ICMAT 2011 D

NANOFORMULATION 2011

Nanocomposites Prepared by Ultrasonic Spray Pyrolysis and their Applications

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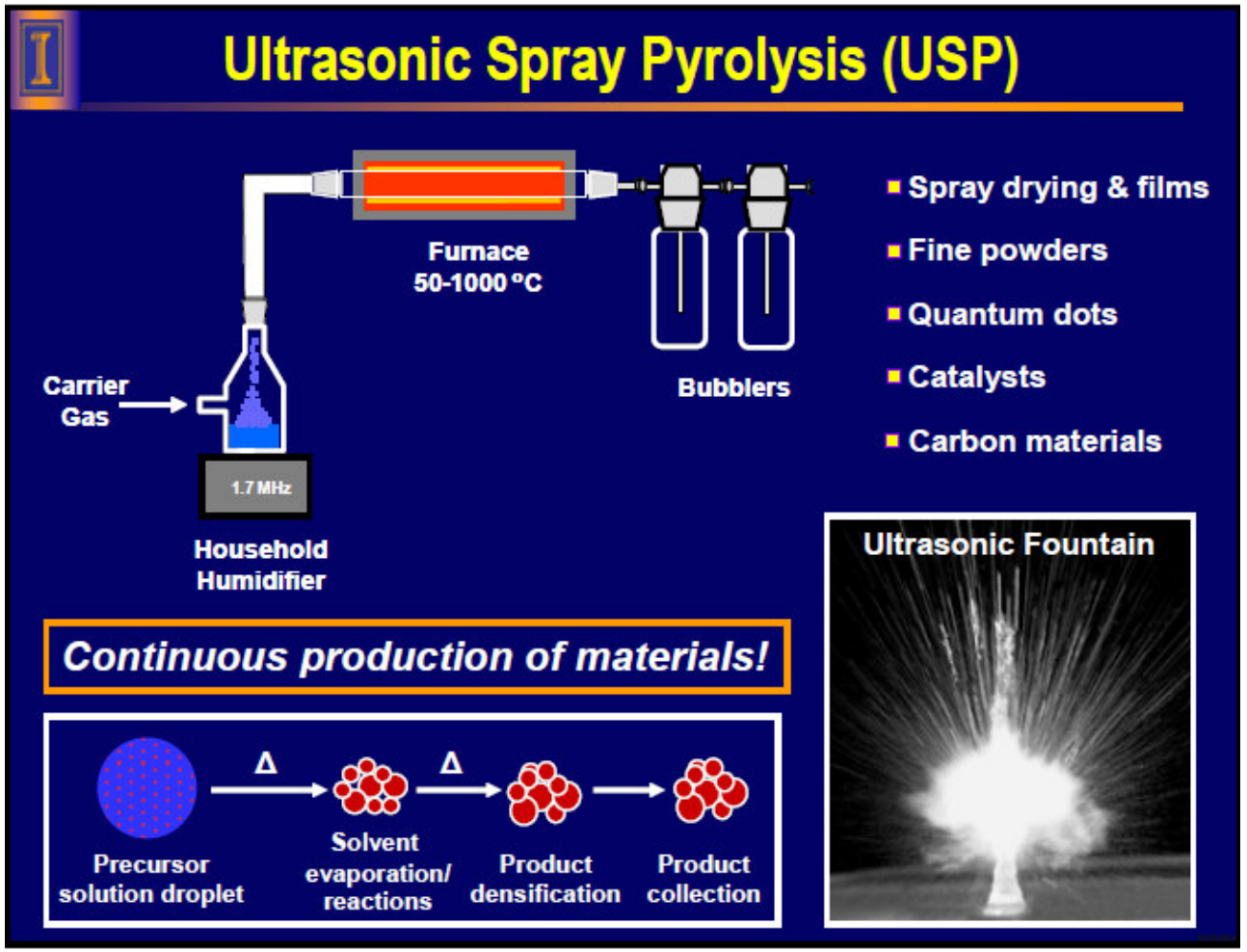
1. Introduction

- One step
- Rapidly
- Continuous
- Scalable



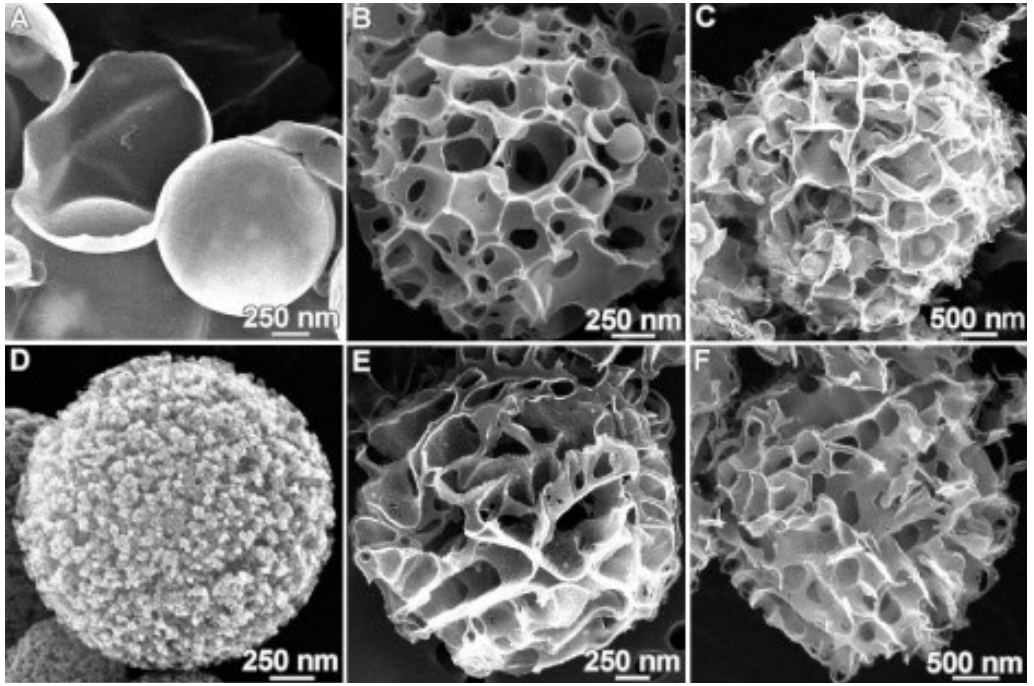
http://www.scs.uiuc.edu/suslick/suslickresearchdescription

Porous Carbon

Precursor:

