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High resolution imaging of molecular assemblies on Si(111):B by non-contact AFM and Kelvin probe spectroscopy at low temperature

Natalia Turek,[1,*] Dominique Deresmes,[1] Judicaël Janneoutot,[2] Younes Makoudi,[2] Frank Palmino,[2] Frédéric Chérioux,[2] Sylvie Godey, Thierry Mélin[1]

[1] *Institut d'Electronique, Microélectronique et Nanotechnologie, IEMN-CNRS UMR 8520, Av. Poincaré, CS 60069, 59652 Villeneuve d'Ascq Cedex, France.*

[2] *Institut FEMTO-ST, CNRS, Université Bourgogne Franche-Comté, 15B Avenue des Montboucons, 25030 Besançon Cedex, France*

* natalia.turek.etu@univ-lille.fr

Abstract:

We studied by non-contact AFM (nc-AFM) the formation of molecular self-assemblies on the passivated surface of boron doped silicon B-Si(111)-($\sqrt{3}$x$\sqrt{3}$) R30°. The investigated molecule (1-(4'cyanophenyl)-2,5-bis(decyloxy)-4-(4'-iodophenyl)benzene) possesses two aliphatic chains attached to a triphenyl core ended with two different terminations (either iodine or cyano group). The use of a passivated semiconductor substrate enables creating regular and extended structures without significant change in electronic properties of molecules [1, 2]. Scanning tunneling microscopy and nc-AFM imaging have been performed using a low-temperature (AFM/STM (JT AFM/STM, SPECS) operated at T=4K with high stiffness Kolibri sensors (k=540 kN/m, f_0=1 MHz). The growth of a periodic molecular network is observed, formed by parallel lines made by molecule aromatic cores and interdigitated aliphatic chains placed between adjacent rows (see Figure 1). We obtain submolecular resolution in the constant height Δf images without intentional tip functionalization [3], but only by conditioning the tip on the silicon surface [4]. We will discuss the high-resolution AFM imaging, as well as the conformation of the molecules in the observed assemblies (e.g. changes in the interdigitated aliphatic chains ordering), and in particular the role of the molecule dipoles. Kelvin probe spectroscopy images with sub-molecular resolution will be presented.

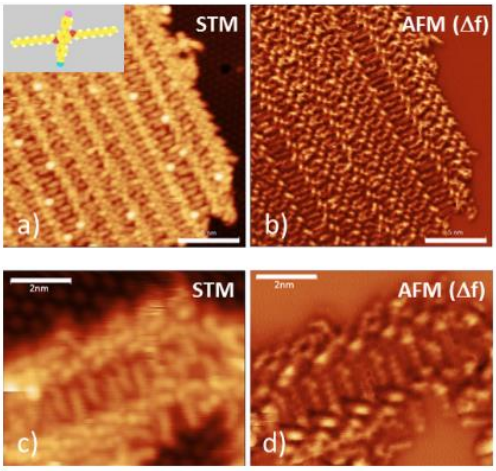

Figure 1 : a) STM image (scale bar 5 nm) of a molecular assembly, V_s=-1.8 V, I_t=5 pA (the molecule is represented in the inset); b) constant height non-contact AFM image of the same zone; c) STM image (scale bar 2 nm) of a small organized domain taken at V_s=-1.9 V, I_t=5 pA; d) corresponding AFM image revealing submolecular contrast. All images have been recorded with a tip oscillation A=50pm.

References

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