NANOWIRES: YOUR LABORATORY AND THEORETICAL BOOK TO UNDERSTAND SURFACE PHENOMENA

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During the last 10 years the fashion of the nanotechnology has widely eclipsed something we knew since early 20th century: how few we know about surfaces. Indeed, nanostructures exhibit most/only surface being this issue harder.

In the recent times we have made efforts controlling size, phase and faceting (fig 1) of such an interesting structures: nanowires. But, a part of a question of fashion, nanowires are interesting because they are unique nanostructures with two important, and complementary characteristics.

The first is surface of nanowires are, in most of cases, close to perfect (theoretical book!) surfaces. This fact allows to study the nanowires from the point of view of surface reactions with matter [1,2,3] and with light [4] (fig. 2). Nanowires show us how surface behaves, but with much more specific surface than a simple surface!

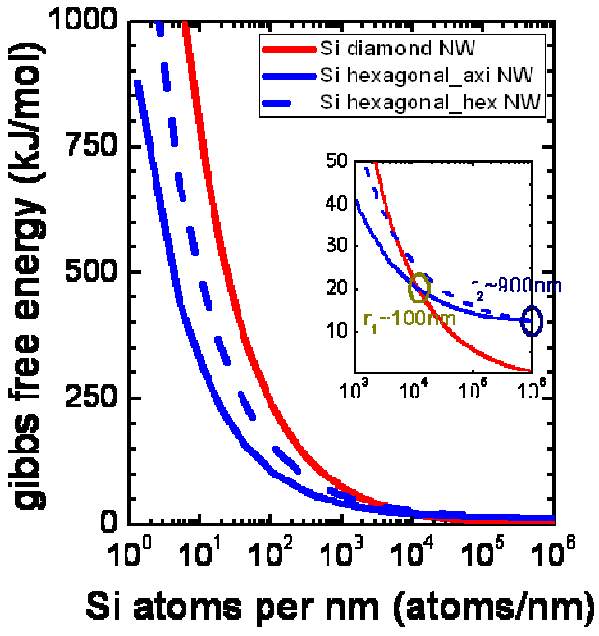

Fig. 1. Basic thermodynamic model that describes the stability of different polymorphs in Si-nanowires.

But this is not the only unique property of the nanowires, at the contrary nanoplatelets, nanostics, nanotrees, nanoonions and other nanothings shows us its stable surfaces.

The second important and unique fact is nano-wires are, as its name indicates, wires, and this means we can (not easily ! [3]) connect to access to its deep physics and chemistry [1,2].

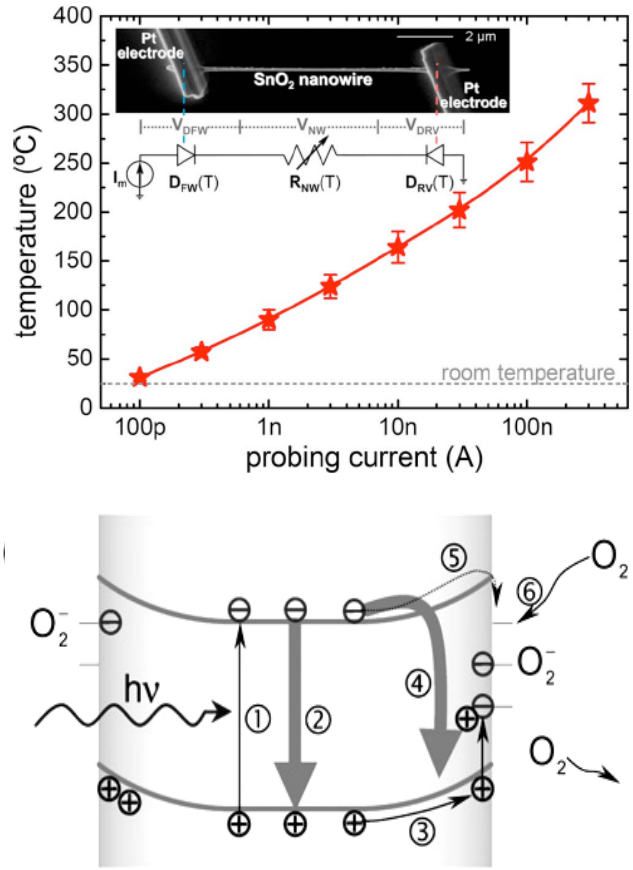

Fig. 2. Top: heating a nano-bonded nanowire using the probing current [6]. Reprinted with permission from Ref.[3]. Copyright *Appl Phys Lett* 2008, American Institute of Physics. Bottom: when some metal oxides are illuminated besides to fotogeneration (1) and radiative recombination (2), new phenomena appears: (3) accumulation of charge, (4) oxygen-assisted surface recombination and adsorption of oxygen (6) assisted by thermally stimulated electrons (5).