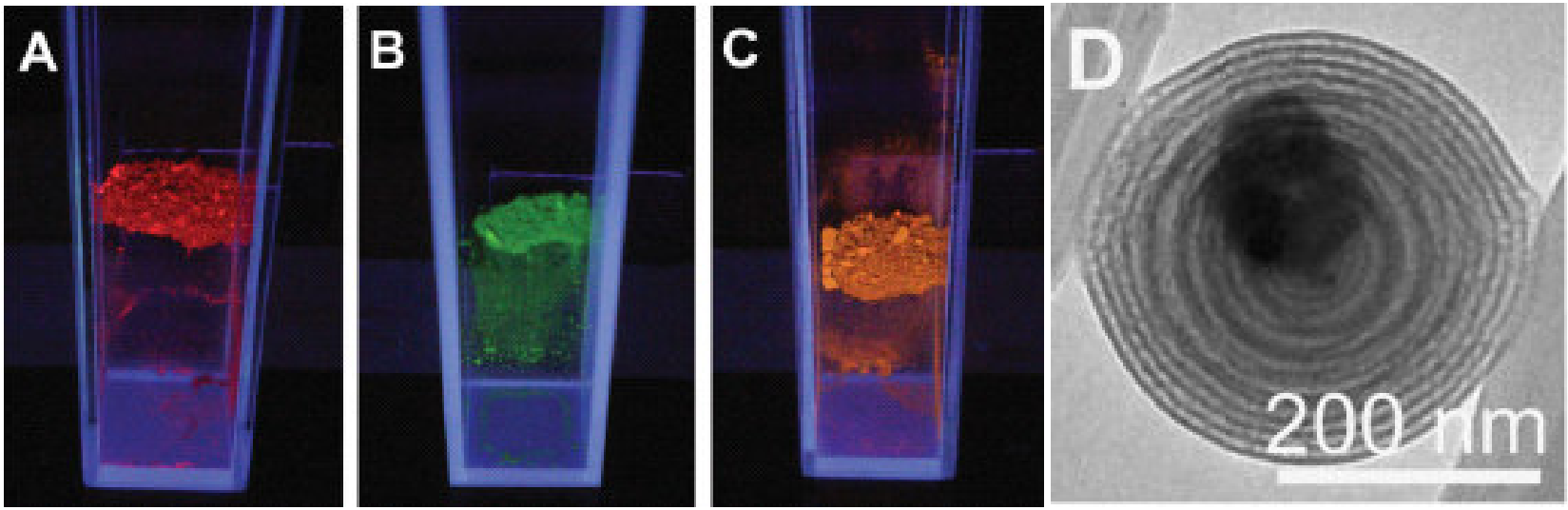
Alkali metal chloroacetate

or dichloroacetate



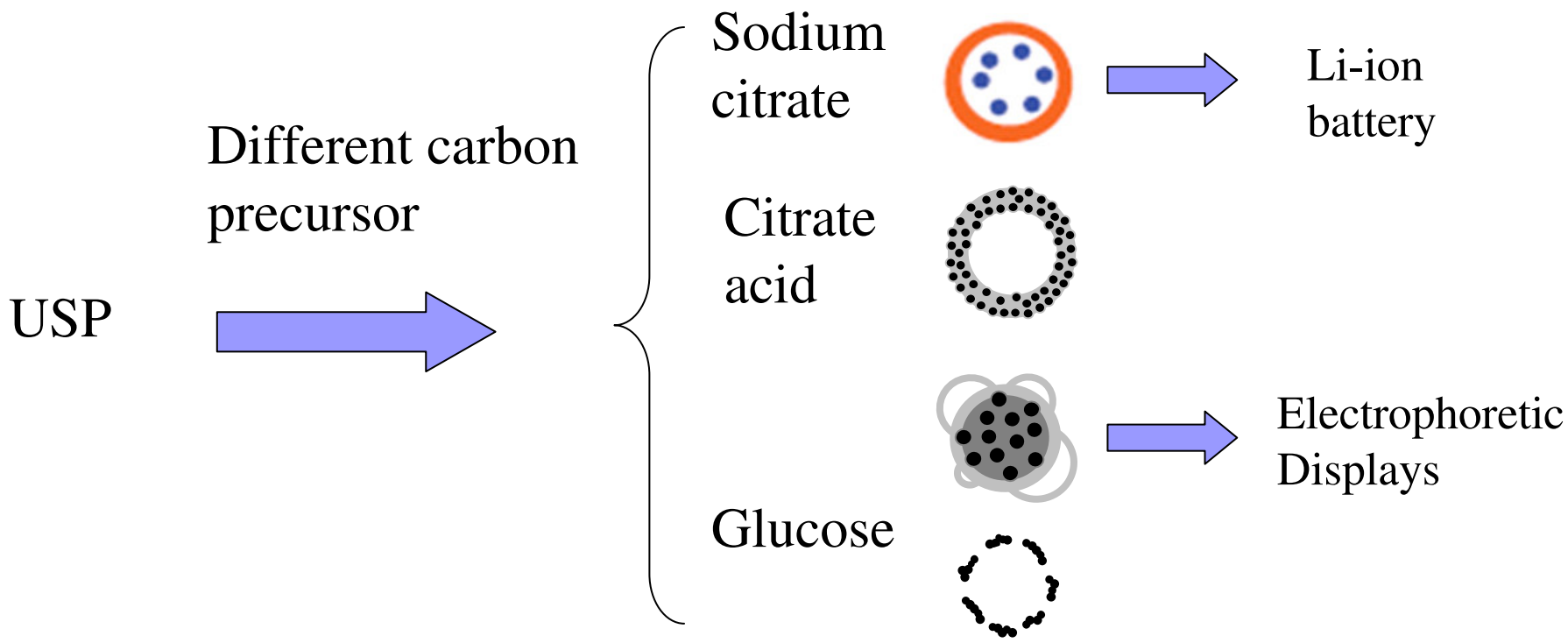
K. S. Suslick, *J. Am. Chem. Soc.*, 2006, 128, 12642.

Magnetic luminescent mesostructured silica Microspheres



J. F. Wang, *Adv. Funct. Mater.,* 2008,18, 2956.

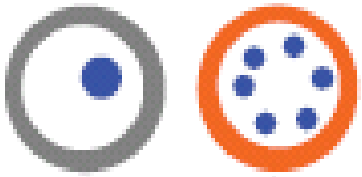
2. Nanocomposites prepared by USP



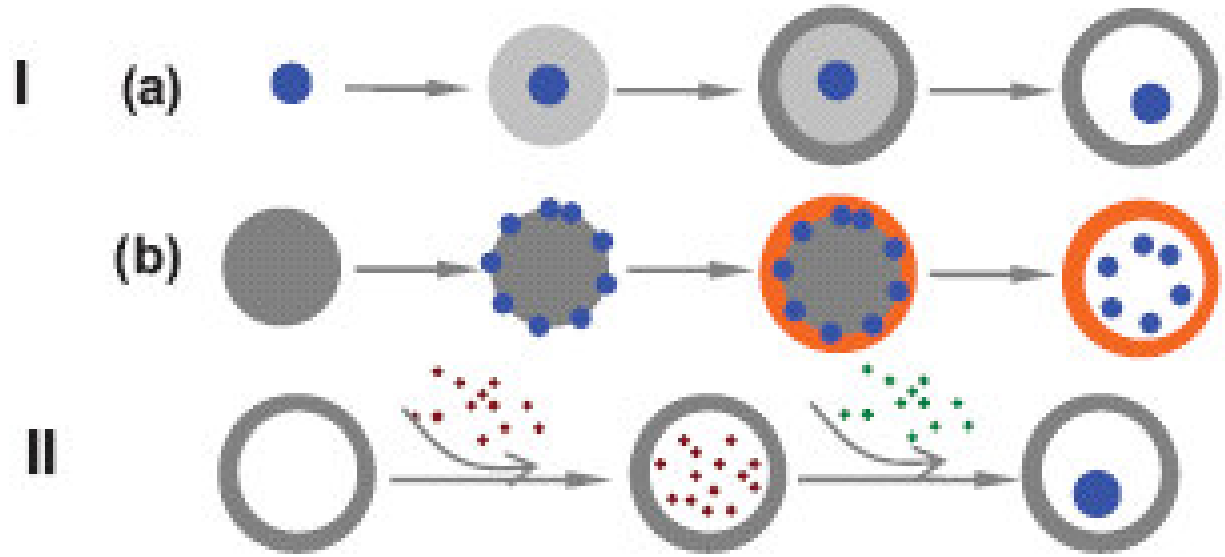
Schematic of the ultrasonic spray pyrolysis (USP) synthesis of nanocomposites

2.1 Rattle-type carbon hollow spheres and their application in Li-ion battery

- **Definition:** Rattle-type hollow spheres (denoted as A@B) refer to hollow shells with a solid particle core and interstitial hollow space in between.



