Soft Matter, Polymers, Composites

MS.1.P015
Pentacene thin films for organic spintronics

P. Graziosi[1,2], M. Prezioso[1,3], I. Bergenti[1], A. Riminucci[1], D. Brunel[1,4], C. Newby[1,5], F. Li[6], Y. Zhan[1,6] M. Fahlmam[6], M. Ghidini[7], D.J. Busquets Mataix[2], D. Pullini[8], A. Dediu[1]

[1]CNR, ISMN, Bologna, Italy, Italy
[2]Universitat Politecnica de Valencia, Valencia, Spain, Spain
[3]University of California, Department of Electrical and Computer Engineering, Santa Barbara - USA, Italy
[4]CEA, IRAMIS, Service de Physique de l'Etat Condensé (CNRS URA) 2464, France, France
[5]Cornell University, Materials Science and Engineering Department, Ithaca - USA, United Kingdom
[6]Linkoping University, Department of Physics, Chemistry and Biology, Sweden, Sweden
[7]University of Parma, Italy, Italy
[8]Centro Ricerche Fiat, Orbassano, Italy, Italy

patrizio.graziosi@gmail.com

The utilization of high mobility organic semiconductors in spintronics is expected to provide a breakthrough improvement in the device operation. Pentacene is a reference material of choice for most OFET investigations and thus is among the main candidates for spintronic applications. We present here the study of the growth dynamics of pentacene on ferromagnetic oxide surfaces, namely on La0,7Sr0,3MnO3 (LSMO) manganites, with a link to vertical pentacene based spin valves prototype devices. It is important to mention that no magnetoresistance has been detected in similar geometry with cobalt electrodes [1].

Pentacene (Pn) films in the thickness range of 3-100 nm were thermally evaporated in UHV conditions on LSMO films at several deposition temperatures. A strictly diffusion limited, thermically activated (Arrhenius-type) growth was found. The molecule diffusion was found to have a strongly anisotropic character. Pentacene molecules form very wide and extended flat islands having size of a few microns. These large structures are delimited by quite high steps and show terraced features. The step height was estimated independently via AFM characterizations and Near Edge X-ray Absorption Fine Structure (NEXAFS) studies and constitutes 1.5 nm, corresponding to 70° angle between molecule axis and surface plane [2].

Pentacene film formation on LSMO layers is quantitatively understood by involving pentacene molecules diffusion on the bare substrate; stable nuclei formation when a certain critical number of molecules meet; nuclei growth, migration, coalescence; molecule diffusion on top of nuclei. A ΔT of about 15°C (from 30°C to 45°C) is sufficient to break the interaction, pentacene develops a weak interaction with the substrate. Pentacene growth appears to be a strictly diffusion limited, a thermally activated, Arrhenius type, process [3].

Vertical prototype spin valve devices are presented based on the Pentacene/LSMO interface and on the Pentacene/Alq_3/LSMO engineered interface, where not only the tuned morphology but also the modified interface energetic are shown to play a major role.

1. T. Ikegami, I. Kawayama, M. Tonouchi, S. Nakao, Y. Yamashita and H. Tada, Appl. Phys. Lett. 92 (2008) 153304.
2. F. Li, P. Graziosi, Q. Tang, Y. Zhan, X. Liu, V. Dediu and M. Fahlman Phy. Rev. B 81 (2010) 205415.

