Mn 添加 AlSb/InAs/GaSb/AlSb ヘテロ接合における 量子異常ホール効果の電子構造計算

Quantum anomalous hall effect calculation in mgnetically-doped AlSb/InAs/GaSb/AlSb heterojunction

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The quantum anomalous Hall effect (QAHE) is quantized version of anomalous Hall effect(AHE). Since QAHE can be realized without using an external magnetic field, recently it obtains much attention to use in energy saving devices. Various predictions such as HgTe/CdTe, InAs/GaSb have been made, but a few QAHE has confirmed experimentally. Experimental observation of QAHE firstly conducted by doping Cr into $(Bi,Se)_2 Te_3$. However it is difficult to make practical use because its observation was at around 30mK [1]. Then, we focus on Mn doped InAs / GaSb which is predicted to be QAHE at relatively high temperature (~ 30K) compared with any other conventional QAHE systems.[2] We performed electronic structure calculation for the first step to understand this systems and clearly show the edge state.

We calculated electronic band structures by k・p 8 band model. Considering that this is QW-sandwiched and periodic structure, the wave function can be expanded in plane waves in z direction. Using effective mass approximation, we calculated the spatial distribution of the wave function by determining the coefficient of each plane wave and then we got electronic structure. We set AlSb 9nm / InAs 6nm / GaSb 9nm to open a band gap, and here we doped Mn 3-4% to make inverted band. Then we got bulk state (Fig2(left)). After that, we introduced insulator next to InAs/GaSb to calculate edge state (Fig1). We successfully obtained the edge state (Fig2(right)).

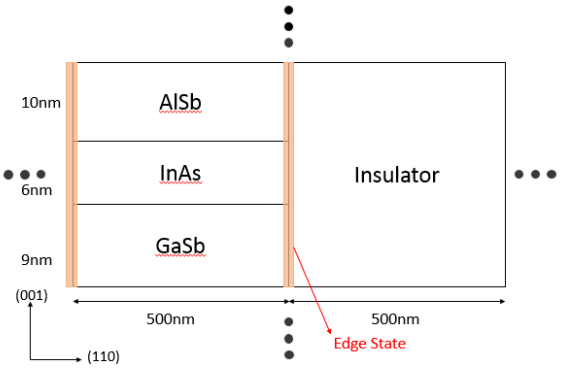

Fig1. Introducing insulator next to Quantum wall of InAs/Gasb

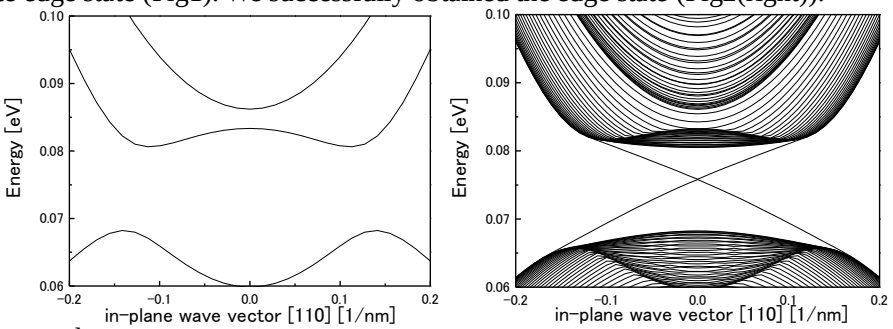

Fig2. Electronic structure of one dimensional version (left) two dimensional version (right)

Reference

[1]Science, 340 6129 CZ Chang et al.,

[2]Phys.Rev.Lett. 113, 147201 Qing-Ze Wang et al.,