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Spectroscopy and electrical characterization of Polyaniline - Ag Composite

K. R. F. Silva[1], L. F. S. Rosa[1], M. E. Leyva, F. González Garcia,[1] A. A. A. de Queiroz[1] and M. R. Silva[1]
(1) ICE-UNIFEI, Universidade Federal de Itajubá, e-mail: <mariae@unifei.edu.br>

Abstract – The preparation of polyaniline - silver (PANI-Ag) composite has been carried out via the reduction of $AgNO_3$ (aq) by polyaniline in aqueous acidic medium (1M HNO_3). The reduction of $AgNO_3$(aq) by powder polyaniline dispersed in aqueous media resulted in the accumulation of the elemental silver (Ag) on the surface of the polyaniline particles. The PANI-Ag composite were characterized using UV-visible absorption spectroscopy, FTIR-ATR spectroscopy and electric conductivity *dc*. The spectroscopic analysis indicate the oxidation of polyaniline emeraldine to pernigraniline. The PANI-Ag composite exhibit excellent electrical properties with *dc* conductivity of 35,1 Scm.

The conjugated polymer – metal composites have attracted much attention because of their applications in chemical, physical, microelectronics, such as biomedicine, electromagnetic shielding. The properties of these systems can be expected to be different from those of the conjugated polymers or metal species, based on the fact that the small sized particles enhance the properties while the polymer matrix offers flexible functionalities. Among the conjugate polymers, polyaniline (PANi) has been of particular interest because of its environmental stability, controllable electrical conductivity, and interesting redox properties.[1]

The polyaniline in the form of emeraldine base (EB) or 50% oxidized base was prepared by chemical oxidative polymerization of aniline in aqueous acidic medium (1*M* HCl) with ammonium peroxydisulfate as an oxidant, according reported in previous works. [2] The emeraldine base was dispersed in aqueous acidic medium (1*M* HNO_3), the concentration of EB was 0,5 % (w/v). The EB dispersion was mixed with $AgNO_3$ 0,37 M. The reaction was carried out at room temperature while stirring for 24 h. The EB and PANI-Ag composite was characterized by spectroscopy analyses UV-vis (FEMTON 432), FTIR-ATR (Perkin-Elmer), electrical DC bulk conductivity on Keithley electrometer 6512 and the magnetic measurements were carried out at room temperature using a vibrating sample magnetometer (Lakeshore).

The Figure 1 shows of UV-vis absorption spectra of the EB and PANI-Ag composite. The solution of EB in CH_3OH present typical spectra of dedoped polyaniline with absorption band around 580 nm related to the π–π^* transition on the polymer chain. The solution of PANI-Ag composite in CH_3OH shows a significant blue shift to the peak around 580 to 540 nm. The absorption band around 540 nm is attributable to pernigraniline. The FTIR spectra of the EB and PANi–Ag composite are comparatively shown in Figure 2. The FTIR spectra of the two samples exhibit the quinoid and benzenoid stretching vibration modes at 1600 and 1500 cm-1 respectively. Integration of the spectroscopic bands attributed to the benzenoid and quinoid rings provides an estimate of the oxidation state of the polymer $R=A_{\nu(1500cm-1)}/A_{\nu(1600cm-1)}$. Integration of the bands give values of R = 1.2 and 0.35 for EB and PANI-Ag composite, respectively. The ratios indicate that the PANI-Ag composite is more oxidized in comparison to EB. This result suggests that PANI's oxidation state changes from the emeraldine base to the fully oxidized pernigraniline. The curves corresponding to magnetization vs applied magnetic field of the EB sample and PANI-Ag composite are presented in Figure 3. The EB and PANI-Ag shows a diamagnetic behaviour. The diamagnetic behaviour is associated with the metallic response meaning that a spin delocalization occurs and a typical metallic diamagnetism is observed. The bulk conductivity of the EB and PANI-Ag composites was $1,2*10^{-5}$ and 35,1 Scm, respectively.

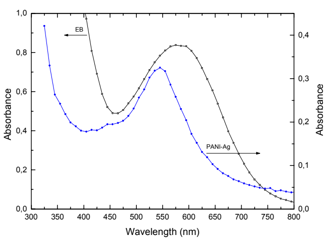

Figure 1: UV-Vis spectra of solution EB and PANI-Ag composite in CH_3OH.

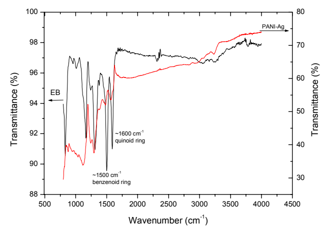

Figure 2: FTIR-ATR spectra of EB and PANI-Ag composite.

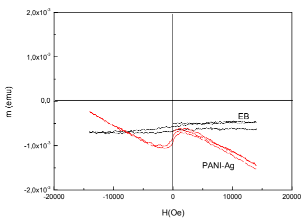

Figure 3: Magnetization data for EB and PANI-Ag.

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