Ballistic Electron Emission Microscopy (BEEM): a local and quantitative probe to study the quality of Au/hexadecanethiols/GaAs(001) heterostructures by imaging buried interfaces and drawing local energy band alignments

Sophie Guézo[a*], Alexandray Junay[a], Pascal Turban[a], Bruno Lépine[a], Gabriel Delhaye[a], Sylvain Tricot[a], Soraya Ababou-Girard[a] et Francine Solal[a]

a. Institut de Physique de Rennes, Département Matériaux-Nanosciences, UMR 6251, Université de Rennes 1, CNRS, 263 avenue du Général Leclerc, 35042 Rennes cedex, France

* sophie.guezo@univ-rennes1.fr

In molecular electronics, metallic top-contact deposition on organic molecular monolayer(OML)/semiconductor hybrid heterostructures is still a critical issue, leading to metal penetration through the molecules and monolayer's damage. Here, we report on the potentialities of BEEM (technique derived from the Scanning Tunneling Microscopy one) to quantitatively characterize the local transport properties at the nanometer scale and the degree of this penetration through the organic monolayer on Au-hexadecanethiols-GaAs(001) heterostructures. At RT, BEEM imaging mode provides mapping of the local hot-electron transmission and demonstrates pronounced inhomogeneities at buried interfaces. Using local transport measurements in spectroscopy mode, local barrier heights and the BEEM current attenuation are measured in each area and compared with the well-known Au/GaAs(001) Schottky contact [1,2]. In order to minimize the degree of gold penetration and obtain homogeneous heterojunctions, an alternative top-contact deposition method is used, based on Buffer-Layer Assisted Growth (BLAG) [3]. BEEM results obtained on such heterostructures are discussed and compared with macroscopic measurements [4]. In this framework, BEEM further appears as a highly powerful and complementary tool to commonly used spatially averaged diffusive transport experiments, essential for understanding such hybrid heterostructures of major interest for molecular electronics. The extension of this work to the case of OML/ferromagnets spinterfaces is in progress.

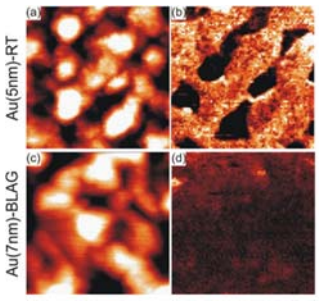

Figure 1 : 50x50nm² STM images of Au surfaces deposited on hexadecanethiols/GaAs(001) (a) at room temperature and (c) by BLAG method. (b) and (d) Corresponding BEEM images of buried interfaces.

[1] S. Guézo, P. Turban*, et al.*, *Physical Review B*, **81**, 085319 (2010).
[2] A. Junay, S. Guézo*, et al.*, *Journal of Applied Physics*, **118**, 085310 (2015).
[3] M. M. Maitani, D. L. Allara*, et al.*, *Applied Physics Letters*, **96**, 173109-3 (2010).
[4] A. Junay, S. Guézo*, et al.*, *The Journal of Physical Chemistry C,* **120**, 24056-24062 (2016)