Charge-current induced spin polarization in BiSbTeSe$_2$ topological insulators

Fan Yang,$^1,*$ Subhamoy Ghatak,$^1$ A. A. Taskin,$^1$ Yoichi Ando,$^1$ Yuichiro Ando,$^2$ Masashi Shiraishi,$^2$ Kouji Segawa,$^3$ Yasushi Kanai,$^3$ Kazuhiko Matsumoto,$^3$ Achim Rosch$^4$

$^1$Institute of Physics II, University of Cologne, Zuelpicher Strasse 77, 50937 Koeln, Germany
$^2$Department of Electronic Science and Engineering, Kyoto University, Katsura, Nishikyo-ku, Kyoto 615-8510, Japan
$^3$Institute of Scientific and Industrial Research, Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
$^4$Institute of Theoretical Physics, University of Cologne, Zuelpicher Strasse 77, 50937 Koeln, Germany

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Abstract

The surface states of 3D topological insulators (TIs) possess a helical spin texture in which the spin and momentum are perpendicularly locked to each other. Due to this spin-momentum locking, a net spin polarization can be induced by a charge current and vice versa. However, topological surface states are expected to give rise to only one type of spin polarization for a given current direction, which has been a limiting factor for spin manipulations. In this talk we report that in devices based on the bulk-insulating topological insulator BiSbTeSe$_2$, two different kinds of spin polarizations were observed in different devices: The spin polarization expected from the topological surface states was detected in a heavily electron-doped device, whereas the opposite polarization was reproducibly observed in devices with low carrier densities [1]. We propose that the latter type of spin polarization stems from topologically-trivial two-dimensional states with a large Rashba spin splitting, which are caused by a strong band bending at the surface of BiSbTeSe$_2$ beneath the ferromagnetic electrode used as a spin detector. This finding paves the way for realizing the “spin transistor” operation in future topological spintronic devices.

References


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