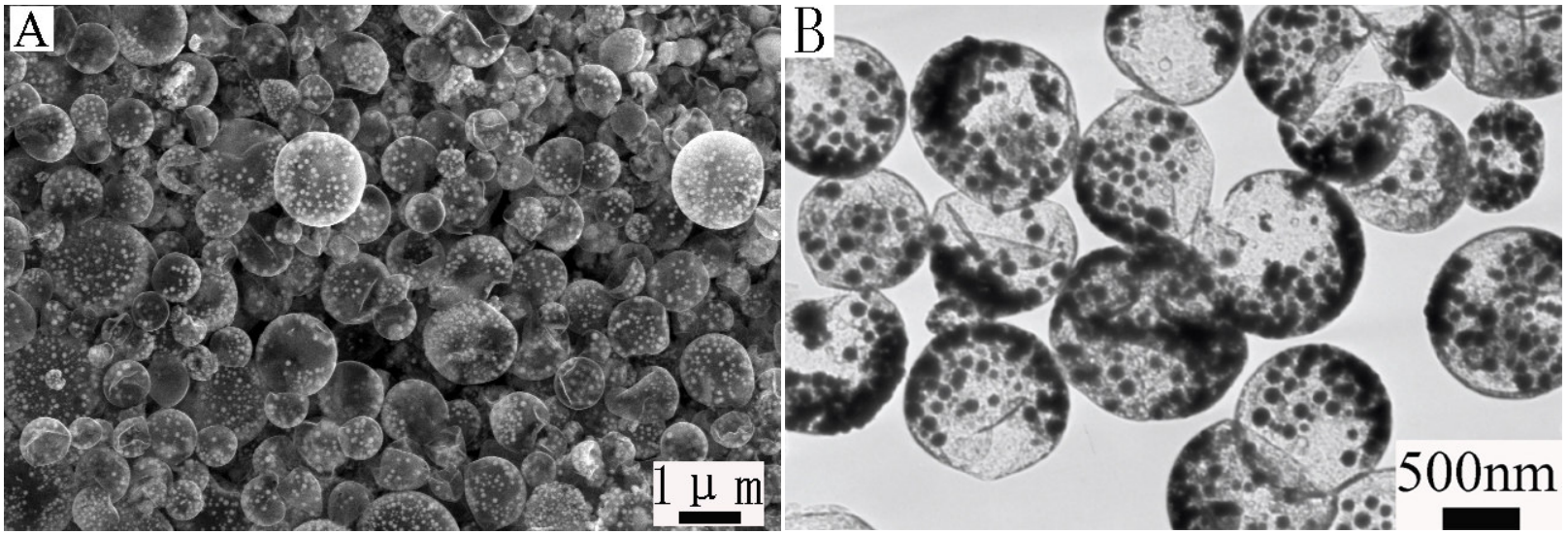
- **Conventional route to A@B**



I Inside-to-outside route

II Outside-to-inside route

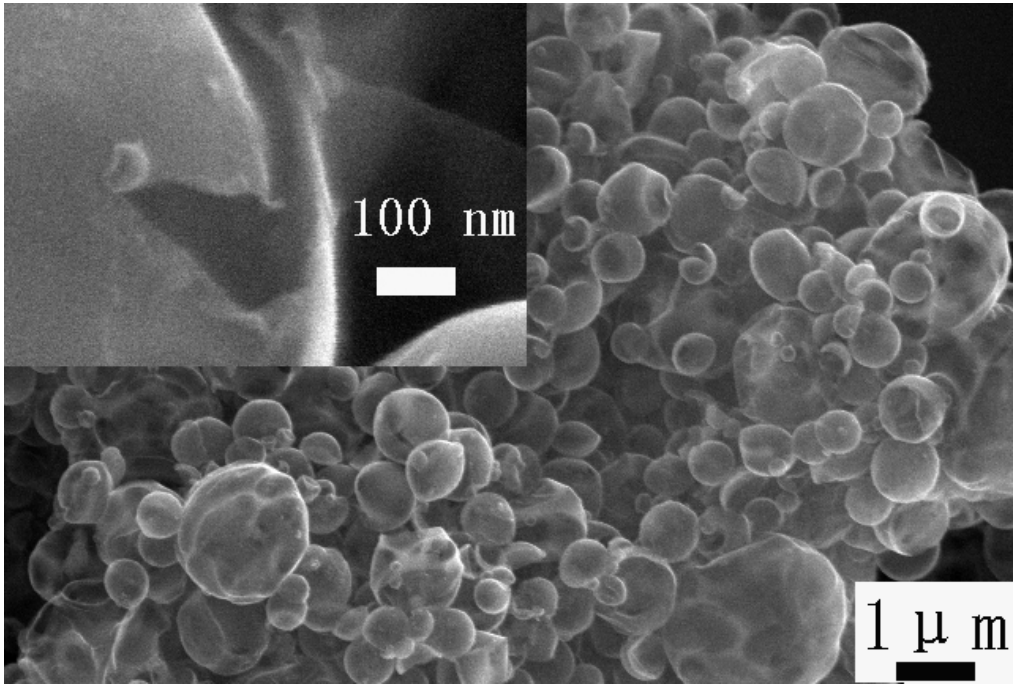
Sn@Carbon



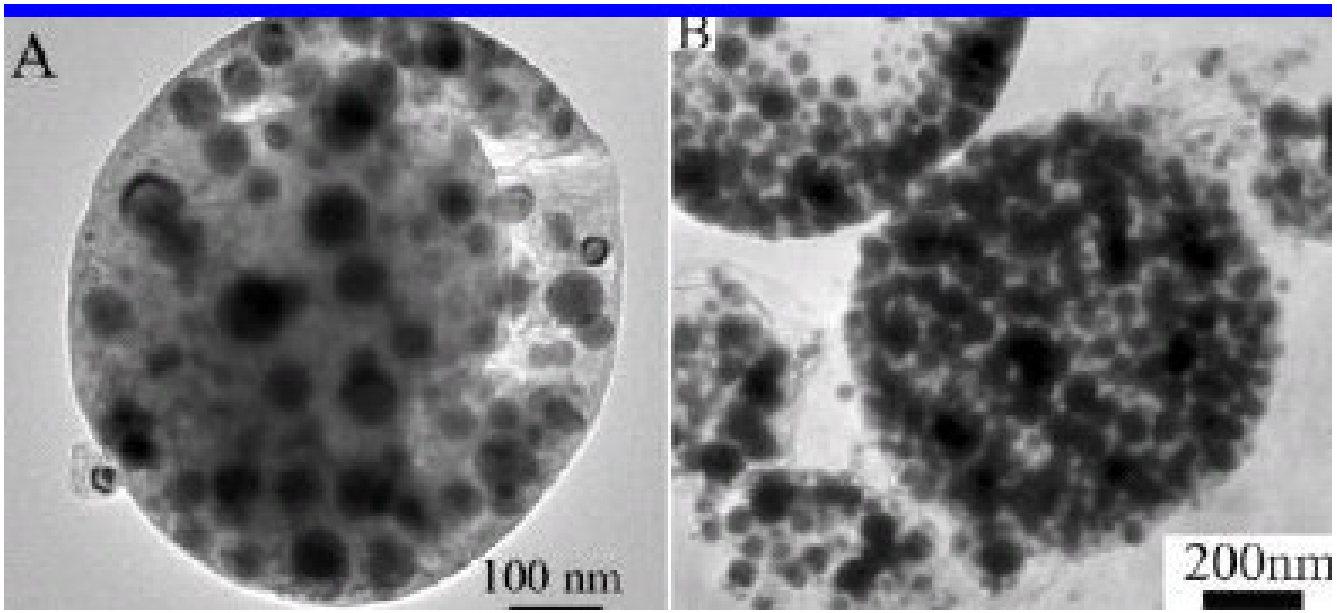
SEM and TEM images of Sn@carbon obtained via USP of aqueous solutions containing $SnCl_4$ and sodium citrate

R. B. Zheng, *J. Phys. Chem. C*, 2009, 113, 11065

Formation mechanism



SEM images of carbon hollow spheres obtained by USP of sodium citrate aqueous solutions



TEM images of Sn@carbon solids (A) collected without water at 700 °C and (B) collected with water at 500 °C.

(1): Sn NPs; capillary force; sodium citrate outer shell

(2): Carbonization

(3): Removing of water-soluble byproduct

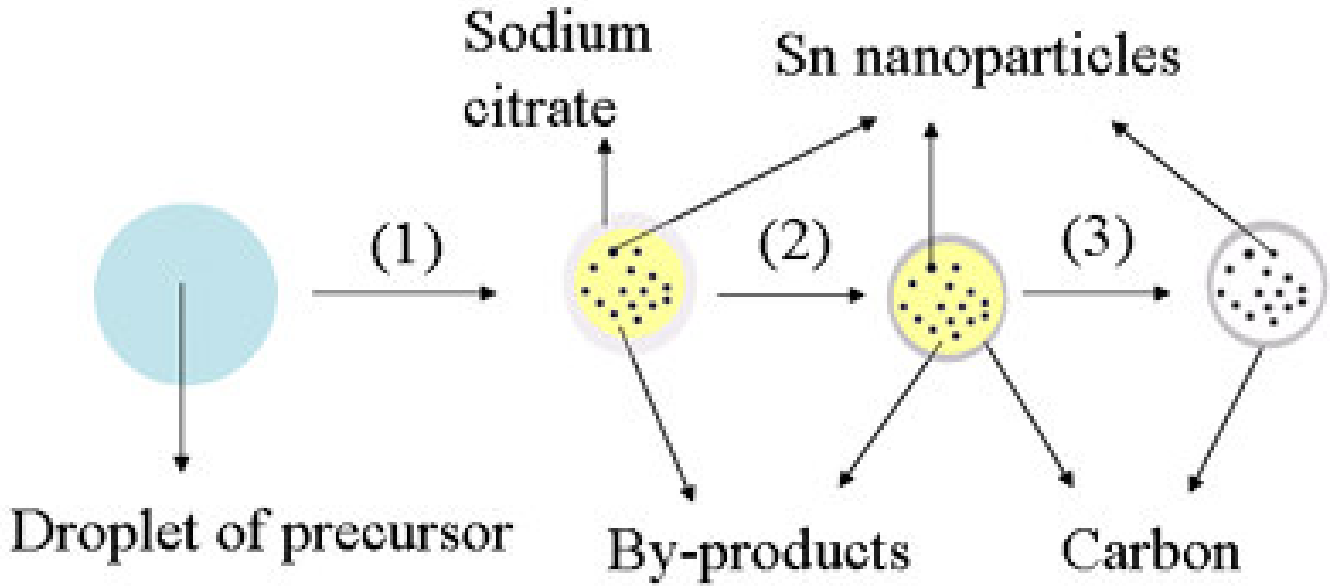
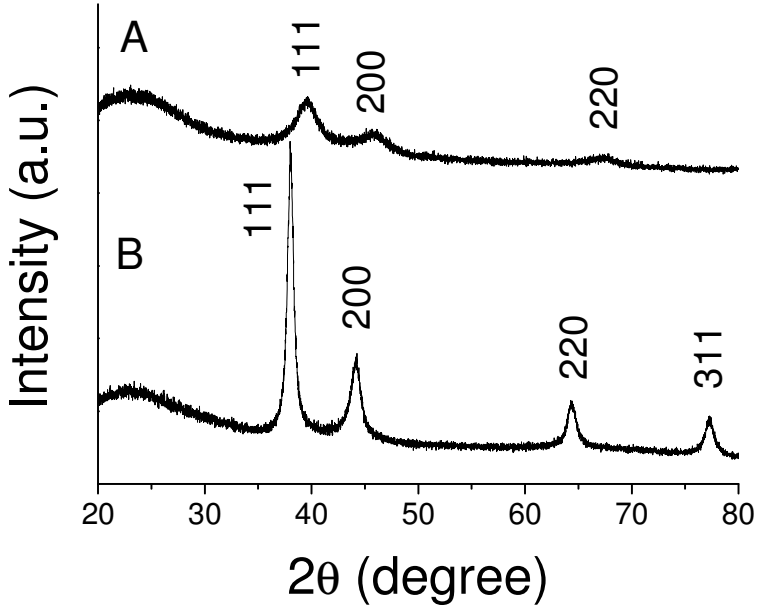
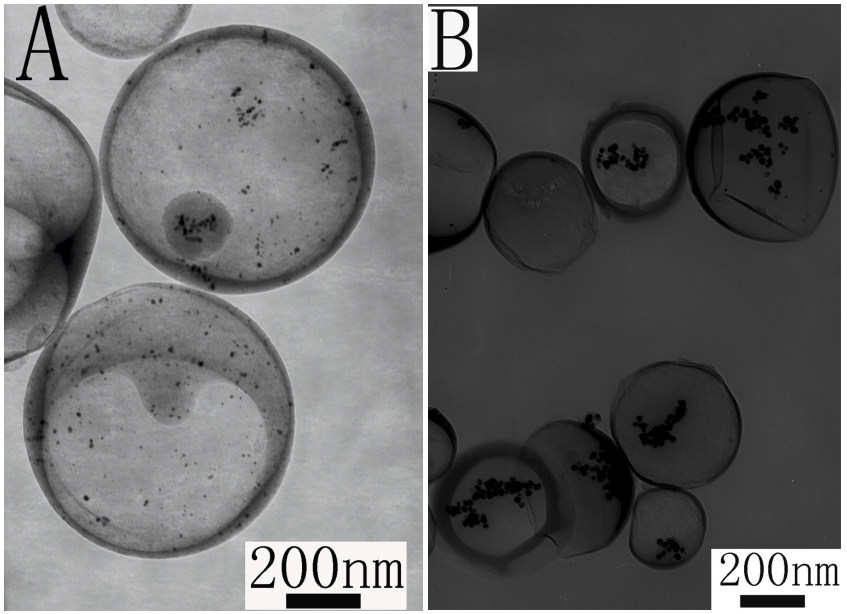


