ELECTRONIC PROPERTIES OF VICINAL BISMUTH SURFACES: Bi(114)

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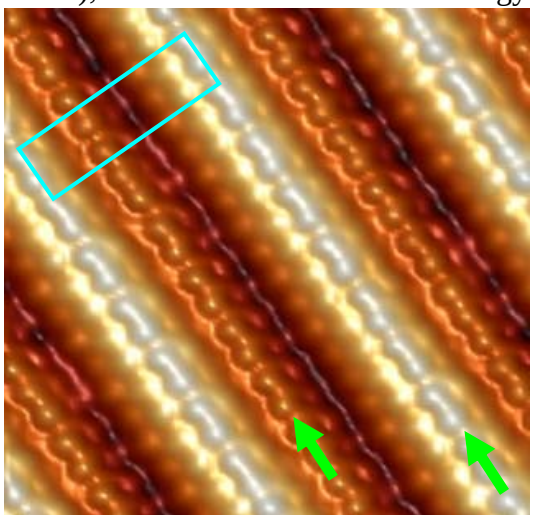
The electronic structure of low-index surfaces of bismuth has been intensively studied in the last years due to the large spin-orbit coupling induced splitting of their surface state bands [1, 2]. The resulting spin-non-degenerate surface bands undergo profound changes in their dispersion and therefore in the Fermi surfaces. This effect has been reported for various systems [3, 4], but the case of bismuth is of particular interest as it is a semimetal; the electronic contribution of Bi surface state bands is prominent at the Fermi energy compared to the bulk one. Moreover, the spin-orbit splitting of bismuth surface bands is by far the strongest reported so far (1.5eV) for pure metals. In summary, Bi surfaces turn out to be an ideal playground to study spin dependent phenomena on non magnetic systems.

In this work we focus on the vicinal surface Bi(114) investigated by means of ultra-high-vacuum low-temperature scanning tunneling microscopy (UHV-LT-STM) at 5K. Concerning the structure of the Bi(114) we find that the surface presents a complex reconstruction involving up to four atomic layers and several missing rows. The unit cell of such a reconstruction is 3nm x 1.4nm. We observe an atomic dimerization at the step edges (along the green arrows in the image). Its origin could be related to a Peierls instability at low temperatures [5]. Such kind of metal-insulator transitions in 1D structures takes place as a result of a band gap opening up at the Fermi energy due to a geometrical distortion of the regular array, increasing the unit cell length (dimerization in our case); the decrease in electronic energy outweighs the increase in lattice energy.

In order to study the electronic structure of the reconstruction and to investigate the origin of the atomic dimerization we have performed scanning tunneling spectroscopy (STS) measurements. High resolution I/V spectra acquired on the upper and bottom chains of dimers unveil the presence of a gap in the energy of states around the Fermi level. These results support the occurrence of a Peierls transition.



Atomic resolved STM image of the Bi(114) reconstruction acquired at 5K. The dimerization can be clearly observed on along the atomic rows marked by green arrows. Unit cell depicted in blue. Tunneling parameters: Size 8.2x8.2nm^2, V = 0.2V , It = 0.26 nA.

References:

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