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CONDUCTING NANOCOMPOSITE ORGANIC FILMS FOR PLASTIC PRESSURE SENSORS AND ELECTRONIC CIRCUITS

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The processing characteristics of organic electronics make them potentially useful for electronic applications where low-cost, large area coverage and flexibility are required. In particular, there is an increasing interest in developing materials that respond to external stimulus such as pressure, temperature or gases. The conducting nanocomposite organic bi-layer (BL) films offer excellent potential in plastic electronics since they combine the electrical properties of molecular organic conductors, which are sensitive to small pressure changes, with the transparency, processability and flexibility of polymers. BL films consist of a polymeric matrix with a topmost layer formed by a micro- or nanocrystalline network of a TTF-based conducting material (TTF=tetrathiafulvalene) [1] (Fig. 1).

In this work, we studied the effect of external strain on the electrical resistance of a BL film formed with the topmost layer of $(BET)_nI_xBr_{3-x}$ crystallites (BET= bis(ethylenethio)tetrathiafulvalene, $n>2$, $1\leq x\leq 3$).[2] The electrical resistance of the BL film demonstrates a high sensitivity to the deformation; in the single-axis deformation range 0-120 μm the variation of resistance linearly depends on absolute strain (Fig. 2). For studied conducting nanocomposite BL films the tensosensitivity $k = (R-R_0)/R_0\varepsilon$ (ε is relative strain, R_0 is the BL film resistance without the strain, R is the resistance of the strained sample) varies in the range 5-6, which is much above the sensitivity of commonly used manganese-based sensors for which k is around 2 [3]. The tensosensitivity of BL films is governed by the type of crystallites, their orientation and the network of nano-scale contacts between them. These parameters can be controlled through the BL film preparation. The conducting nano- and microcrystalline layer of an organic molecular conductor is used as a high tensosensitive material to detect and transmit pressure data. The polymeric matrix serves as a support for the placement of the conducting layer over it. In addition, we have developed a novel technique, namely *thermochemical printing of organic conductors (TCPOC)*, for patterning the BL films.[4] The patterning is realized employing a local heat source –using a laser radiation source- since by local heating the film surface the conducting areas, formed by the TTF salts, can be converted into insulating areas, formed mainly by the neutral TTF derivatives. We further demonstrate here the potential of this novel technique for the design of electronic circuitry, components and devices (Fig. 3)

Considering their strain sensitivity, versatility and processability, the reported BL films are very promising in "*plastic electronic*" applications such as smart clothes, biomedicine or robotic interfaces.

References:

[1] a) E. E. Laukhina, V. A. Merzhanov, S. I. Pesotskii, A. G. Khomenko, E. B. Yagubskii, J. Ulanski, M. Kryszewski, J. K. Jeszka, *Synth. Met.*, **70** (1995) 797. b) M. Mas–Torrent, E. Laukhina, C. Rovira, J. Veciana, V. Tkacheva, L. Zorina, S. Khasanov, *Adv. Funct. Mater.*,

11, 299 (2001). c) E. Laukhina, V. Tkacheva, S. Khasanov, L. Zorina, J. Gomez-Segura, A. Perez del Pino, J. Veciana, V. Laukhin, C. Rovira, ChemPhysChem, **7** (2006) 920.

[2] E. Laukhina, M. Mas-Torrent, J. Veciana, C. Rovira, V. Laukhin, Patent Appl., ES 200602887.

[3] Vishay, DMS Messtechnologie, Formel&Tabellen, Measurements Group Messtechnik, Munchen (1991).

[4] M. Mas-Torrent, E. E. Laukhina, V. Laukhin, C. M. Creely, D. V. Petrov, C. Rovira, J. Veciana, *J. Mater. Chem.*, **16** (2006) 543; Patent Application, ES 200501879.

Figures:

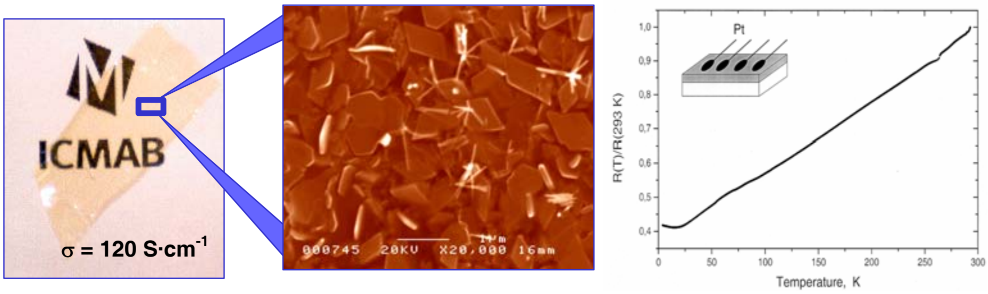

Fig.1 View through a metal-like BL film with a surface layer of $(BETTTF)_2Br{\cdot}3H_2O$ nanocrystals, SEM image of the surface layer showing the network of conducting nanocrystals, and normalized resistance of the conducting surface layer versus temperature.

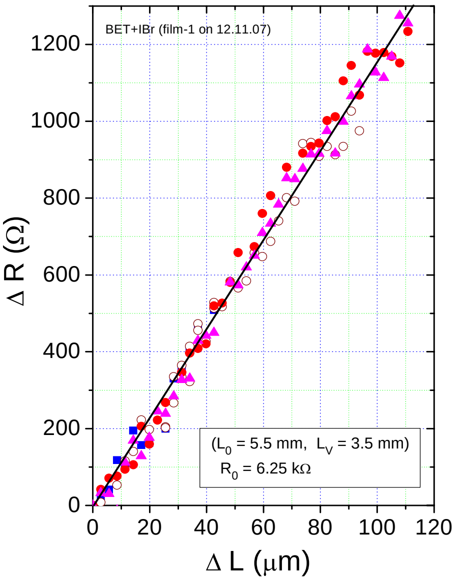

Figure 2. Absolute strain dependence of the resistance of the nanocomposite BL film sample at room temperature; $\Delta R = R - R_0$.

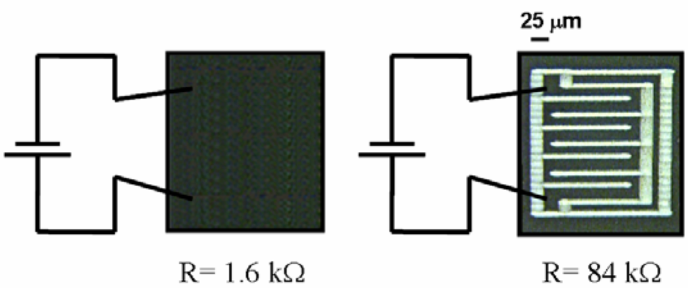

Figure 3. Electronic circuits in which the BL films of nanocrystals β-$(BET\text{-}TTF)_{2.5}I_3$ without patterning (left) and after patterning (right) are used as micro-resistors. The light zones in the right figure correspond to the laser writing path and are insulating.