Illustration of the M@carbon obtained via USP of aqueous solutions containing metal salts and sodium citrate

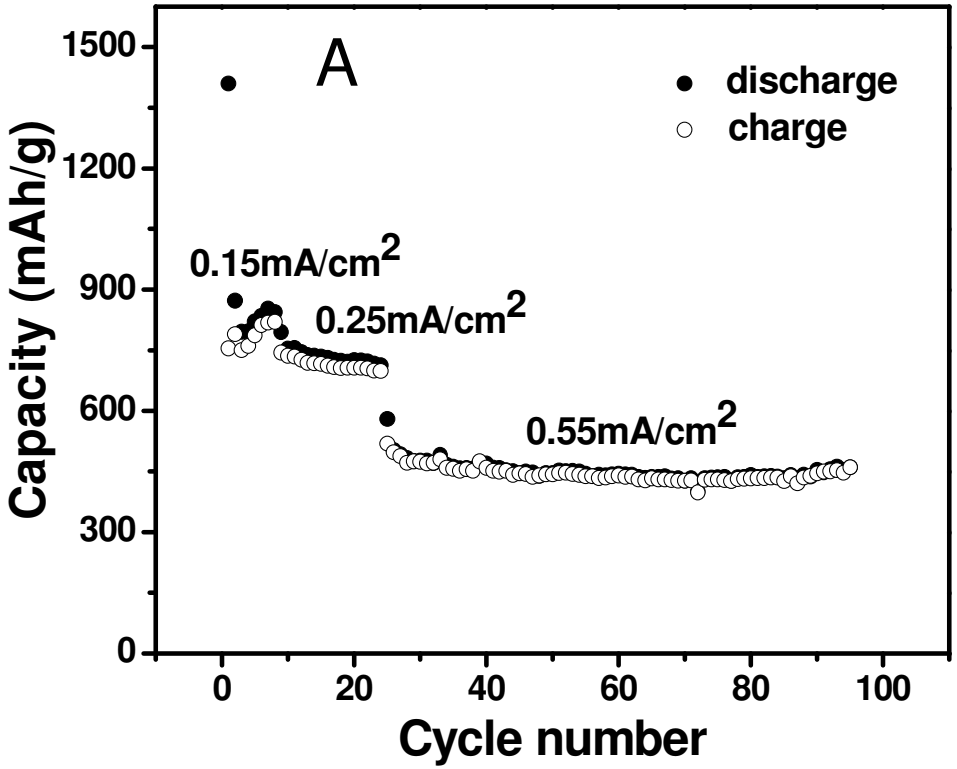
Other M@Carbon by USP





XRD and TEM of (A) Pt@carbon and (B) Ag@Carbon obtained via USP of aqueous solutions containing metal salts and sodium citrate

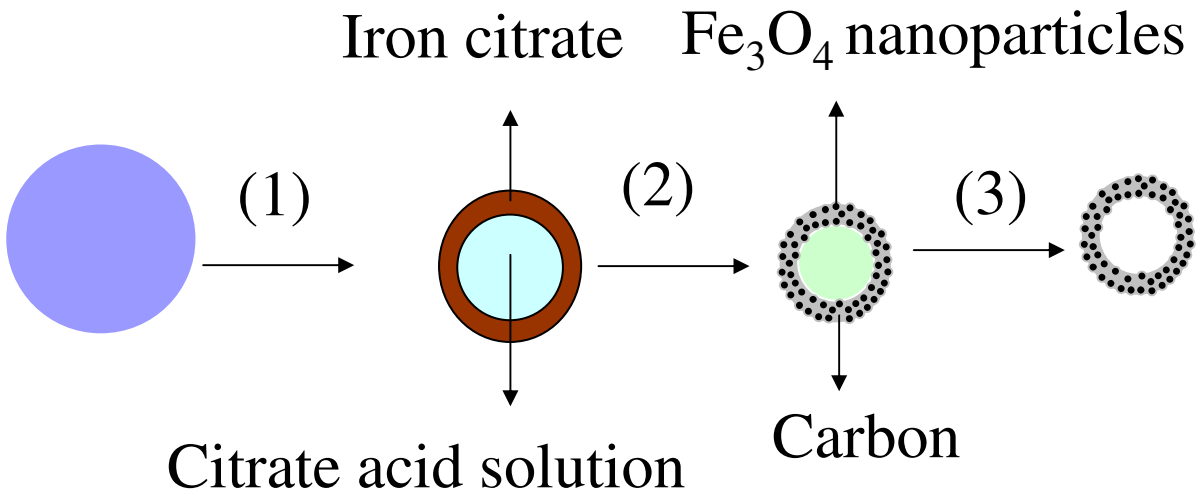
The applications of Sn@C in Li-ion battery



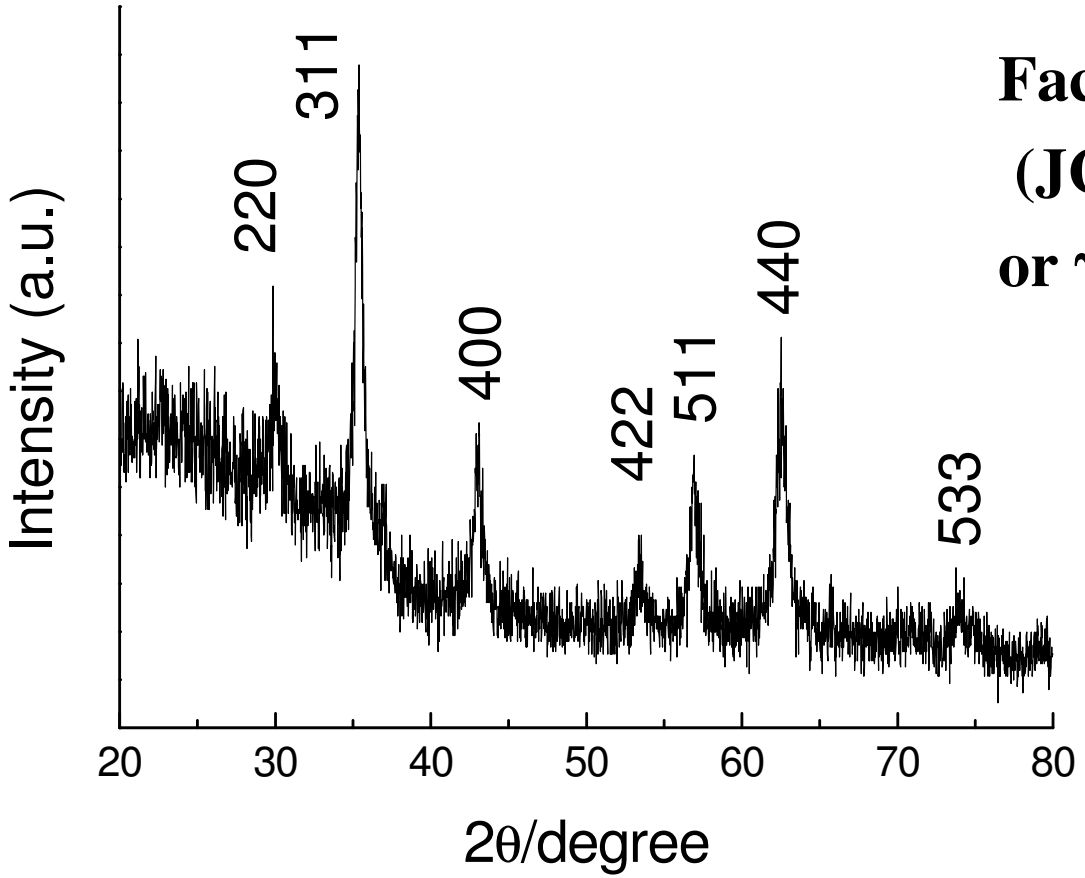
The cycling performance in the 0 mV-3 V (vs. Li^+/Li) voltage window at different rate of Sn@carbon (46 wt % Sn).

