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Topological Insulators from a Chemist's Perspective

Lukas Müchler,^[a] Haijun Zhang,^[b]
Stanislav Chadov,^[a] Binghai Yan,^[a]
Frederick Casper,^[c] Jürgen Kübler,^[d]
Shou-Cheng Zhang,^[b] and Claudia Felser*^[a,c]

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Topological insulators are formed out of heavy atoms and host special surface or edge states. The electronic structure is characterized by a Dirac cone within a bulk band gap (see Figure 1) that is generated by strong relativistic effects. A chemist's perspective in terms of bonds, bands, symmetry, and nuclear charge is provided.

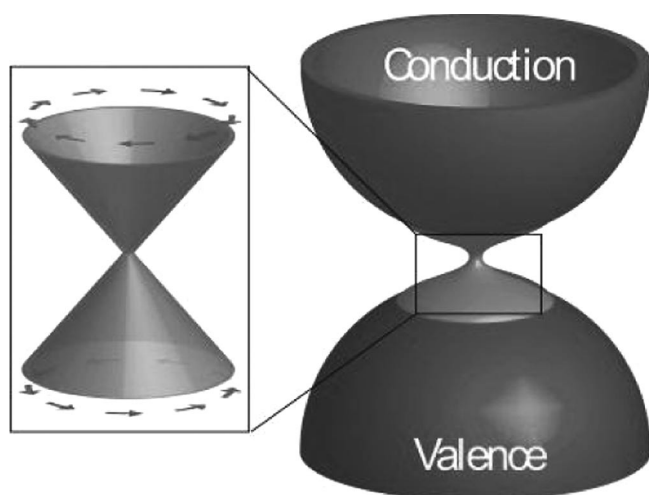


Figure 1. Generic band structure of a topological insulator. A Dirac cone with a chiral spin structure exists within the bulk band gap.^[1]

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* Prof. Dr. C. Felser
E-Mail: felser@cpfs.mpg.de

[a] Institute for Inorganic and Analytical Chemistry, Johannes Gutenberg University of Mainz, 55128 Mainz, Germany

[b] Department of Physics, McCullough Building, Stanford University, Stanford, CA 94305-404531, USA

[c] Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany

[d] Institut für Festkörperphysik, Technische Universität, Karolinenplatz 5, 64289 Darmstadt, Germany

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Synthesis of PbBiO₂Br Nanoparticles

Stephan Dankesreiter^[a] and Arno Pfitzner*^[a]

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PbBiO₂Br is a promising substitute for the UV light active photocatalyst TiO₂. With its band gap of about 500 nm^[1], organic synthesis can be photo-catalyzed using visible light.^[2] Bulk PbBiO₂Br prepared via solid state chemistry showed already good photocatalytic results using visible light.^[3] Nanoparticles of this material are expected to increase the catalytic activity because of a significantly increased specific surface area. PbBiO₂Br nanoparticles were prepared by dispersing Pb(OAc)₂·3H₂O, Bi₅O(NO₃)₄(OH)₉ and NaBr in ethylene glycol (EG) or H₂O, resp. After heating at various temperatures, white dispersions turned yellow. Dry powders were analyzed by UV-Vis absorption, BET absorption, XRD and TEM imaging. Particles prepared in EG showed large specific surface areas, blue shift of light absorption and broad reflections in XRD patterns. Particles prepared in aqueous dispersions are larger in size. But here also larger specific surface areas, broad reflections in XRD and a blue shift of light absorption is observed. TEM images of these powders showed aggregates of flake-like particles. With this route, it was possible to synthesize the first quaternary semiconductor nanomaterial.

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* Prof. Dr. A. Pfitzner

E-Mail: Arno.Pfitzner@chemie.uni-regensburg.de

[a] Institut für Anorganische Chemie, Universität Regensburg, Universitätsstraße 31, 93040 Regensburg, Germany