

## Core-shell magnetic nanoparticles of $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3 / \text{SiO}_2$

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**Abstract** –  $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3 / \text{SiO}_2$  ( $x=0.22-0.25-0.27-0.33$ ) core-shell nanoparticles have been synthesized by liquid-mix method and coated by sol-gel process. A polymerized complex reaction has been used to obtain the nanoparticles after a thermal treatment. Metal nitrates, as starting materials, citric acid to complex the cations and ethylene glycol were used to make the polymeric final product. The coating has been performed using tetramethoxysilan (TMOS) in an isopropyl alcohol suspension. Coated nanoparticles between 20 and 40 nm in diameter have been characterized by transmission (TEM) and scanning (SEM) electron microscopy, diffuse reflectance Fourier transform infrared spectroscopy (DRFTIR) and X ray diffraction.

$\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3$  system behave as ferromagnetic material at room temperature with Curie temperature ( $T_c$ ) between 300K for  $x=0.20$  and 370K for  $x=0.33$  [1], this property is useful for biomedical applications as hyperthermia oncological treatments [2].

$\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3$  ( $x=0.22-0.25-0.27-0.33$ ) nanoparticles have been synthesized by liquid-mix method starting from lanthanum, strontium and manganese nitrates in aqueous solution, adding citric acid and ethylene glycol to make the polymerization under magnetic stirring at around 343 K. The product obtained has been treated at 373 K during 24 hs and after milling the resulting powder has been calcined at 873, 973 or 1073 K in a convection furnace.

The mixed oxide nanoparticles have been coated using TMOS in isopropyl alcohol under ultrasonic wave field with basic catalysis ( $\text{NH}_4\text{OH}$ ).

The samples have been characterized by X ray diffraction, single phase materials have been obtained at 1073 K for  $x=0.22-0.25-0.27-0.33$  and the same results were obtained at 873 and 973 K only for  $x=0.25-0.27-0.33$ . The crystalline structure corresponds to the R-3c space group reported for this solid solution. The crystalline size was obtained from the mean half width peak by the Scherrer formula.

The particle size distribution was studied by TEM analysis.

DRFTIR analysis has shown that the spectrum of nanoparticle surface is similar to that of silicic acid ( $\text{SiO}_2 \cdot x\text{H}_2\text{O}$ ). The solubility of the coated particles in acidic media is low; these results confirm that the particles are fully coated.

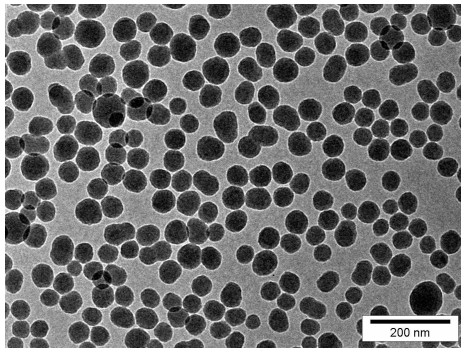


Figure 1: TEM image of  $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3 / \text{SiO}_2$  particles

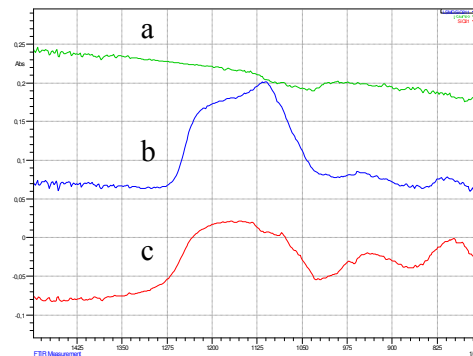


Figure 2: DRFTIR spectra of a)  $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3$  particles, b)  $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3 / \text{SiO}_2$  particles and c)  $\text{SiO}_2 \cdot x\text{H}_2\text{O}$  particles

### References

- [1] L. P. Gor'kov, V. Z. Kresin, Physics Report, 400(2004) 149-208  
[2] K.L Ang, S. Venkatraman, R.V. Ramanujan, Materials science and Engineering C 27 (2007) 347-351