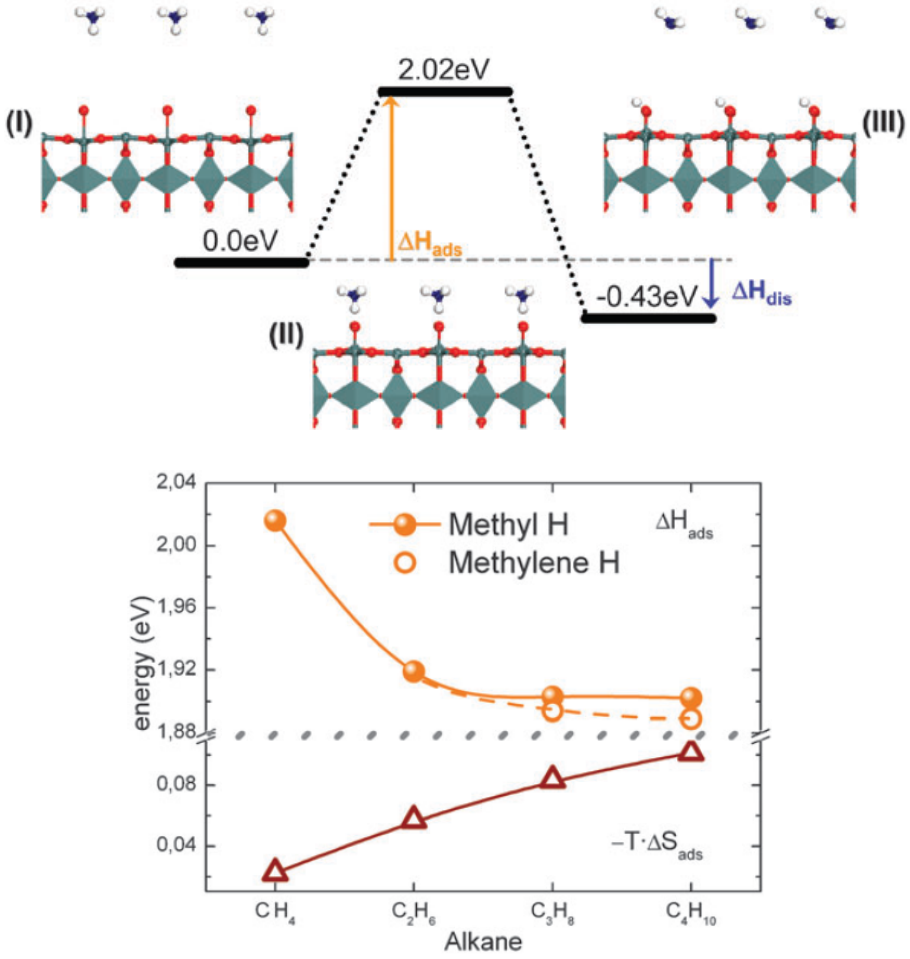

Fig. 3. Chemical absorption is an important features of metal oxide NW. Top image show the schematic representation of of the atomistic models of chemisorption and the energy profile. Bottom, ab initio (DFT) computation of the enthalpy dissociation barrier as function of alkane chain length [3]. Reprinted with permission from Ref.[2]. Copyright *Phys. Chem. Chem. Phys.* 2009, The Royal Society of Chemistry.

In this paper we present, trough our systematic research in the last 4 years, an approach to the understanding of surface phenomena taking advantage of wonderful surface laboratories such as nanowires, that allow interactions (light, matter) while electrically probing.

We can learn from surfaces that they are important at the nanoscale, even are responsible of phase change [1], mater exchange [2] (fig 3) or luminescence levels when they exchange matter [3], or electron-hole separation [4]. The question is how easy was to test all this features of surfaces in nanowires and how difficult would be to test in real surface!

References:

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[3] Ultralow power consumption gas sensors based on self-heated individual nanowires, J.D. Prades, Appl. Phys. Lett. 93 (2008) 123110-3

[4] Defect study of SnO_2 nanostructures by cathodoluminescence analysis: Application to nanowires, J. D. Prades et al, Sensors and Actuators B 126 (2007) 6–12