

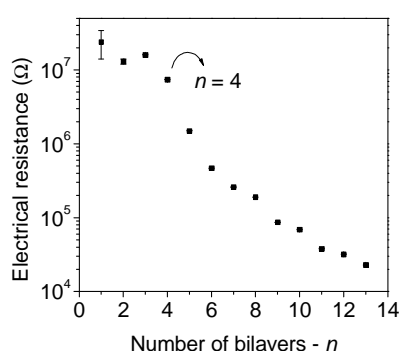
## Electrical characterization of polyaniline/poly(vinyl sulfonic acid) layer-by-layer films

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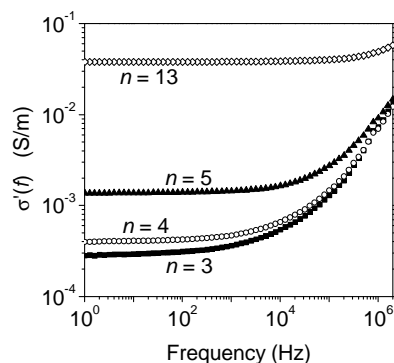
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**Abstract** – Ultrathin polyaniline/poly(vinyl sulfonic acid) films were deposited onto NiCr interdigitated microelectrode recovered with Au (NiCr/Au) line arrays and characterized by dc and ac electrical measurements according to the polymer thickness. We observed a significant change in the electrical resistance of the polymer film when its thickness reaches the Au electrode. The alternating conductivity of the system is observed to obey the typical behavior of disordered materials with additional influence of NiCr-PANI/PVS interfacial layer. A model is presented for the ac conductivity of the polymer system, which encompasses the NiCr-PANI/PVS effects and the activation energy for carrier hopping.

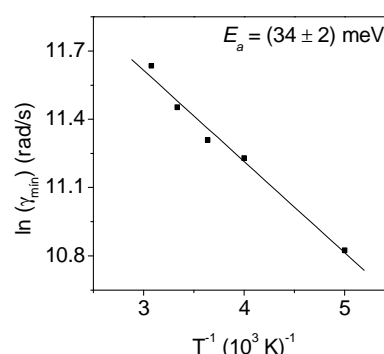
Since the first report on the semiconducting nature of *trans*-polyacetylene in 1970's [1], there have been considerable efforts to understand the electrical properties of conjugated polymers. Among this special class of polymeric materials, polyaniline (PANI) appears as a potential candidate from the technological standpoint on account of its low cost and ability to behave either as a semiconductor or as a metal, depending on the degree and type of doping used. Furthermore, PANI offers a great opportunity to explore new concepts in a variety of polymer devices ranging from electronic to chemical sensors [2]. Due to their potential applications as nanostructured devices, a better understanding of the conduction mechanisms and interface effects is crucial for determining the electronic transport across the multilayers, which depends on the irregularities of the material structure and also on the electrode effects [3]. However, the influence of the electrode material and the mechanisms governing the transport of charge carriers in those devices are not yet well understood. In this sense, in this paper we investigated the electrical dc and ac conductivities of films containing alternated layers of PANI and the anionic polyelectrolyte - poly(vinyl sulfonic acid) (PVS), deposited on interdigitated NiCr recovered with Au (NiCr/Au) line arrays previously evaporated on glass substrates. The results demonstrated a significant change in the electrical resistance when the thickness of the films was the same of the NiCr layer, as showed in the Fig. 1. This effect was attributed to the higher interfacial electrical resistance between NiCr and the polymer film, compared to the resistance of the Au-film interface and polymer bulk. The alternating conductivity of the polymer was typical of solid disordered materials, under the influence of the NiCr electrode, as showed in the Fig. 2 for films with number of bilayers ( $n$ ) equal 3, 4, 5 and 13. To investigate the charge transport mechanism in such material, it was developed a model based on random free energy barrier model [4] for the ac conductivity of the polymer system according to the number of bilayers, which encompasses the disordered properties of Lbl films and the NiCr-PANI/PVS interfacial effects. The models allowed a rough estimation of the thickness and the conductivity of the NiCr-PANI/PVS interfacial layer and dielectric constant of PANI/PVS film [5]. The presence of a broad spectrum of relaxation times in the PANI/PVS system was also inferred from the model, as well as the activation energy at about 34 meV of the maximum barrier for carrier hopping (Fig. 3). Finally, it was obtained that the bulk conductivity ( $9.6 \times 10^{-4}$  S/m) is higher than the total conductivity ( $6.9 \times 10^{-4}$  S/m) of the Lbl system. This work was sponsored by CAPES, Fapemig, CNPq and INEO/CNPq.



**Figure 1:** Electrical resistance vs. number of PANI/PVS bilayers ( $n$ ).



**Figure 2:** Real,  $\sigma'(f)$ , component of the ac conductivity for  $n = 3, 4, 5$  and  $12$ .



**Figure 3:**  $\ln \gamma_{\min}$  vs.  $T^{-1}$ . The curve present an activation energy  $E_a = (34 \pm 2)$  meV when fitted by Arrhenius process.

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