TcSUH Special Seminar

Chalcogenide-type Nanostructures: Topological Insulator Nature Versus Thermoelectric Performance

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ABSTRACT:
In this presentation we challenge the interconnection between thermoelectric performance and topological insulator nature of chalcogenide-type materials. While topological surface states seem to play a minor role in the thermoelectric transport in bulk materials [1], it will be shown that they severely contribute to the transport in nanostructures due to their high surface-to-volume ratio [2-4]. Specifically, thermoelectric and magnetotransport experiments on ALD-grown Sb_2Te_3 thin films as well as on VLS-grown Sb_2Te_3 and Bi_2Te_3 nanowires are presented and the results of which are interpreted using thermoelectric transport calculations [5]. In all systems investigated, the maximum TE performance converges towards the maximum TE performance of the surface states with decreasing system size into the nanometer-range, limiting their application in efficient thermoelectric devices.

BIO:
Professor Nielsch received his Ph.D. degree from the Max Planck Institute of Microstructure Physics in 2002. After completion of the Ph.D. program, he worked as a Postdoctoral Associate at the MIT, Department of Materials Science and Engineering for a short period. From 2003 to 2007, he was a Project Leader of the BMBF Nanotechnology Research Group: "Multifunctional Nanowires and Nanotubes" at the Max Planck Institute of Microstructure Physics, Halle, Germany. From 2007 to 2015, he was a W2-Professorship of Experimental Physics at the Institute of Applied Physics, University of Hamburg. Currently, he is Director of the Institute of Metallic Materials and W3-Professor of Metallic Materials and Metal Physics at Technische Universität Dresden.

In 2012, he was an Editor in Chief of the IOP journal "Semiconductor Science and Technology". In 2011, he was acknowledged as one of the world's top 100 materials' scientists of the last decade (2000-2010) by Thomson Reuters/Web of Science. In 2006, he received a research Prize for Basic Research of the State Saxony-Anhalt.

[1] Kornelius Nielsch, Julien Bachmann, Johannes Kimling, and Harald Böttner, "Thermoelectric Nanostructures: From Physical Model Systems towards Nanograined Composites", *Adv. Eng. Mater.* **1**, 713-731 (2011).
[2] Bacel Hamdou, Johannes Gooth, August Dorn, Eckhard Pippel, and Kornelius Nielsch, "Aharonov-Bohm oscillations and weak antilocalization in topological insulator Sb_2Te_3 nanowires", *Appl. Phys. Lett.* **102**, 22110 (2013).
[3] Bacel Hamdou, Johannes Gooth, August Dorn, Eckhard Pippel, and Kornelius Nielsch, "Surface state dominated transport in topological insulator Bi_2Te_3 nanowires", *Appl. Phys. Lett.* **103**, 193107 (2013).
[4] Johannes Gooth, Bacel Hamdou, August Dorn, Robert Zierold, and Kornelius Nielsch, "Resolving the Dirac cone on the surface of Bi_2Te_3 topological insulator nanowires by field-effect measurements", *Appl. Phys. Lett.* **104**, 243115 (2014).
[5] Johannes Gooth, Jan Goeran Gluschke, Robert Zierold, Martin Leijnse, Heiner Linke, Kornelius Nielsch, "Thermoelectric performance of classical topological insulator nanowires", *arXiv:1405.1592* (2014).

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