11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Transparent Nanocomposite Bacterial Cellulose Used as Flexible Substrate for OLED

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Abstract – In this work, nanocomposite substrates based on bacterial cellulose (BC) and Boehmite-siloxane systems were used as substrates for fabrication of flexible OLEDs (FOLEDs). The nanocomposites formations improve the optical transmittance of the BC in the visible range. Transmittance of 66% at 550nm was found for the BC-nanoconposite/ITO substrate when compared to the 40% value at the same wavelength for the BC/ITO substrate. The ITO film was deposited at room temperature onto BC and glass using rf magnetron sputtering. Resistivity, mobility and the carrier concentration values of the ITO films for different configuration are compared and discussed. Preliminary results of FOLEDs fabricated onto BC and BC nanocomposite substrates are also presented.

Flexible Organic Light Emitting Diodes (FOLEDs) hold great promise in research dedicated to the development of new optoelectronic and photonic devices, since electronic paper (e-paper) to medical sensors. One of the possible and recent applications of FOLEDs consists in their use for photodynamic therapy (PDT) to treat skin cancer and other skin diseases [1]. For these purpose, the use of suitable flexible substrates with also biocompatible properties is crucial for the development of the devices. In this sense, Bacterial Cellulose (BC) is an interesting material. Cellulose is the most abundant natural biopolymer on the earth, synthesized by plants, algae and also some species of bacteria. In particular BC produced by Gram-negative, acetic acid bacteria *Gluconacetobacter xylinus* displays several unique properties when compared to plant cellulose. In our previous work a biodegradable and biocompatible FOLED based on Bacterial cellulose (BC) membrane as substrate was presented [2]. However, the BC optical transmittance in the visible range is generally poor and the device light emitting properties are reduced. An increase in transmittance is, therefore, a must for these applications.

In this work, nanocomposite substrates based on bacterial cellulose (BC) and Boehmite-siloxane systems with improved optical transmittance in the visible region were used as flexible substrate for OLED applications. The nanocomposites formations improve the optical transmittance in visible range. Transmittance of 66% at 550nm was found for the BC-nanoconposite/ITO (Indium Tin Oxide) substrate when compared to the 40% value at the same wavelength for the BC/ITO substrate. ITO film was deposited at room temperature onto membranes and glass using rf magnetron sputtering with a rf power of 60 W and at pressure of 1 mtorr in Ar atmosphere. The resistivity, the mobility and the carrier concentration are presented in Table 1. Finally, FOLEDs with the following structure: BC/ITO(170nm)/copper phthalocyanine (CuPc) (30 nm)/ (N,N´-bis(1-naphtyl)-N,N´- diphenyl-1,1´-biphenyl-4,4´-diamine) (NPB) (55 nm)/ tris(8- hydroxyquinoline) aluminum (50 nm)/ aluminum (Al) (120 nm) was produced in high vacuum environment and characterized. The best devices present a luminance of about 2400 cd/m^2. Fig.1 show a picture of a nanocomposite BC based FOLED produced.

Table 1: Electrical properties of ITO thin films.

Material	Resistivity ($x10^{-4}$ Ω/Cm)	Carrier Concentration (10^{20}/cm3)	Mobility (cm^2/V.s)
BC	4.7	5,56	23,7
NC-BC	4,9	1,50	8,08
Glass	4,6	7,3	18,7

Figure. 1 – Nanocomposite BC based FOLED.

References

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