
<input type="checkbox"/> UNIV SAO PAULO	58	2.4786
<input type="checkbox"/> TOHOKU UNIV	53	2.2650
<input type="checkbox"/> NATL TAIWAN UNIV	52	2.2222
<input type="checkbox"/> DA YEH UNIV	50	2.1368
<input type="checkbox"/> NATL TAIWAN NORMAL UNIV	43	1.8376
<input type="checkbox"/> RUSSIAN ACAD SCI	41	1.7521
<input type="checkbox"/> CHINESE ACAD SCI	40	1.7094

Web Of Science Results Analysis

Results Analysis
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Author Country/Territory Document Type Institution Name

ANALYZE Rank results by the selected field.

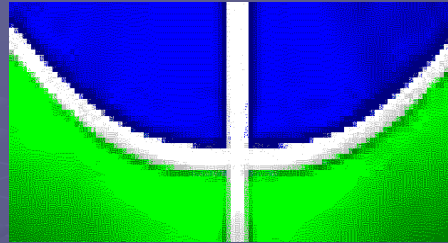
1945-2008

Use the checkboxes below to view the records.
Note: The number of records displayed may be greater than the listed Record Count if the original set contained more records than the number of records analyzed.

VIEW RECORDS

Field: Institution Name	Record Count	% of 3729	Bar Chart
<input type="checkbox"/> UNIV PARIS 06	192	5.1488 %	■
<input type="checkbox"/> UNIV BRASILIA	164	4.3980 %	■
<input type="checkbox"/> TOHOKU UNIV	121	3.2448 %	■
<input type="checkbox"/> UNIV SAO PAULO	72	1.9308 %	■
<input type="checkbox"/> RUSSIAN ACAD SCI	65	1.7431 %	■
<input type="checkbox"/> UNIV DUBLIN TRINITY COLL	62	1.6626 %	■
<input type="checkbox"/> UNIV FED GOIAS	62	1.6626 %	■
<input type="checkbox"/> NATL TAIWAN UNIV	58	1.5554 %	■
<input type="checkbox"/> KEIO UNIV	55	1.4749 %	■
<input type="checkbox"/> UNIV COLL N WALES	53	1.4213 %	■

Acknowledgments



END