One dimensional metallic phase and Peierls instability of In linear chains on a Si(111) Surface

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Abstract

One dimensional (1D) metallic systems are important for their exotic physical properties and readily tractable theoretical models. Up to now, very few materials have been shown to have quasi-one dimensional properties. Recently, we found that the 4×1 In overlayer on the Si(111) surface, which forms a linear-chain structure, has 1D metallic bands and undergoes a metal-insulator phase transition at ~ 130 K [1]. The resulting ground state was shown to be a "4×2" phase with periodic doubling along the linear chains as shown in low-temperature STM and LEED/RHEED data [1]. This finding is thought to provide a completely new type of 1D Peierls systems composed of well-ordered metallic chains on a solid surface.

In order to verify that this phase transition is due to a Peierls instability, we have measured the Fermi contours and surface bandstructures in detail for the room temperature 4×1 phase. The experiments were conducted on the photoemission end station of the ALS undulator beam line 7.0.1. The Fermi contours obtained from the 4×1 phase (see figure) show three electron pockets centered on the X point of the surface Brillouin zone. One of these three bands crosses the Fermi level at the zone center (middle of the Γ-X line) and has a virtually ideal one-dimensional Fermi contour, which gives a perfect nesting condition for the $4 \times 1 \rightarrow 4 \times 2$ Peierls transition. Detailed discussion of the data including those from the preliminary low temperature measurements will be presented.

[1] H. W. Yeom et al., Phys. Rev. Lett in press.

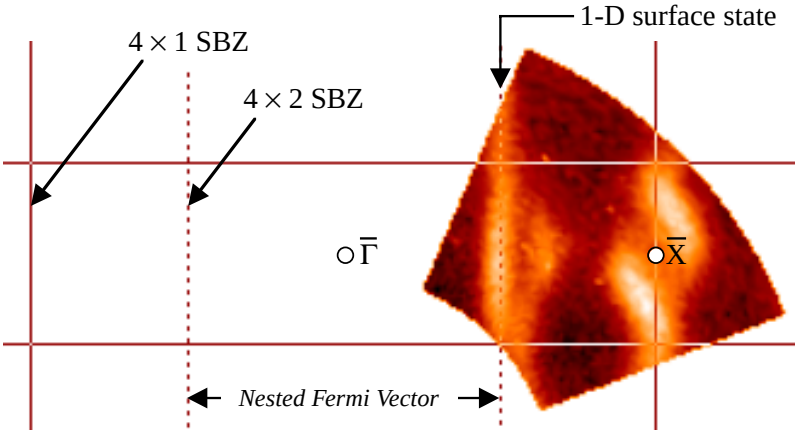

Figure. Fermi level intensity map of the 4×1 reconstruction acquired at room temperature for part of the surface Brillouin zone (SBZ) (solid lines). Surface state crossings appear as light features. For comparison, the low-temperature 4×2 SBZ is also indicated (dashed lines).

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