3. P. Graziosi, Material engineering in hybrid spintronic devices, PhD thesis, 2010.

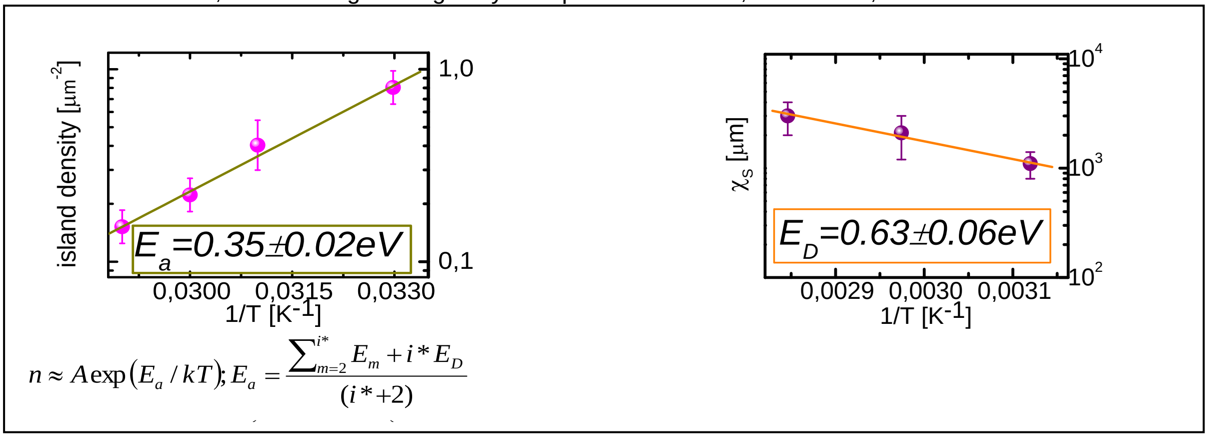

Figure 1. Arrhenius plots of the pentacene stable islands density and diffusion length obtained from 2 ML coverage of the LSMO surface, detected by AFM.

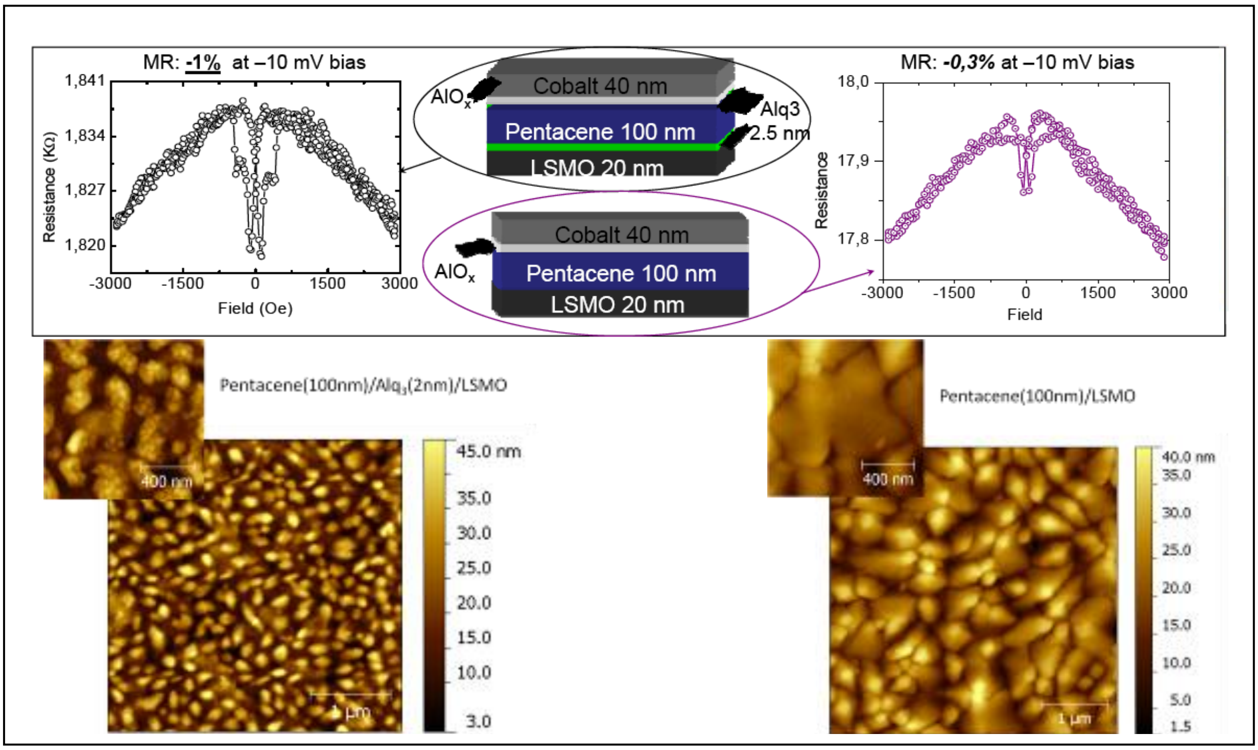

Figure 2. Prototype spin valve devices based on bare pentacene (right) and on Alq_3-tailored interfaces (left) as described in the sketch. In the bottom row the respective AFM images are shown.