INTEGRATION OF MOLECULES ON A CHIP : FROM THE Si-H SURFACE CHEMISTRY TO NANOMETER SIZED DIODES

L. BARATON [1], J.P. BOURGOIN [2], V. DERYCKE[2], E. DUJARDIN [2], C. CHEVROT [3], S. PALACIN [1], D. VUILLAUME [4]

1- CEA-SACLAY, DSM/DRECAM/SPCSI, Bât. 466, 91191 Gif-sur-Yvette Cedex, France
2- CEA-SACLAY, DSM/DRECAM/SCM, Bât 125, 91191 Gif-sur Yvette Cedex, France
3-LPME, CNRS, Université de Cergy-Pontoise, Site Neuville II, 5 Mail Gay-Lussac, 95031 Neuville/Oise, France
4-IEMN, CNRS, BP69 Avenue Poincare, Villeneuve d'Ascq 59652 Cedex, France

This work aims at building a hybrid device[1] which core element consists in a few number of organic molecules sandwiched between a bottom silicon electrode and a top single wall carbon nanotube electrode. The σ–π–σ type monolayer (consisting of an aliphatic chain, a conjugated ring, and another aliphatic chain) is expected to give rise to negative differential resistance behavior under bias.

The first part of the project focused on the formation of the σ–π–σ monolayer, covalently bounded to a silicon surface, in a multistep and thus convergent process. We started from hydrogen terminated silicon surfaces and thermally grafted a first monolayer[2]. This first monolayer ends with chemical groups that were used to build the whole target molecule *via* mild reactions (Figure 1).

We chose hydrogen terminated silicium as a starting material in order to have a direct injection of the electrons from the electrode to the σ–π–σ molecule. Thus, we paid particular attention, during the whole process, to prevent the substrate from reoxidising. This was surveyed by HR-XPS of the Si2p core level, whereas the chemical modifications of the surface were monitored by ATR infrared spectroscopy.

Once we proved that a σ–π–σ monolayer could be achieved on large surfaces of hydrogen terminated silicium, we designed a device (Figure 2) based on a cross-bar configuration in order to integrate it on a chip. The device is designed in order to avoid any current leakage from the contacting gold electrodes of the chip through the oxide layer and to allow the contact of only few molecules.

Starting from a thick oxide layer, we thinned it locally until reaching the underlying bulk silicium. This was achieved in two steps of e-beam lithography and etching process. Then the grafting took place and SWNT top electrode was finally deposited in a cross junction configuration and contacted.

References :

(1) **Joachim, C.; Gimzewski, J. K.; Aviram, A. *Nature* 2000, *408*, 541-548.**

(2) **Buriak, J. M. *Chem. Rev.* 2002, *102*, 1271-1308.**

Figures :

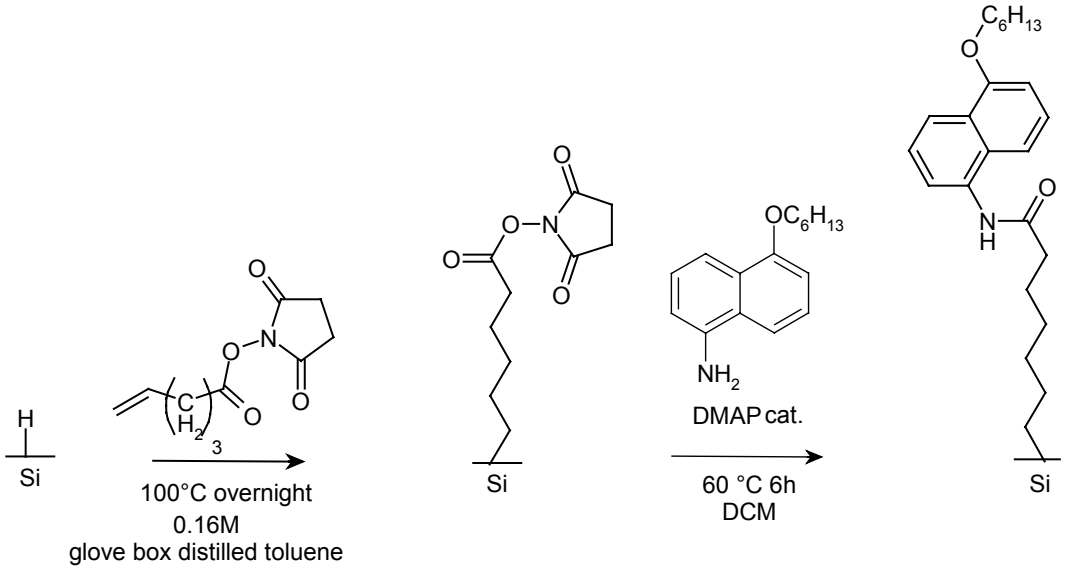

Figure 1 : Schematic route to a structured monolayer covalently bounded to a silicium surface

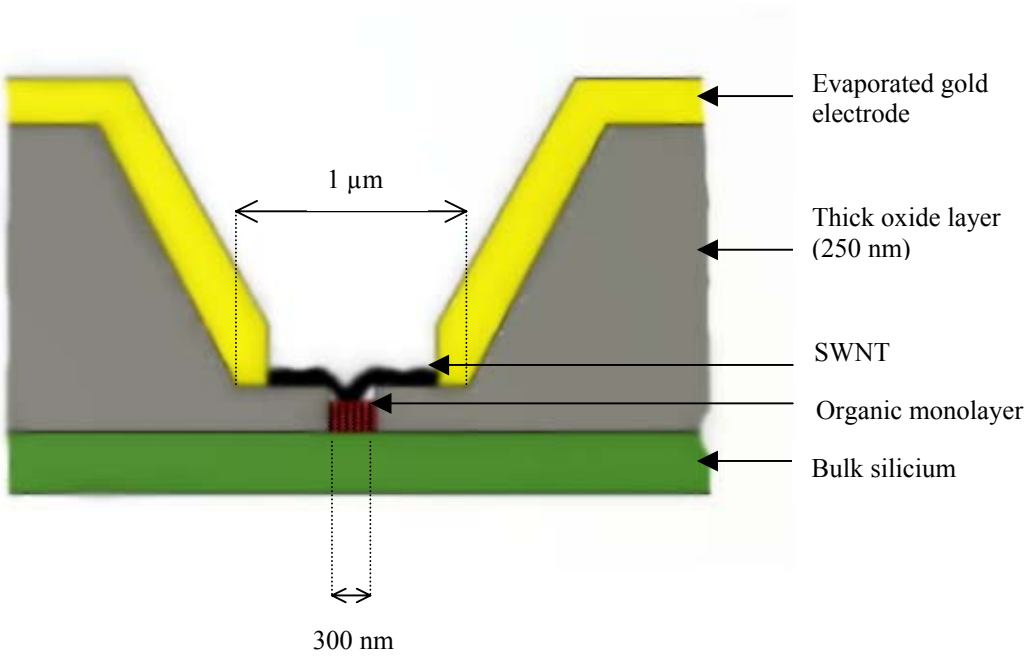

Figure 2 : Design of the device.