2.2 Magnetic carbon hollow spheres

Reactant: aqueous solutions containing $FeCl_2$ and citrate acid

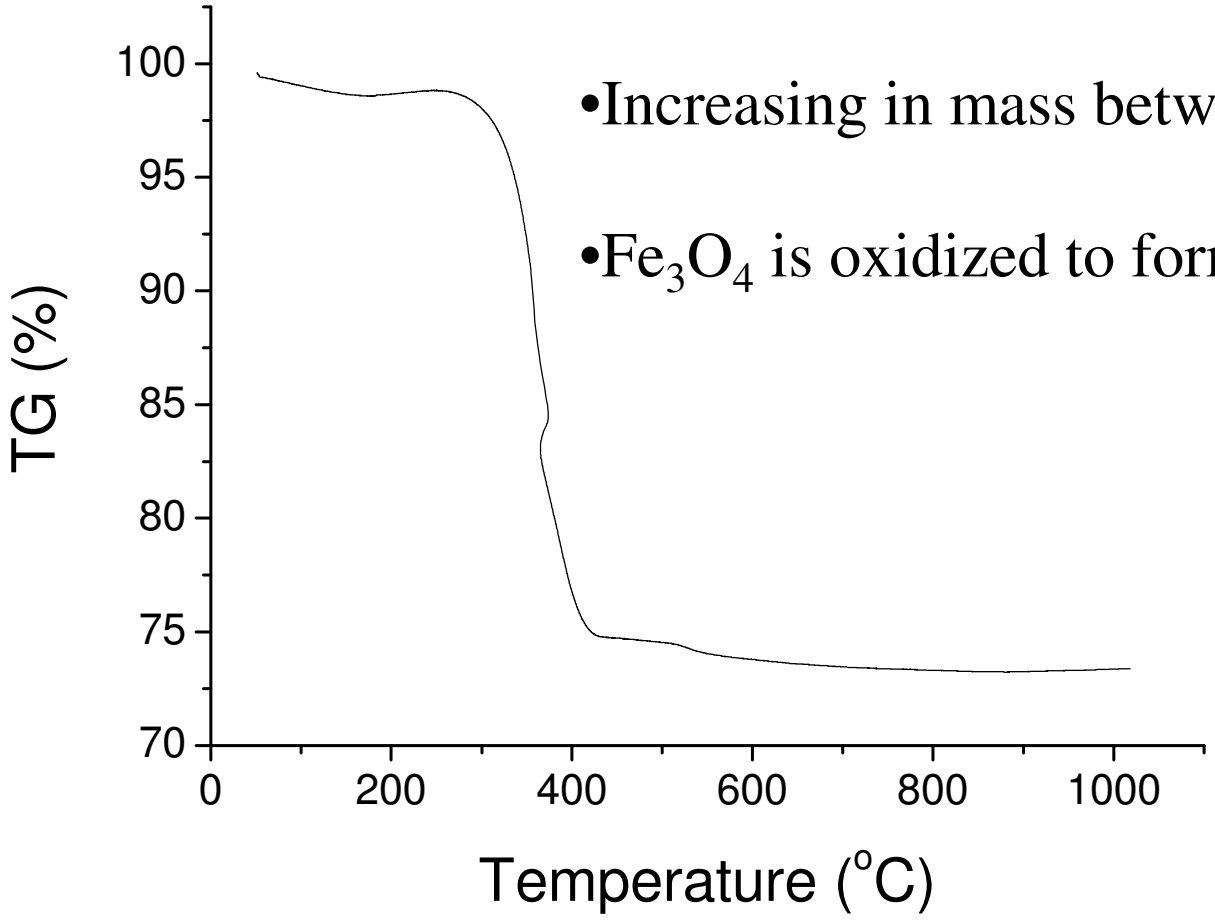


Formation mechanism



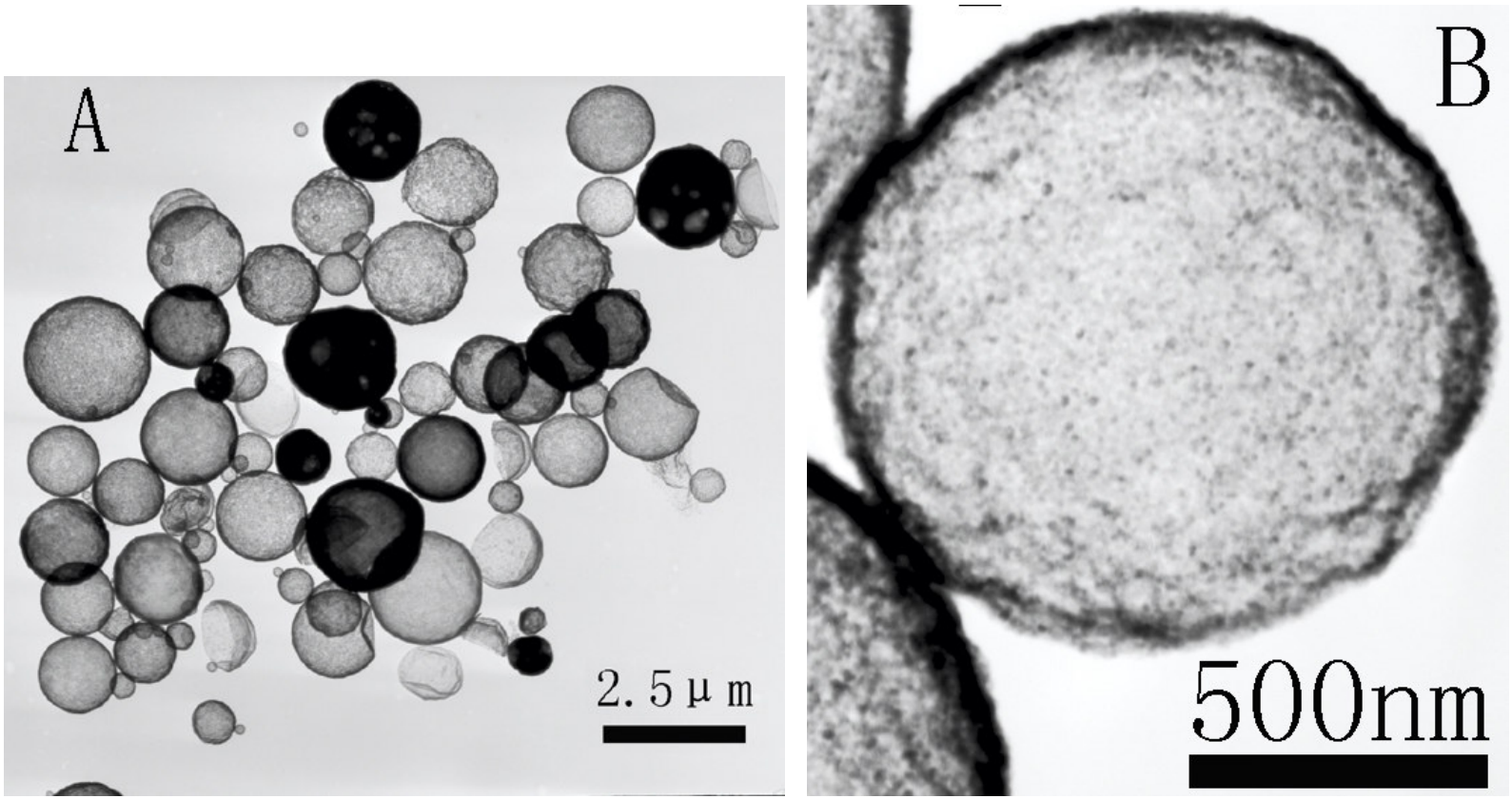
Face-centered cubic Fe_3O_4 (JCPDS file No. 48–1487) or γ-Fe_2O_3

XRD patterns of Fe_3O_4-C magnetic hollow spheres obtained by USP of aqueous solutions containing $FeCl_2$ and citrate acid.



