STM/STS study on film thickness depending electronic states in α-Sn/InSb(001)

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Recently, localized states formed at the interface between two materials having different topology, which are called topological insulators, have got a lot of attention. α-Sn (gray tin) under compressive strain is a strong topological insulator [1][2],while that under tensile strain is a Weyl semimetal phase [3]. Multiple topological nature of α-Sn is to be the material essential. In this study, we study film thickness depending electronic states in α-Sn by STM/STS techniques. Simultaneously we have made electronic structure calculation in α-Sn thin films based on tight-binding (TB) model using the TB parameters given by S. Küfneret[4]. Figure 1 shows the electronic structure in a 84ML-α-Sn thin film with 0.23% compressive strain. In the calculation surfaces are terminated by hydrogen to remove the trivial surface states. The point surrounded by the red circle is Dirac point and the black dashed lines guide Tss-derived bands.

We prepared clean InSb(001) surface by several cycles of Ar spattering and thermal annealing in a ultrahigh vacuum (Fig 2(a)). Alpha-Sn thin films grown on the InSb(001) surface by molecular beam epitaxy(MBE) with a growth rate of 4ML/h at room temperature. The surface of Sn films (Fig 2(b)) was observed by scanning tunneling microscopy/spectroscopy (STM / STS) at 78K. In the presentation, we will discuss on thickness depending electronic states in α-Sn by comparing STM/STS data and local density of states obtained by electronic structure calculation.

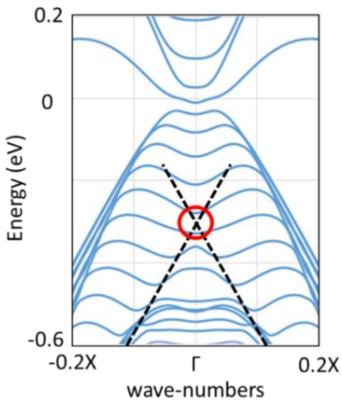

Fig. 1 Calculated band structure along [100] for the slab of 84 Sn layer. The black dashed lines guide TSS-derived bands. The Dirac point is indicated by red circle.

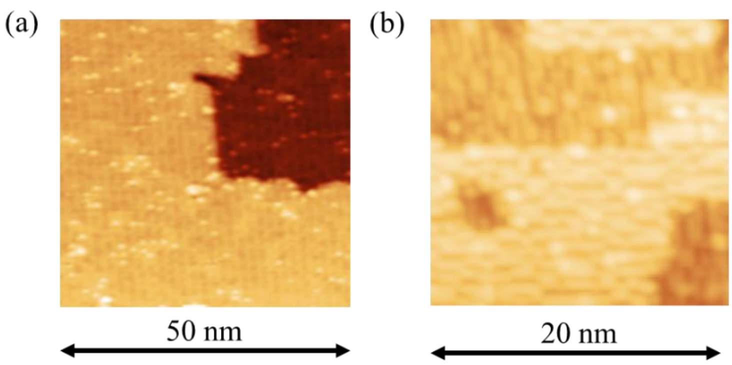

Fig. 2 STM images of InSb(a) and Sn thin film(b) surface

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[2] A. Barfuss, et.al, Phys. Rev. Lett **111**,157205(2013).
[3] D. Zhang, et. al, Phys. Rev. B **97**, 195139 (2018).
[4] S Küfner et .al, Phys. Rev. B **90**,125312(2014).