Electrical characterization of poly(amide-imide) thin films

R. S. Ywata[1], F. M. Shimizu[1], E. M. Lopes[1], N. Alves[1], A. J. F. de Carvalho[2] and José A. Giacometti[1]

[1]*Faculdade de Ciências e Tecnologia, UNESP, Presidente Prudente, SP, Brazil*

[2]*Departamento de Engenharia de Materiais, Aeronáutica e Automobilística, USP, São Carlos, SP, Brazil*

The electric capacitance of dielectric layers in organic thin film transistors (OTFTs) is very important to find desirable electric OTFTs characteristics, for example, low threshold voltage. Also, Steudel et al[1] showed that low surface roughness is important to increase the carrier mobility in the semiconductor layer. Many polymeric materials have been tested and used to fabricate OTFTs. Cross-linked polymers are preferable because they are non soluble in solvents used to deposit the organic semiconductor film. A candidate material for organic electronics is the co-polymer poly(amide-imide) (PAI), which is amorphous, cross-linkable, with exceptional mechanical, thermal and chemical properties.

In this work, metal-insulator-metal (MIM) structures made from the co-polymer PAI were characterized trough AC measurements using the frequency response analyzer Solartron and AFM scanning microscopy. PAI films were deposited on ITO glass slides by spin-coating the polymer from NMP solution and then treating it at 200 ^{o}C in a vacuum oven to remove residual volatile solvent. The cross-linking was achieved heating the sample at 300 ^{o}C for 1 hour. Thicker films were prepared depositing additional layers and repeating the thermal treatment. Finally, a gold electrode was vacuum deposited to form the ITO/PAI/Au MIM structure. MIM structures were conditioned in a vacuum chamber and measurements were performed under high vacuum (~10^{-6} Torr). Experiments performed in air were also carried out to evaluate the effect of oxygen and moisture.

Impedance measurements carried out from 1 Hz to 1 MHz showed that the capacitance of MIM devices is almost frequency independent; varying from 500 to 900 pF using PAI films with 2 to 4 layers, and the loss tangent is of order of 10^{-3}. AFM characterization of PAI film surface showed RMS roughness from 0.2 to 0.9 nm, which indicates high surface uniformity.

We concluded that the co-polymer PAI is a good candidate for application as dielectric layer in OTFTs and metal-insulator-metal (MIS) devices. Furthermore, PAI/P3HT MIS devices were already fabricated and they showed electric characteristics comparable to devices made from other high insulating polymeric materials.

Keywords: poly(amide-imide), organic thin film transistors, dielectric layer.

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References

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e-mail: ricardo_ywata@ig.com.br
address: Rua Roberto Simonsen, 305. CEP 19060-900, Presidente Prudente - SP