RECENT RESULTS ON CHARGE TRANSPORT IN MOLECULAR JUNCTIONS AND DEVICES BASED ON ORGANIC SELF-ASSEMBLED MONOLAYERS.

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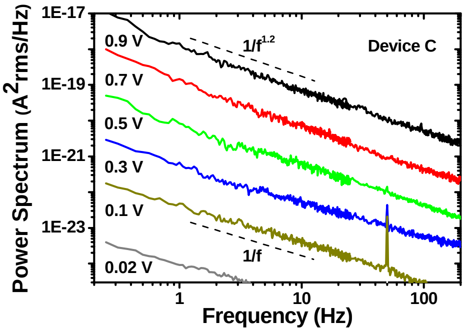
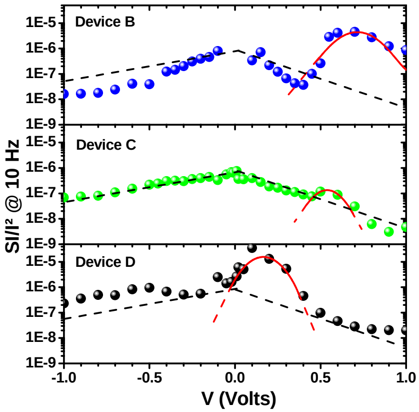
Monolayers of organic molecules are one of the main systems studied in molecular electronics. I will review some of our recent results on this topic.

Low frequency noise in molecular tunnel junction. Recently, very high quality alkyl monolayers on oxide-free silicon were reported to be a basic system, very reproducible to study the electrical transport through these molecules.[1,2] The low frequency tunnel current noise characteristics of the monolayer have been investigated for the first time.[3] Clear $1/f^{\gamma}$ power spectrum noise is observed with $1 < \gamma < 1.2$. The normalized power spectrum current noise (S_I/I^2) is similar to that of inorganic tunnel junctions.[4] However, a local increase is observed at certain bias range, when $V > 0.4$ V in most of the devices, with an amplitude varying from device to device. We attribute this effect to an energy dependent trap induced tunnel current. The nature of the trap will be discussed.

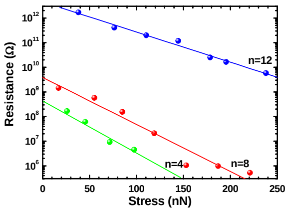


Low frequency ($1/f^{\gamma}$) power spectrum current noise for device C. γ varies from 1 at low voltages to 1.2 at 1 V.

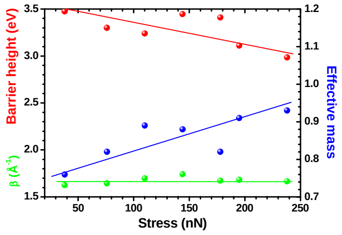


Normalized power spectrum current noise S_I/I^2 as a function of bias V. The curve for device C follows asymptotes (dashed lines) which are used as a reference for other devices. A local increase of noise over the asymptotes is pointed out with Gaussian shape.

Effect of a mechanical stress on charge transport in molecular tunnel junction. The effect of the stress on the tunnel barrier properties (effective mass and barrier height) formed by an organic monolayer between the two metallic electrodes is not well understood. We have studied the electrical transport through an alkylthiol monolayer by *Conducting*-AFM in the stress range 20 to 250 nN. We observe a decrease of the tunnel barrier height (from 3.5 to 3eV) and an increase of the effective mass (from 0.76 to 0.93). As a consequence, the tunnel decay value β is constant ($1.68 \pm 0.04 Å^{-1}$) in the range of stress. These features will be compared with the literature[5,6] and discussed in accordance with a simple model of the electronic structure of the stressed molecule.

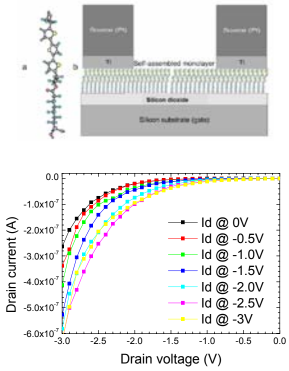


Resistances measured between -300mV and 300mV for the different SAMs, and dependence of the resistance with the stress.

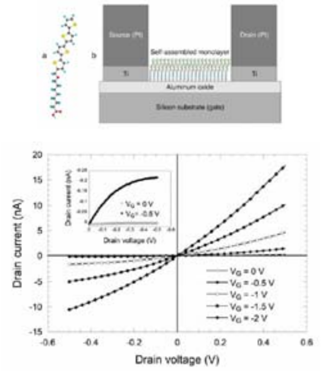


Effective mass and barrier height obtained by a fit on SAM n=12 with the Simmons's equation, the contact area and the SAM thickness are calculated as a function of the stress.

Self-assembled monolayer field-effect transistor. We report on an organic field-effect transistor built on a self-assembled monolayers (SAM) made of bifunctional molecules comprising a short alkyl chain linked to an oligothiophene moiety that act as the active semiconductor.[7] The SAM was deposited on a thin oxide layer (alumina or silica) that served as the gate insulator. Platinum-titanium source and drain electrodes (either top or bottom contact configuration) were patterned through e-beam lithography, with a channel length ranging between 20 and 1000 nm. A few devices offered well-defined curves with a clear saturation, thus allowing us to estimate a mobility of 0.0035 cm^2/Vs for quaterthiophene and 8x10^{-4} cm^2/Vs for terthiophene. In the first case, the on-off ratio reaches 1800 at a gate voltage of -2 V. Interestingly, the device operates at room temperature and very low bias, which may open the way to applications where low consumption is required.



SAMFET top-contact configuration with a C8-terthiophene SAM. L=100 nm, W=20µm, SiO$_2$ 10 nm. Mobility μ_{max}=8.3x10^{-4} cm^{2}V^{-1}s^{-1}, I_{on}/I_{off}=60.



SAMFET bottom-contact configuration with a C8-quaterthiophene SAM. L=60 nm, W=10µm, Al$_2$O$_3$ 100 nm. μ_{max}=3.5x10^{-3} cm^{2}V^{-1}s^{-1}, I_{on}/I_{off}=1800.

I thank my colleagues S. Lenfant, D. Guérin, N. Clément, S. Pleutin for the work done in our group. Work on 1/f noise was done in collaboration with O. Seitz and D. Cahen (Weizmann Institute); work on SAMFET was done in collaboration M. Mottaghi, P. Lang, F. Rodriguez, A. Rumyantseva, A. Yasser, G. Horowitz (ITODYS, CNRS, Paris).

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