- Increasing in mass between 180 and 280 °C
- Fe_3O_4 is oxidized to form Fe_2O_3

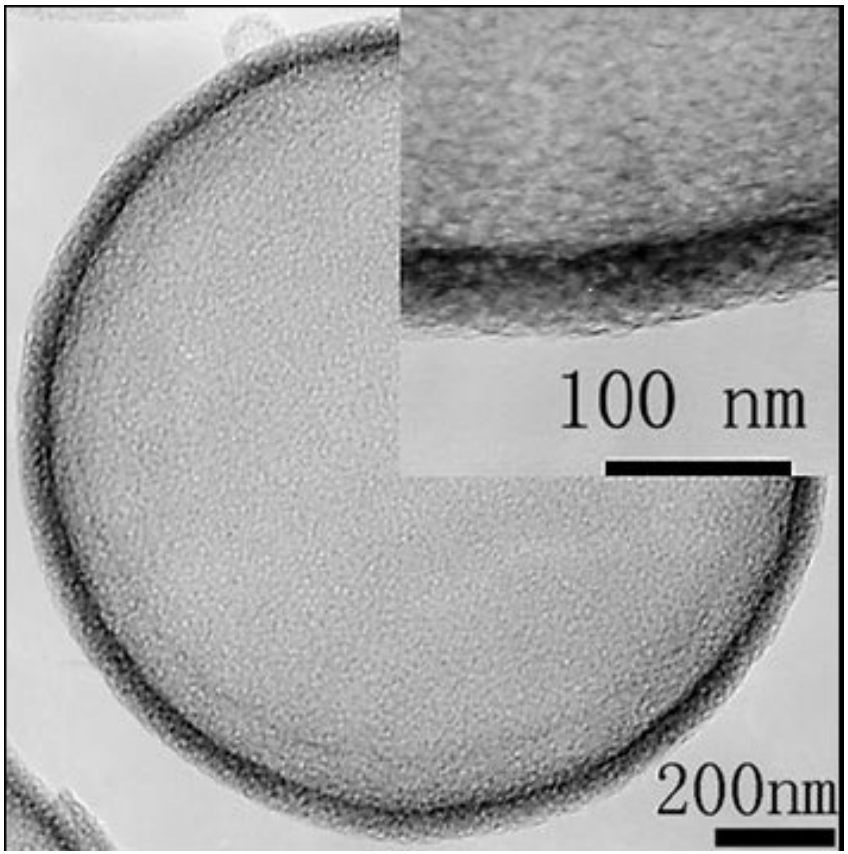
TGA of Fe_3O_4-C magnetic hollow spheres



TEM images of Fe_3O_4-C magnetic hollow spheres obtained by USP of aqueous solutions containing $FeCl_2$ and citrate acid

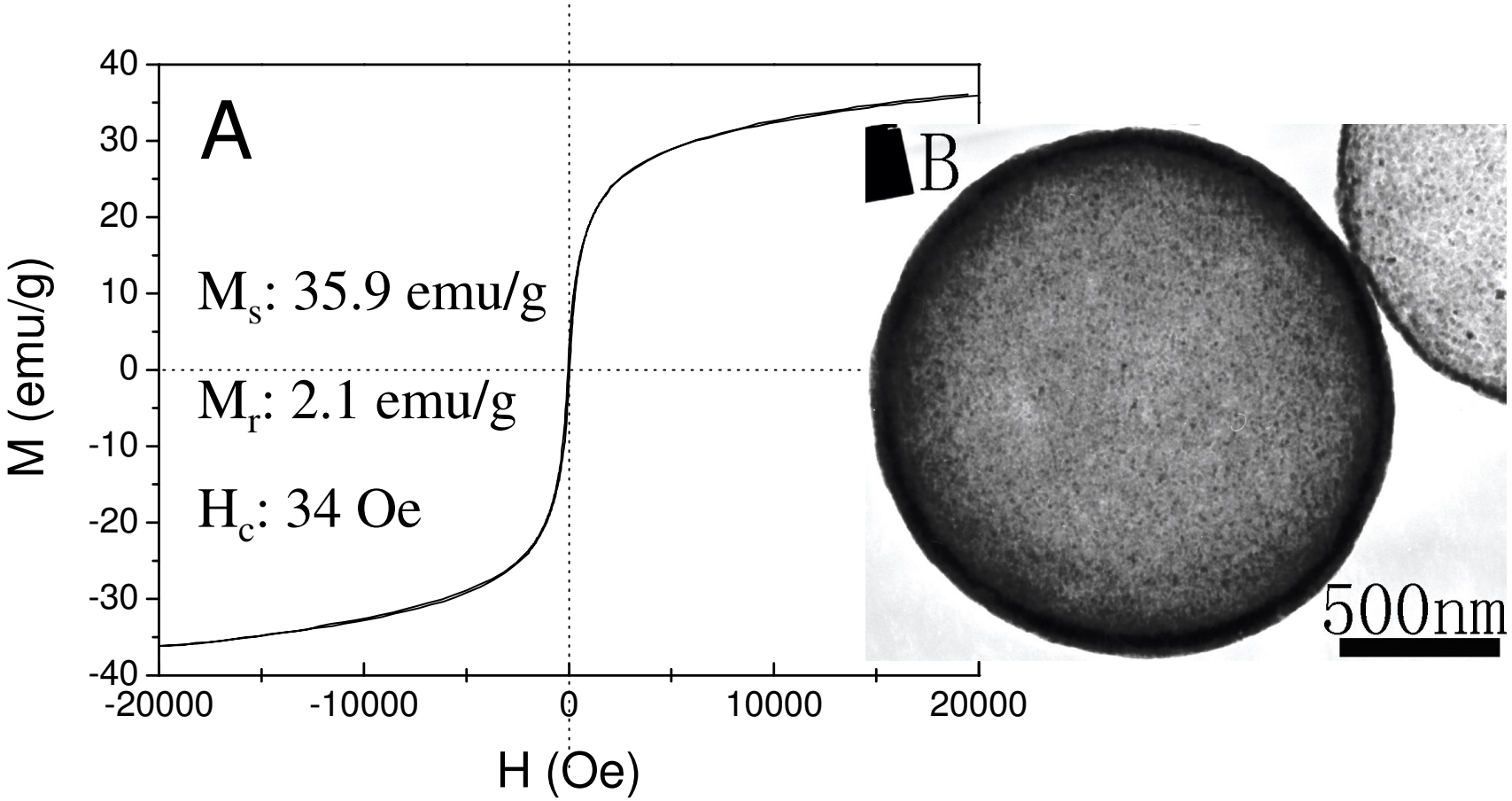
R. B. Zheng, *Eur. J. Inorg. Chem.*, 2009, 20, 3003

Porous hollow carbon spheres



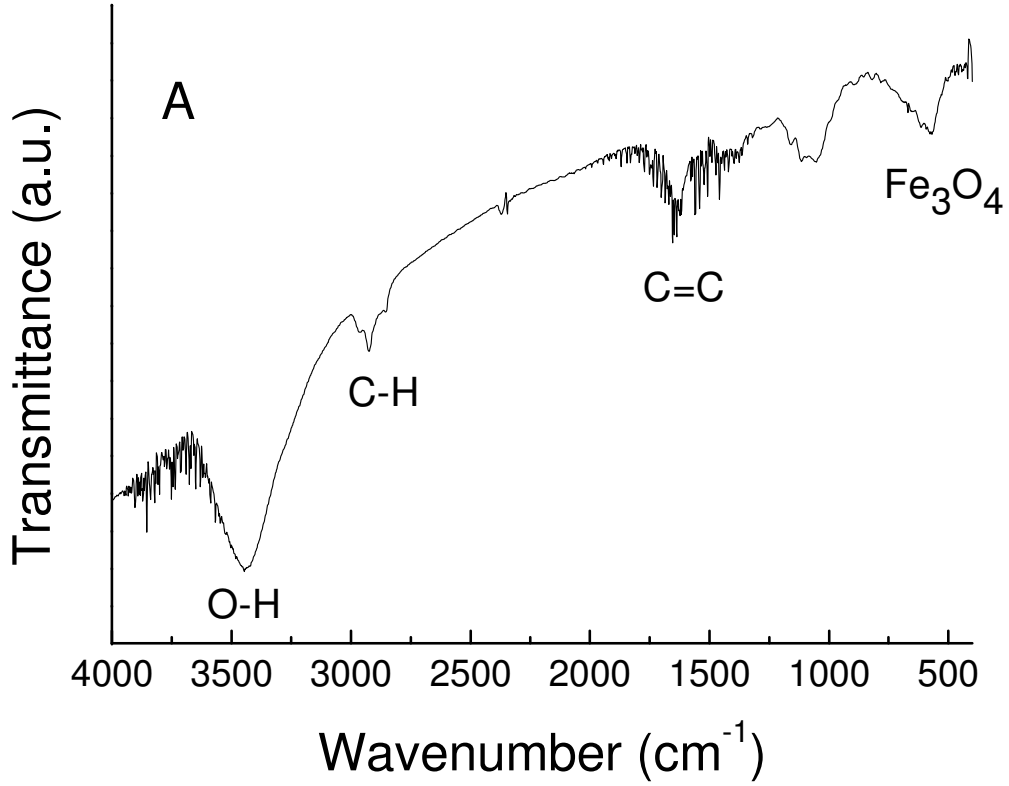
TEM images of porous hollow carbon spheres obtained by acid treatment of Fe_3O_4-C magnetic hollow spheres in concentrated HCl (12 M) for 12 h.

