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Influence of traps on PCBM Organic Magnetoresistance studied by Impedance Spectroscopy

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In 2004, a new type of magnetoresistance has been observed at room temperature, low magnetic field (about a few mT) in non magnetic organic materials sandwiched between non magnetic electrodes [1]. This effect has been named organic magnetoresistance (OMAR) and is believed to be an interesting tool for the study of electrical transport in organic materials. Furthermore, OMAR has been shown to enhance the yield of the photoconversion in photovoltaic cells [2-3]. However, there is still a lack of understanding of the OMAR mechanism.

In particular, the influence of the organic film structures on OMAR is still poorly understood, although traps seem to have a great influence on the OMAR value [4]. In order to determine more precisely what is the role of traps, we have measured OMAR of diodes based on [6,6]-phenyl-C_{61}-butyric acid methylester (PCBM) for various annealing temperatures (fig1). From the results, it appears that the MR ratio value and even its sign can be changed by the structure of PCBM. To find which features of the structure are responsible for such drastic change, Impedance Spectroscopy measurements have been carried out. We obtained the Nyquist plot (fig2) and the capacitance curves (fig3), which gave us respectively more information about the electronic processes taking place in the device and on the density of states as well as the charge mobility. More detailed results will be discussed during the presentation.

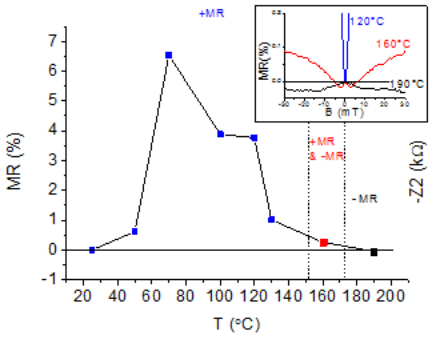

Fig1. Evolution of OMAR with annealing temperature. In insert, MR curves at 120°C, 160°C and 190°C.

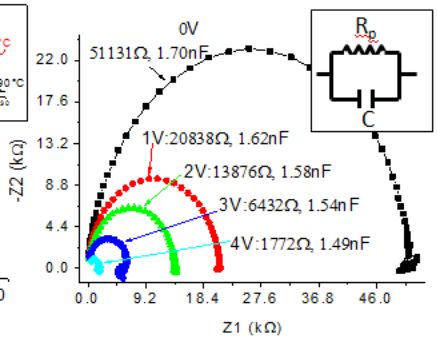

Fig. 2. Nyquist diagram of PCBM diode annealed at 120°C, modeled by the EC in insert.

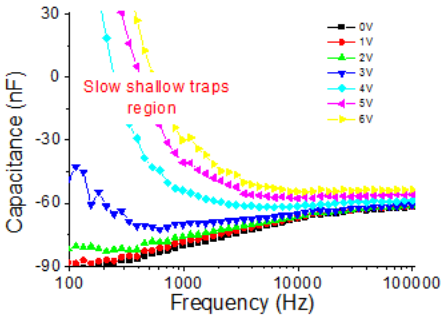

Fig. 3. Parallel capacitance vs. frequency. The low and intermediate frequencies region give information on slow and fast shallow traps, respectively.

[1] T.L. Francis et al., *New J. Phys.*, **6**, 185 (2004).
[2] Y. Lei et al., *Org. Elec.*, **10**, 1288-1292 (2009).
[3] Z. Xu et al., *J. Appl. Phys.*, **103**, 043909 (2008).
[4] J. Rybicki et al., *Phys. Rev. Lett.*, **109**, 076603 (2012).