Relevance of surface chemistry of inorganic colloids in liquid-phase processing

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colloidal processing

OBJECTIVES

Surface Chemistry Manipulation to:

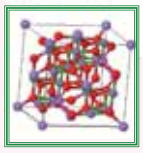
- Preserve Chemical and Crystallographic Stability of Colloids
- Enhance Reliability of Shaping & Assembling from the Colloidal Suspensions
- Profit from Synergism of Liquid-Phase Synthesis and Colloidal Processing

Colloids have been assembled and packed by Electrophoretic Deposition (EPD) from diluted slurries (<1vol.%)

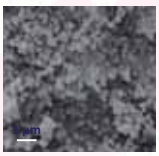
CASE 1

Dispersion of tri-oxide colloids in organic media

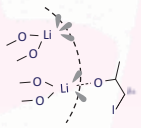
HV Rechargeable Lithium Batteries: Coating of [C/$LiNi_{0.5}Mn_{1.5}O_4$] composite shaped by electrophoresis from a suspension in acetone-I_2 solution[1].



✓$LiNi_{0.5}Mn_{1.5}O_4$ Lattice

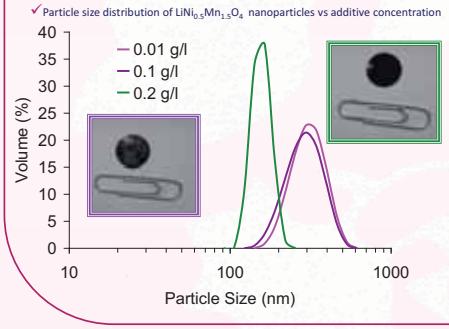


✓$LiNi_{0.5}Mn_{1.5}O_4$ nanoparticles



Adjusting I_2 content, iodoacetone completely covers the solid surfaces optimizing the dispersing conditions.

✓Particle size distribution of $LiNi_{0.5}Mn_{1.5}O_4$ nanoparticles vs additive concentration

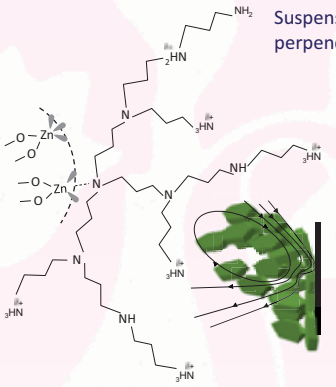


✓General view of the coating & C/$LiNi_{0.5}Mn_{1.5}O_4$ film micrograph

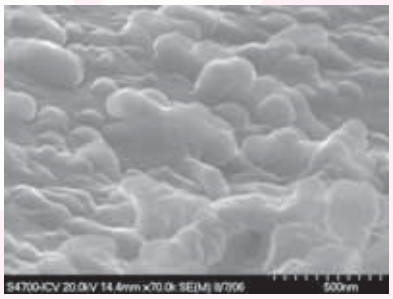
CASE 2

Organized assembly of flakes-like nanoparticles

ZnO nanoflakes have been obtained by precipitation and stabilized in aqueous media adding Polythilenimine to avoid Zn^{2+} solution and improve ZnO dispersion [2].



Suspension stability allows nanoflakes packing perpendicularly to the substrate during film shaping.

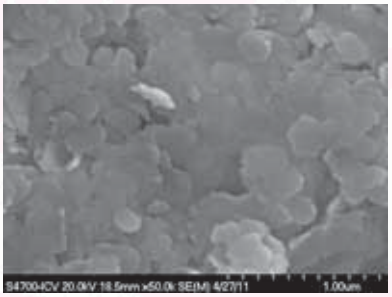


✓Micrograph of ZnO flake-like colloids packed in an organized thin film

Ultrasound Synthesis & Organized assembly

✓TEM micrograph of $Ni(OH)_2$ flake-like colloids

Nanoflakes have been obtained applying ultrasound during the precipitation of $Ni(OH)_2$ in amonia solution[3].



