A nontrivial behavior of the resonant tunneling current along the tip-sample distance on semiconductor surfaces.

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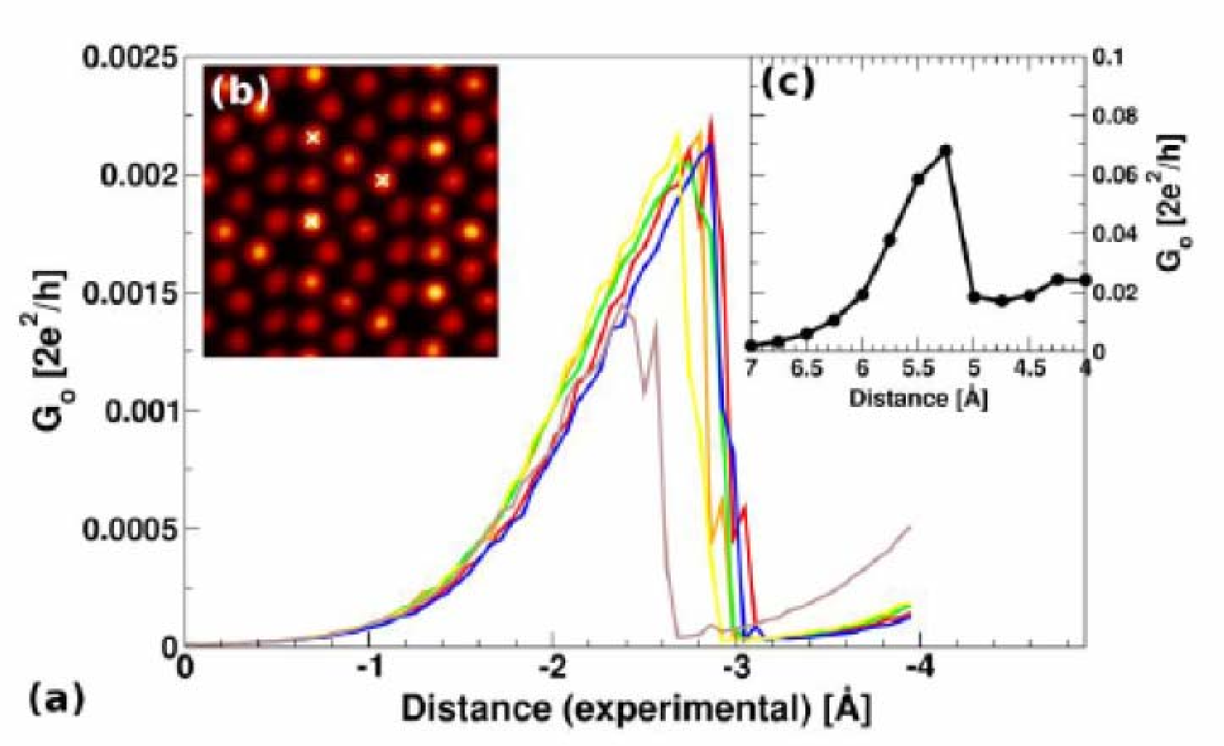
Resumen

While standard as Scanning Probe Microscope (SPM) image procedures operate mostly at so called the tunneling regime, more and more applications take place in the near-to-the contact regime (see e.g. [1]). Extensive experimental and theoretical studies of the transition regime for different metallic surfaces [2] have been performed in the last years. In general, all these works confirmed the intuitive picture of the increase of the tunneling current with the reduction of the tip-sample distance showing the exponential shape of current curves. In this work, we combine STM measurements, first principle DFT total energy methods and calculations of the electron currents based on Green's function techniques [3] to clarify the mechanism of the resonant tunneling through 'dangling bond' states of Si adatoms on the Si(111)-(7x7) surface. We show that the commonly accepted assumptions about the above discussed behaviour of the tunneling current is violated in the case of a resonant tunneling processes on semiconductor surfaces [4]. In the near to-contact regime, a substantial decrease of the tunneling current, almost to zero, is both experimentally (see Fig. 1) and theoretically (see inset Fig.1) observed. As we demonstrate here, this effect is driven by the substantial modification of surface 'dangling bond' states due to the short range chemical interaction between the tip apex atom and the surface adatom [5].

Referencias:

[1] W. A. Hofer, A. S. Foster, and A. L. Shluger, Rev. Mod. Phys. 75, 1287 (2003)
[2] W.A. Hofer and A.J. Fisher, Phys. Rev. Lett. 91, 036803 (2003)
[3] J.M. Blanco et al, Phys. Rev. B 70, 085405 (2004)
[4] P. Jelínek, M. Švec, P. Pou, R. Pérez and V. Cháb, Phys. Rev. Lett. (submitted)
[5] Y. Sugimoto et al, Phys. Rev. B 73, 205329 (2006)

Figuras:



0.0025
0.002
0.0015
0.001
0.0005
0
G_o [2e^2/h]
(b)
(c)
0.1
0.08
0.06
0.04
0.02
0
7
6.5
6
5.5
5
4.5
4
Distance [Å]
G_o [2e^2/h]
0
-1
-2
-3
-4
(a)
Distance (experimental) [Å]