

TOKUMOTO LAB.

Physical properties of layered materials

Department of Materials and Environmental Science



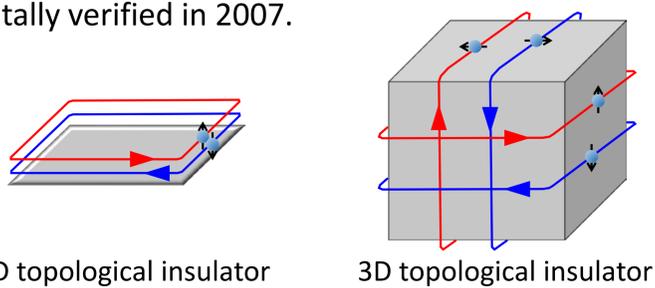
Nanostructure Materials Science

Department of Materials Engineering, Graduate School of Engineering

<http://www.tokumoto.iis.u-tokyo.ac.jp>

◆ Topological insulator

Topological insulators are quantum materials that have a bulk band gap as an ordinary insulator but have protected metallic conducting states on their edge/surface. Topological insulators were first predicted in 2005, and have been experimentally verified in 2007.

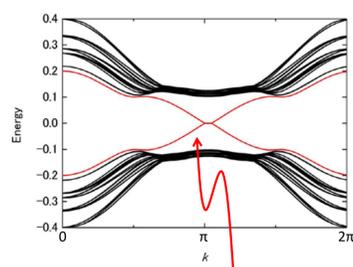
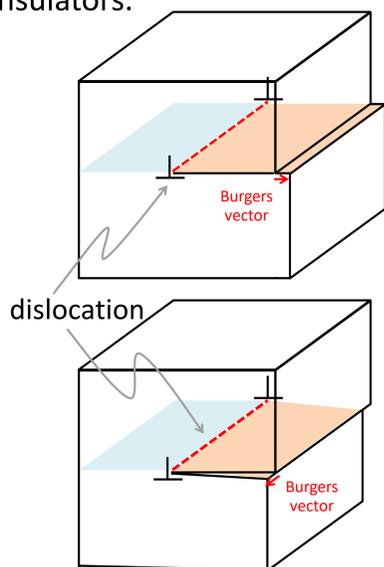


Metallic edge/surface states

- helically spin-polarized
- massless Dirac fermions
- robust against nonmagnetic disorder

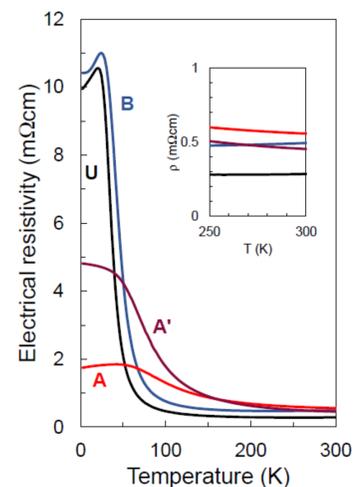
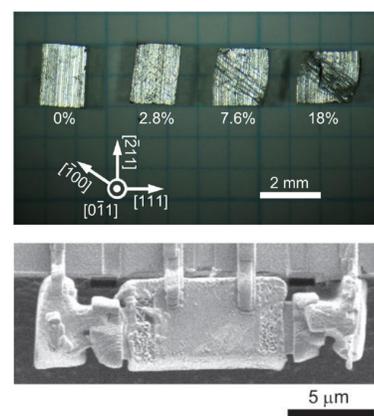
◆ Dislocations in topological insulators

In 2009, it has been theoretically predicted that the metallic states also occur along dislocations in 3D topological insulators.



Metallic states localized along dislocations in topological insulators

Experimental verification of dislocation conduction in Bi-Sb topological insulator

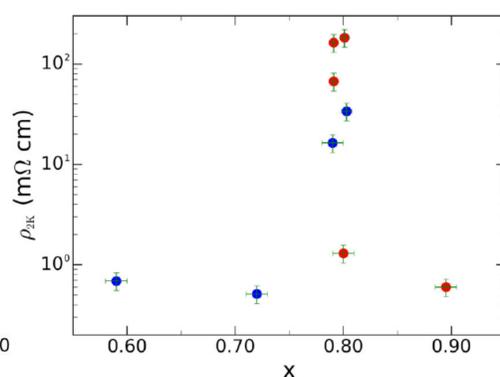
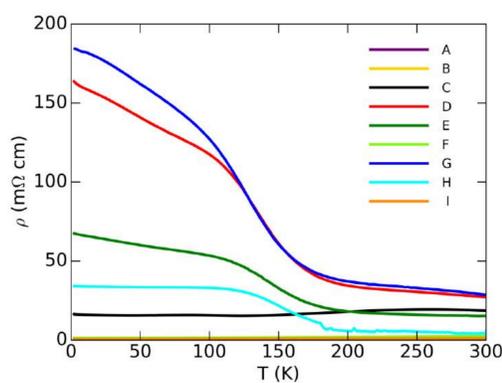


H. Hamasaki et al., *J. Phys. Soc. Jpn.*, **89** (2020) 023703.

◆ Enhancing bulk insulation of topological insulators

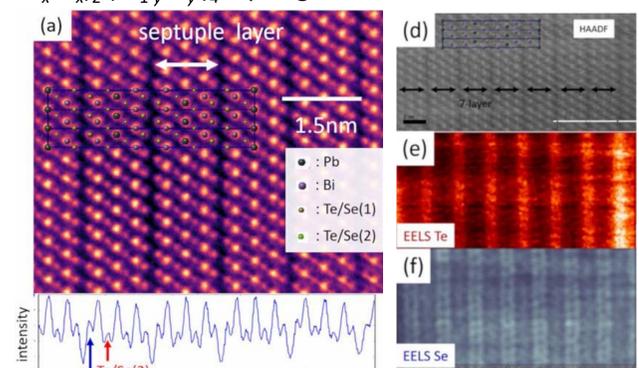
One of the most urgent tasks in the field of topological insulators is to achieve a bulk-insulating state, which is a prerequisite for the study of characteristic surface or dislocation transport phenomena.

Optimizing composition of $Pb(Bi_{1-x}Sb_x)_2Te_4$ topological insulator to achieve a bulk-insulating state



Y. Hattori et al., *Phys. Rev. Mater.*, **1** (2017) 074201.

Direct observation of Te/Se ordering, which is a key structure to achieve lower bulk conduction, in $Pb(Bi_{1-x}Sb_x)_2(Te_{1-y}Se_y)_4$ topological insulator.



Y. Hattori et al., *Sci. Rep.*, **10** (2020) 7957.