Polyvinylbutiral has been added as synthesis and dispersing aid. Nanoflakes pack aligned to the substrate during coating formation by electrophoresis.

✓Micrograph of $Ni(OH)_2$ flake-like colloids packed in an organized thin film

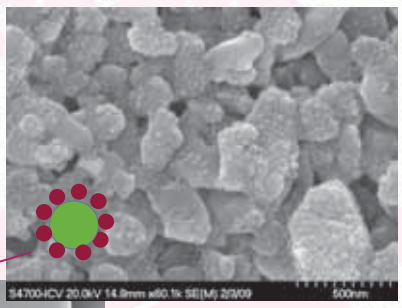
CASE 3

Core-shell structures through Dispersion & Heterocoagulation

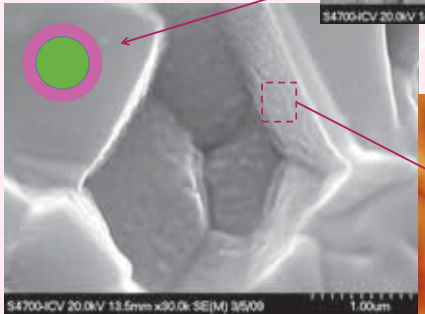
Core-shell colloids of Al_2O_3-SiO_2 have been packed by electrophoresis.

25 nm 300 nm

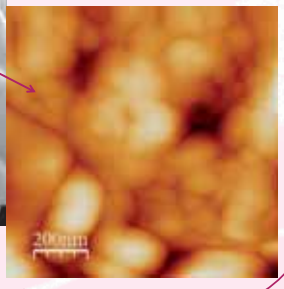
A thermal treatment of 1550°C leads to core-shell structures of Al_2O_3 covered by mullite ($3Al_2O_3 \cdot 2SiO_2$)



✓Micrographs of Al_2O_3-SiO_2 core-shell colloids



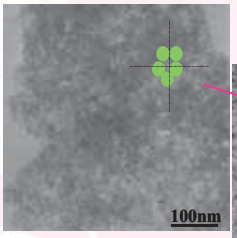
✓Micrographs of Al_2O_3-mulite core-shell structures



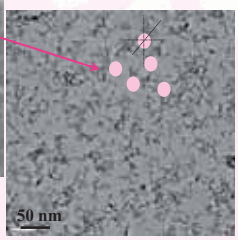
✓Topography Image of mulite shell

CASE 4

Synergism of Hydrothermal Synthesis & Electrophoretic Deposition

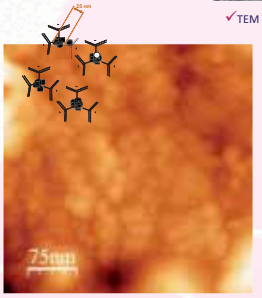


✓TEM of as-synthesized YSZ colloids

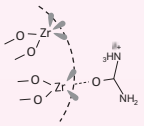


✓TEM of dispersed YSZ colloids

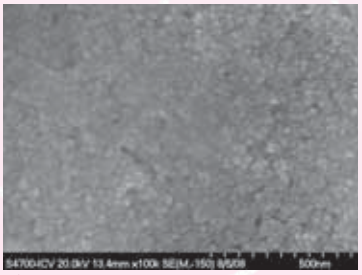
YSZ Dispersed Nano-Spheres



✓Topography Image of YSZ coating



Synthetic YSZ nano-spheres have been dispersed in the post-reaction medium adjusting urea content, and later assembled and packed in a layer by layer process electrically driven[4].



✓Micrographs of YSZ film

[1] A. Caballero et al., J.Power Sources., 158 (2006) 583; [2] M. Verde et al. *J.Electrochem.Soc., 157 (2010) H55;* [3] S. Cabañas et al., *Ultrason.Sonochem., 18 (2011) 901*; [4] I. Gonzalo-Juan et al., *J.Eur.Ceram.Soc, 29 (2009) 3185*.

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