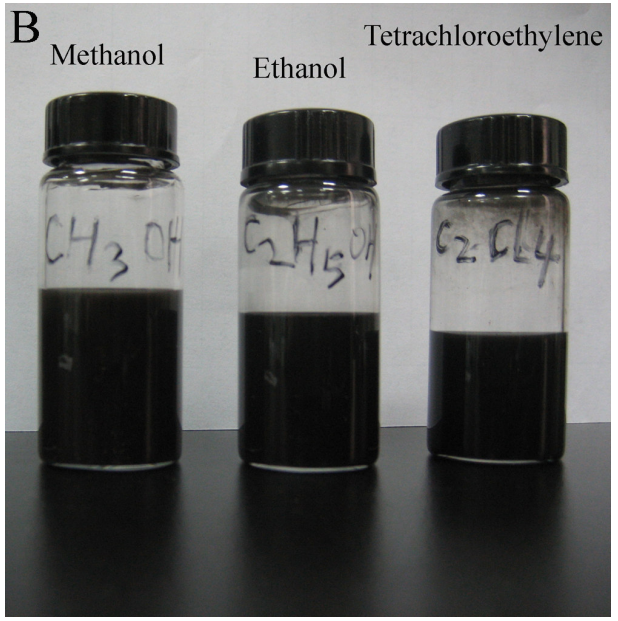
Acid-durability



(A) The **M–H hysteresis loop** and (B) **TEM image** of MCHMs after acid treatment (pH = 1) at room temperature for 10 d.

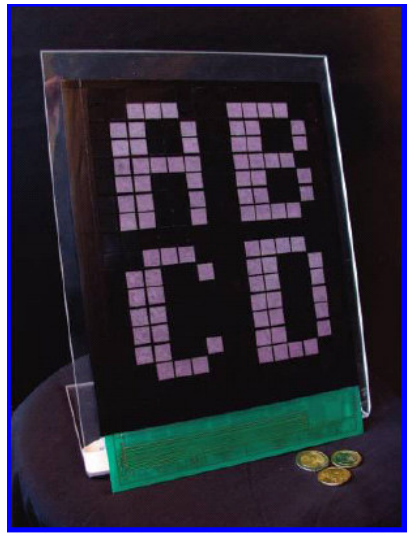
Good dispersibility in various solvents





FTIR spectrum of sample HC 2; (B): **photographs** of sample HC 2 suspensions in methanol, ethanol and tetrachloroethylene.

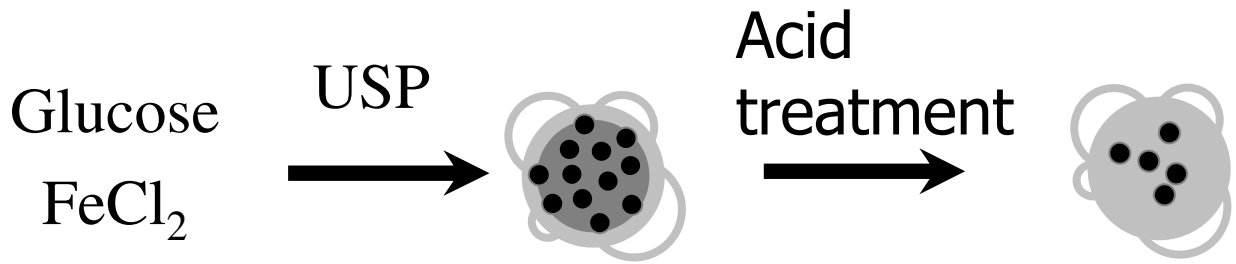
2.3 Carbon–Iron Oxide Microspheres' Black Pigments and their application in Electrophoretic Displays

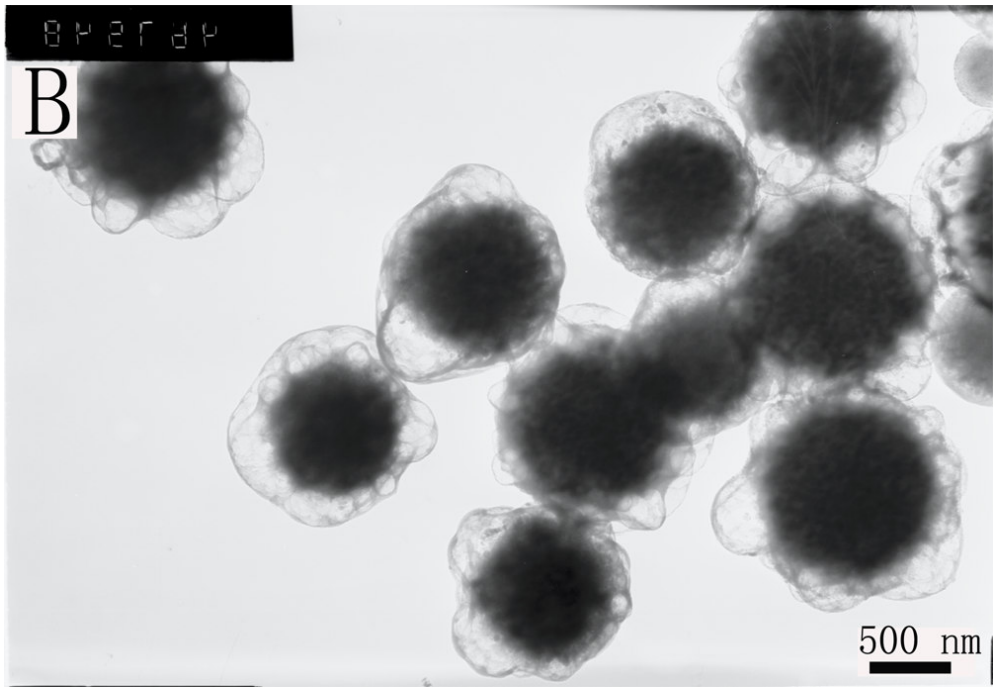


- Carbon black: density, 0.8 g/cm^3
- Tetrachloroethylene: density, 1.6 g/cm^3

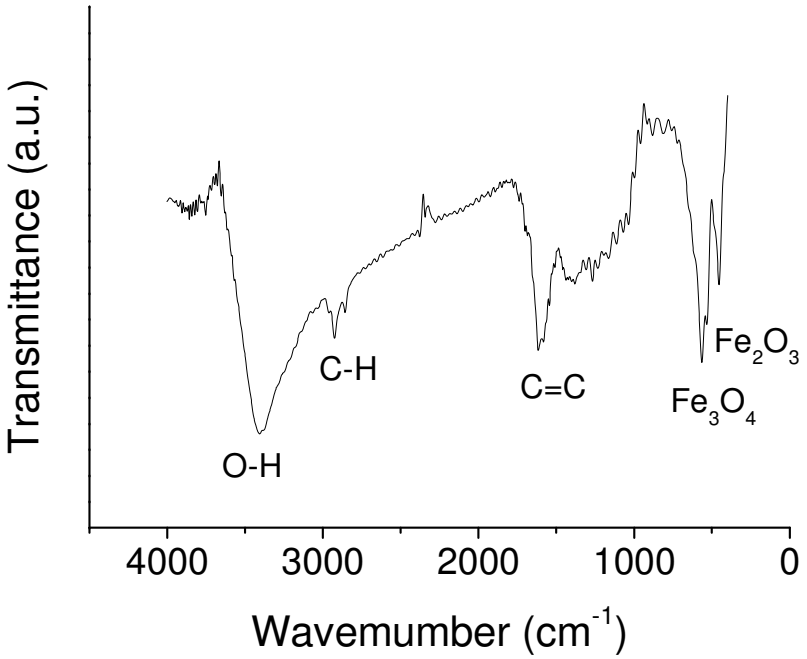
B. Comiskey, et al., *Nature*, 1998, 394, 253

