Mott Insulator and Spin Hall Insulator: Elucidating the Physics of Nontrivial Insulators

Yoichi Ando
(Osaka University, Institute of Scientific and Industrial Research, Professor)

【Outline of survey】

Insulators are attracting renewed interests. For example, when carriers are doped to Mott insulators where electric current cannot flow due to strong electron correlations, “colossal effects” such as high-temperature superconductivity or colossal magnetoresistance could show up, but the essential physics of the carrier doping to Mott insulators is still not well understood. Also, it has been predicted that in some insulators where the spin-orbit interaction opens the gap, spin current is induced by electric fields without any charge current. Such materials are called spin Hall insulators and they may play an important role in future spintronics; however, the predicted effect has not been confirmed.

In this project, we experimentally address two fundamental questions, “*How* the Mott insulators transform into a metal upon carrier doping” and “Whether the spin Hall insulators exist at all”, by taking advantage of the elaborate techniques for high-quality crystal growth, precise doping control, and ultra-low-temperature experiments, which the PI has developed in his past research.

【Expected results】

The problem of doping a Mott insulator is one of the unsolved fundamental problems in the condensed-matter physics, and the present research is expected to give a clue to its solution. In particular, by elucidating the essence of the electronic state in doped cuprates where the high-temperature superconductivity shows up, a firm basis for understanding the superconductivity mechanism will be established. The experiments of the spin Hall insulators will deepen our understanding of the “intrinsic” spin currents which originate from band-structure characteristics; furthermore, new methods for controlling and detecting spin current will be developed during the course of this research.

【References】

・Mobility of the Doped Holes and the Antiferromagnetic Correlations in Underdoped High-Tc Cuprates, Y. Ando et al., Phys. Rev. Lett. 87 (2001) 017001.
・Electrical Resistivity Anisotropy from Self-Organized One-Dimensionality in High-Temperature Superconductors, Y. Ando et al.,, Phys. Rev. Lett. 88 (2002) 137005.

【Term of project】 FY2007－2011	**【Budget allocation】 13,800,000 yen** (2007 direct cost)
【Homepage address】	http://www.sanken.osaka-u.ac.jp/labs/fmc/