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Magnetic nanocomposite films of $CoFe_2O_4$ nanoparticles and conducting polymers

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Abstract – Magnetic nanocomposite films of $CoFe_2O_4$ nanoparticles (∅~15 nm) were assembled employing the layer-by-layer technique in combination with two conducting polymers (PANI and PEDOT). The structure, morphology, electrical, and magnetic properties of the nanocomposites were investigated by UV-Vis spectroscopy, electrical and magnetic measurements, atomic force and transmission electron microscopy.

Magnetic nanomaterials have received a continuous interest due to their potential technological applications including coatings for EMI shielding, capacitors, spintronic devices, biomedicine, and sensors. Some of those applications demand for the preparation of thin films. In this regard, the layer-by-layer technique (LbL) has appeared as a powerful method that provides high control of film morphology, thickness and composition at the nanometer scale. The technique is based on the spontaneous adsorption of nanolayers of oppositely charged electrolytes from their respective solutions/suspensions onto solid substrates. The LbL is very useful for the preparation of multifunctional nancomposites as for instance those composed by magnetic nanoparticles hosted in conducting polymer matrixes [1]. One of the most applicable iron oxide magnetic fluid is the one composed of cobalt ferrite nanoparticles which presents high magnetocrystalline anisotropy, high coercivity, moderate saturation magnetization, and high stability [2]. In this contribution, we present the preparation of different multilayered nanocomposite films via LbL, comprising positively-charged cobalt ferrite ($CoFe_2O_4$) nanoparticles hosted in polyaniline (PANI) and polystyrene sulfonic acid doped poly(3,4-ethylenedioxythiophene) (PEDOT:PSS) layers.

The films were deposited by the alternate immersion of the glass slides in the diluted magnetic fluid containing the $CoFe_2O_4$ nanoparticles, used as cations and in the PEDOT:PSS complex solution as a polyanion. For films containing PANI, an intermediate layer of sulfonated lignin (SL) was deposited as a polyanion. Two different types of film architectures were assembled: $(CoFe_2O_4/PEDOT{:}PSS)_n$ and $(CoFe_2O_4/SL/PANI/SL)_n$, where n represents the number of bi- or tetra- layers and varies from 1 up to 10. The UV-vis spectroscopy data showed a stepwise growth of films with a same amount of materials being deposited per each adsorbed layer. The nanoparticle's morphology in the fluid assessed by TEM (Fig. 1) is typically spherical, 15 nm in diameter. The same morphology was present in the adsorbed films as showed by the tapping AFM images of the $(CoFe_2O_4/SL/PANI/SL)_2$ film (Fig. 2). The film surface is entirely covered by nanoparticles, which forms a dense layer of packed particles and a few aggregates. Magnetization measurements (MxH curves) of either dried magnetic fluid or film samples showed no histeresis at room temperature that indicated the superparamagnetic behavior. In addition, the nanocomposite films exhibited reasonable electrical conductivity (~0.001 S cm^{-1}) as measured by the Van der Pauw method. In conclusion, this work presents the preparation of multilayered nanocomposites composed by $CoFe_2O_4$ superparamagnetic nanoparticles and two different conducting polymers which display potential applications as active layers in chemical sensors and other magneto-electrical devices.

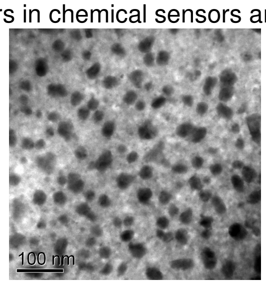

Figure 1: TEM micrograph of the cobalt ferrite nanoparticle.

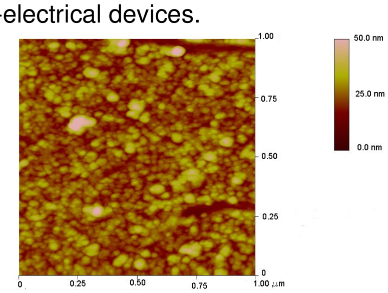

Figure 2:. AFM image of $(CoFe_2O_4/SL/PANI/SL)_2$ LbL film.

References

1. L.G. Paterno. M.A.G. Soler, F.J. Fonseca, J.P. Sinnecker, E.H.C. Sinnecker, E.C.D. Lima, M.A. Novak, P.C. Morais, J. Phys. Chem. C, 113, 5087 (2009).

2. S.W. da Silva, T.F.O. Melo, M.A.G. Soler, E.C.D. Lima, M.F. Da Silva, P.C. Morais, IEEE Trans. Magn., 39, 2645 (2003).