Doping-eroding route

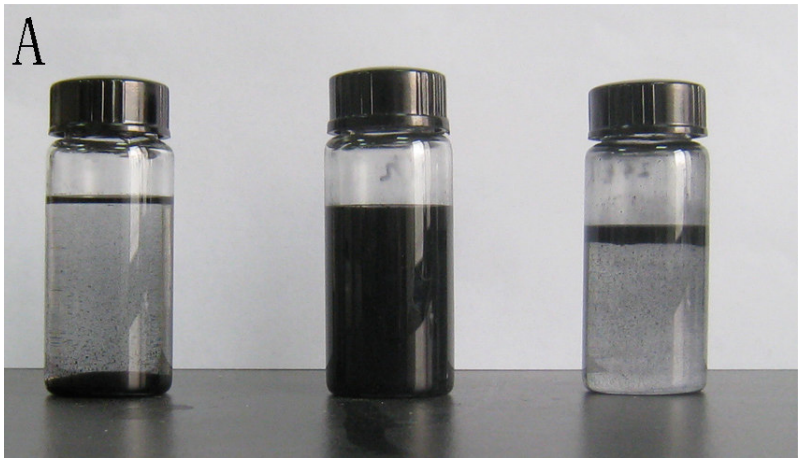




2.2 g/cm^3, 1.7 g/cm^3, 1.5 g/cm^3



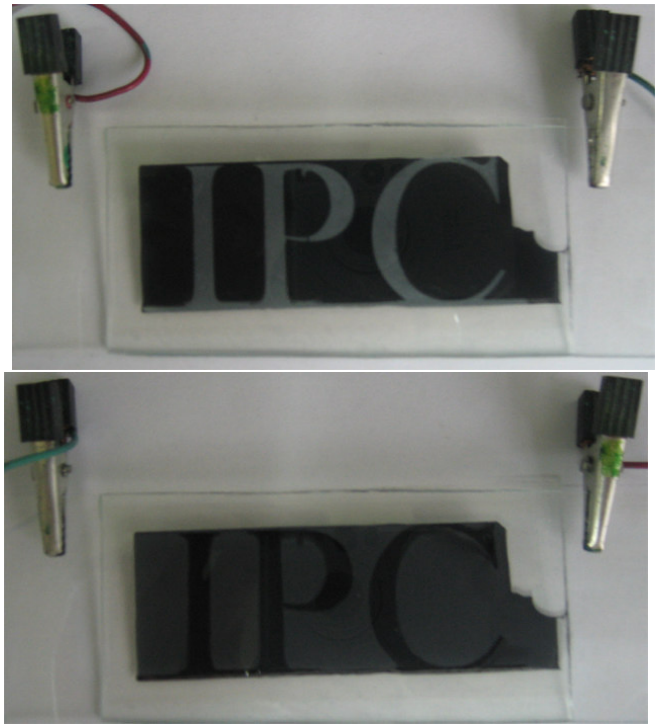
FT-IR spectrum of carbon-iron oxide



Carbon-iron oxide with (from left to right 0, 1, 12 h) etching time are dispersed in tetrachloroethylene.

X. W. Meng, R.B. Zheng, et al, Nanoscale Res Lett 2010, 5,1664.

Black-white e-paper

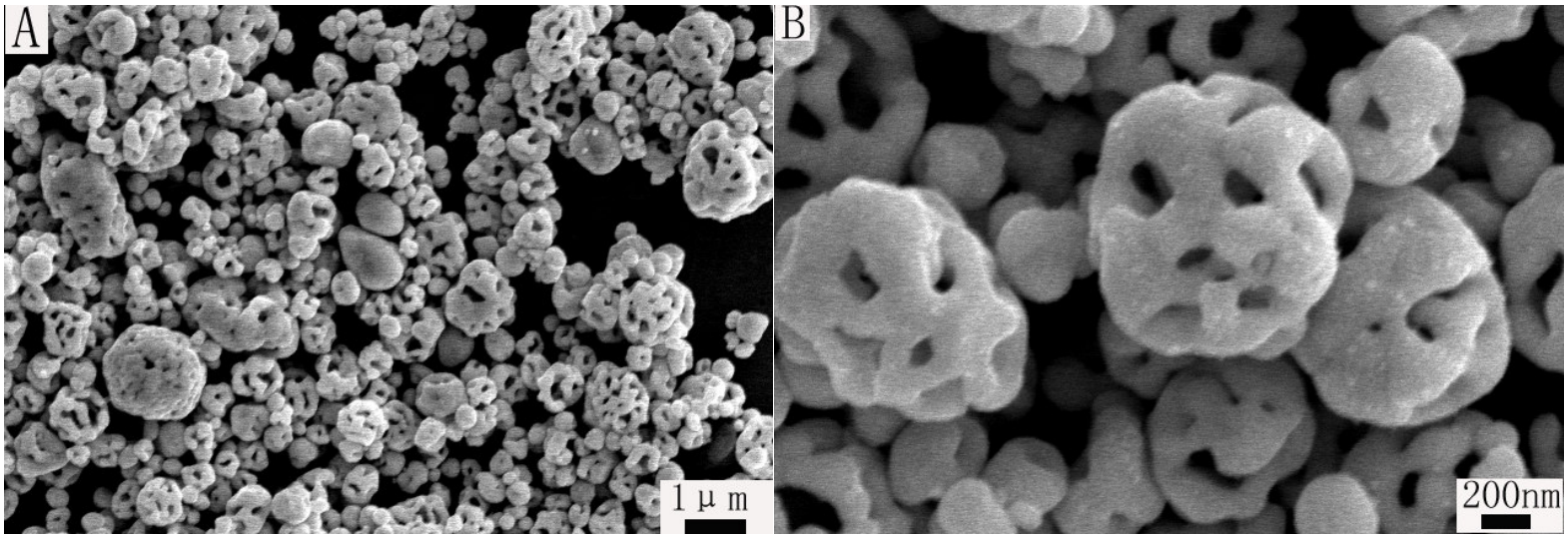


2.4 Silver porous hollow spheres

Glucose
$AgNO_3$

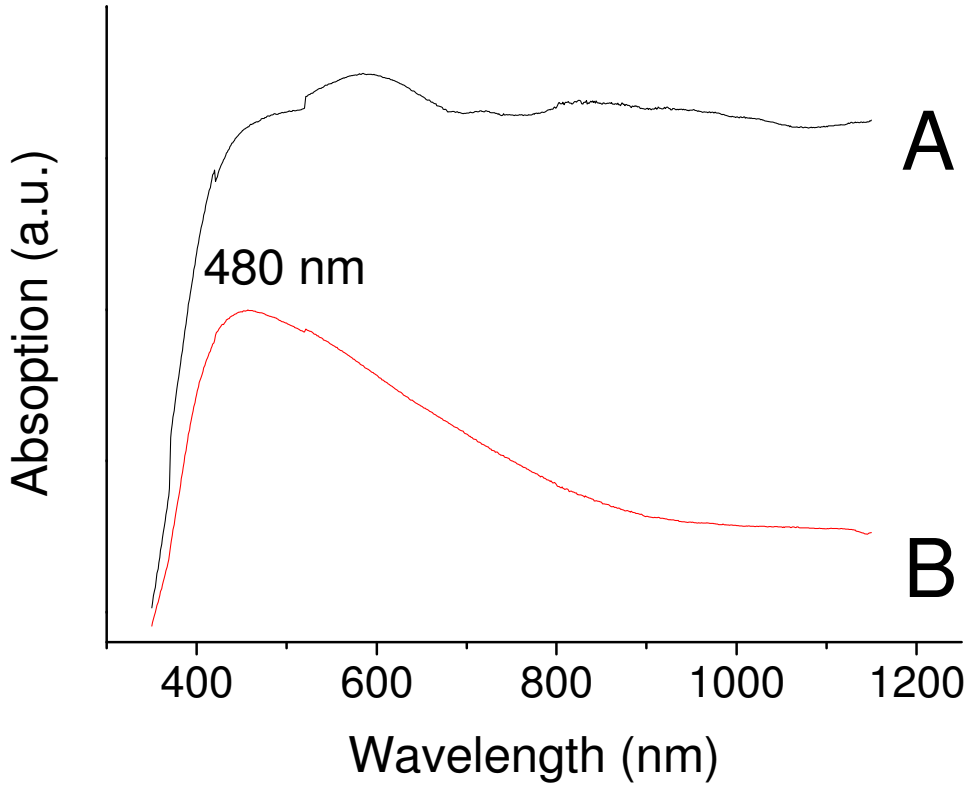
USP

Glucose worked as reducing agent and pore-forming directing agent



SEM of SPHS prepared via USP of aqueous solutions containing glucose and $AgNO_3$

R.B. Zheng, *Applied surface sci.,* 2011, 257, 2367



Vis-NIR spectrum of SPHS (A) and silver solid spheres (B) fabricated via USP.

Thanks for your attention!!!