Synthesis the Nanotubes of lanthanum-nickel oxides

*A. Zenatti[1], A. C. Lanfredi[1], J. F. Queiruga Rey[1], E. R. Leite[2], E. Longo[3], R. F. Jardim[4], M. T. Escote[1]

(1) Centro Engenharia, Modelagem e Ciências Sociais, Universidade Federal do ABC, Rua Santa Adélia, 166, Bairro Bangu, Santo André, SP, Brasil. alessandra.zenatti@ufabc.edu.br.
(2) LIEC – Depto. Química, Universidade Federal de São Carlos, São Carlos, SP, Brasil.
(3) LIEC – Instituto Química, UNESP – Araraquara, Araraquara, SP, Brasil.
(4) Depto de Materiais e Mecânica, Instituto de Física, Universidade de São Paulo, São Paulo, SP, Brasil.

Abstract Nanotubes of $LaNiO_3$ (LNO) compounds have been produced using a template assisted technique. The influence of the viscosity, proportion of metal:acid citric and the time of deposition on the formation of these LNO nanotubes were investigated. X-ray diffraction revealed the formation of the crystalline perovskite $LaNiO_3$ structure. High-resolution scanning electron microscopy showed the formation of agglomerated nanotubes of LNO. The size, thickness and length of the nanotubes depend on the conditions used to the deposition of the polymeric resin on the template.

Oxides with structure perovskite $RNiO_3$ (R = rare earth) have been studied due to their interesting physical and chemical properties. In particular, the LNO compound presents a metallic conductivity in a wide range of temperature. The temperature dependence the electric resistivity $\rho(T)$ of the polycrystalline samples and films LNO revealed a metallic behavior to room temperature (~300K) until 1.5 K.[1] Also, recently the synthesis of one-dimensional nanostructures, such as nanowires, nanotubes of perovskite $LaNiO_3$ have been reported.[2,3] In this sense, this work reported the study of the experimental conditions to produce $LaNiO_3$ (LNO) nanostructures using the template assisted synthesis. In this procedure, mesoporous anodic aluminum oxide templates were filled with a chemical solution prepared by the polymeric precursors-modified route. For this, commercially aluminum oxide membranes were immersed in a polymeric resin within stoichiometric amounts of La-Ni. The samples were characterized by X-ray powder diffraction (XRD), thermogravimetric analysis (TG) and high-resolution scanning electron microscopy (HRSEM). The crystallization temperature was verified by thermal analysis and showed that crystallization occur for temperatures higher than 550 °C. In fact, results of XRD of samples heat-treated at 600 °C revealed that these samples crystallize in perovskite-like $LaNiO_3$ structure. The effects of the synthesis conditions to produce nanotube or nanowire of LNO were investigated by HRSEM. In this step, we have produce samples with different time of deposition, and different proportion of citric acid and metal and with polymeric solution presenting different viscosity. The images of HRSEM revealed that samples prepared through different immersion times 0.5 1.0, 3.0 and 24 h and under vacuum promote the formation of nanotubes of $LaNiO_3$. Theses nanostructures present 60.000 nm and 100-60 nm of length and width, respectively. The walls thicknesses of the nanotubes are approximately 27 nm. All the parameters studied to the deposition of the precursor solution on the template resulted in the nanotube grown. The variation of the proportion of citric acid and metal (3:1 and 1:1) and the time of deposition (0.5-24 h) resulted in more oxide filling the porous of membranes. The use of a vacuum pump during the deposition process allowed the production of nice, but agglomerated, $LaNiO_3$ nanotubes.

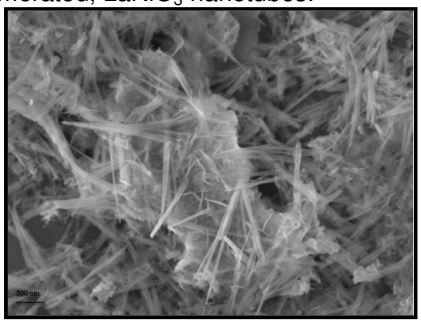

Figure 1: HRSEM image dissolved sample of LNO deposited using a vacuum.

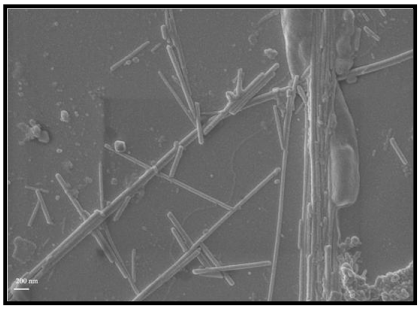

Figure 2: HRSEM image dissolved sample of LNO deposited using a vacuum.

References

[1] P. Lacorre, J. B. Torrance, J. Pannetier, A. I. Nazzal, P. W. Wang, T. C. Huang, J. Solid State Chem. 91,225, (1991).
[2] Zhi Yang, Yi Huang, Bin Dong, Hu-Lin Li, J. Solid State Chem. 178, 1157 (2005).
[3] M.Tagliazucchi, R. D. Sanchez, H. E. Troiani, E. J. Calvo, Solid State Comm., 137, 212, (2006).