

2次元トポロジカル絶縁体 AlSb/InAs/GaSb/AlSb ヘテロ構造の 断面 STM/STS 観測

X-STM/STS study of 2D-topological insulator AlSb/InAs/GaSb/AlSb hetero-structures

○安藤 達人¹、加来 滋¹、吉野 淳二¹(1. 東工大院理工)

○Tatsuhito Ando¹, Shigeru Kaku¹, Junji Yoshino¹ (1.Tokyo Tech., Dept. Phys.)

E-mail: ando.t.ak@m.titech.ac.jp

Two-dimensional topological insulators (2D-TI) are a novel class of materials which are insulating in the bulk with unique one-dimensional(1D) channels at the edge. These 1D edge states are helical, namely the spin and the momentum directions locked to each other, and therefore are protected from backscattering. HgTe/CdTe[1] and InAs/GaSb[2] quantum well(QW) systems are known as 2D-TI. Especially, the InAs/GaSb QW system attracts much attention because of its fairly large energy gap. At appropriately designed well thickness of this system, the InAs conduction band and the GaSb valence band are anti-crossed and inverted at the hetero-interface to open hybridized mini-gap and helical edge channels are expected to form. These edge channels have been confirmed by electric measurements[3]. In this report, we report on scanning tunneling microscopy/spectroscopy(STM/STS) observations of InAs/GaSb heterojunctions.

We calculated electronic band structures by a 8-band $k \cdot p$ model, shown in Fig. 1. Figs. 1(a) and (b) represents bulk states and edge states around mini-gap, respectively. In order to confirm the electronic states at InAs/GaSb interfaces by STM/STS measurements, we have prepared a QW sample, AlSb(10nm)/InAs(12nm)/GaSb(9nm)/AlSb(10nm), by molecular beam epitaxy on a n-doped InAs (001) substrate. The samples cleaved in UHV are observed by a low temperature ($< 78\text{K}$) STM system with a W-tip in UHV ($< 2 \times 10^{-10}\text{Torr}$). Figs. 2(a) and 2(b) show typical STM and STS image of cleaved surface over an InAs/GaSb hetero-structure, respectively. Fig. 2(c) shows line profiles of STS images obtained at various sample biases. In the presentation, we will make a comparison between calculated local density of states profiles and STS profiles including edge states at the energy around hybridized mini-gap.

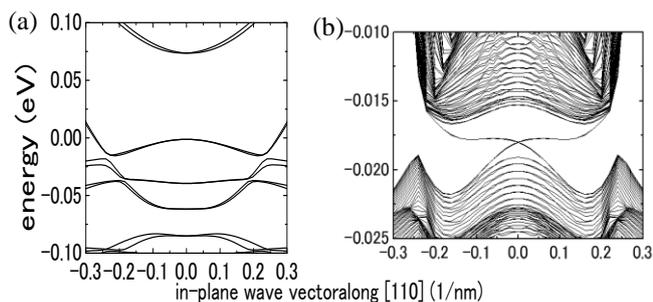


Fig. 1 Electric band structures (a)in bulk. (b)at surface including edge states.

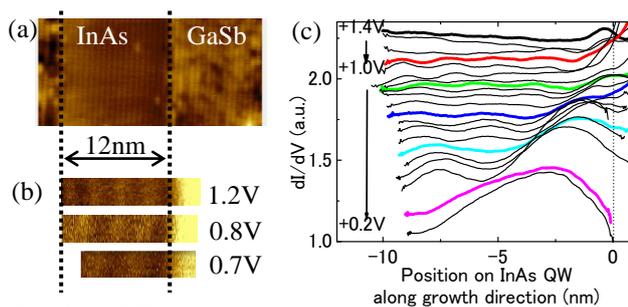


Fig. 2 (a)STM topographic image and (b)STS images of the AlSb/InAs/GaSb/AlSb hetero-structure.

(c) Line profiles of (b).

References

- [1] M. Konig et al. Science **318**, 766 (2007).
- [2] C. Liu et al., Phys. Rev. Lett. **100**, 236601-1 (2008).
- [3] I. Knez et al., Phys. Rev. Lett. **107**, 136603 (2011).