TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

OPTIMAS light-spin-matter

EINLADUNG ZUM SONDERSEMINAR
IEEE Magnetics Society Distinguished Lecture

Freitag, 11.10.2019, um 10:30 Uhr
Raum 46-387/388

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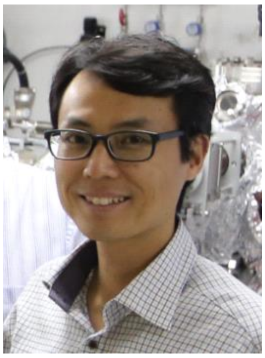
Spin-Orbit Technologies: From Magnetic Memory to Terahertz Generation

Spintronic devices utilize an electric current to alter the state of a magnetic material and thus find great applications in magnetic memory. Over the last decade, spintronic research has focused largely on techniques based on spin-orbit coupling, such as spin-orbit torques (SOTs), to alter the magnetic state. The phenomenon of spin-orbit coupling in magnetic heterostructures was also recently used to generate terahertz emission and thus bridge the gap between spintronics and optoelectronics research.
I will introduce the basic concepts of SOTs, such as their physical origin, the effect of SOTs on a magnetic material, and how to quantitatively measure this effect [1,2]. Next, I will discuss the latest trends in SOT research, such as the exploration of novel material systems like topological insulators and two-dimensional materials to improve the operation efficiency [2,3]. Following this, some of the technical challenges in SOT-based magnetic memory will be highlighted [3]. Moving forward, I will introduce the process of terahertz generation in magnetic heterostructures [4], where the spin-orbit coupling phenomenon plays a dominant role. I will discuss the details of how this terahertz emission process can be extended to novel material systems such as ferrimagnets [5] and topological materials [6]. The final section will focus on how the terahertz generation process can be used to measure SOTs in magnetic heterostructures, thus highlighting the interrelation between terahertz generation and the SOTs, which are linked by the underlying spin-orbit coupling.

[1] X. Qiu et al., "Characterization and manipulation of spin orbit torque in magnetic heterostructures" *Adv. Mater.,* **30**, 1705699 (2018).
[2] Y. Wang et al., "FMR-related phenomena in spintronic devices" *J. Phys. D: Appl. Phys.,* **51**, 273002 (2018).
[3] R. Ramaswamy et al., "Recent advances in spin-orbit torques: Moving towards device applications" *Appl. Phys. Rev.,* **5**, 031107 (2018).
[4] Y. Wu et al., "High-performance THz emitters based on ferromagnetic/nonmagnetic heterostructures" *Adv. Mater.,* **29**, 1603031 (2017).
[5] M. Chen, et al., "Terahertz emission from compensated magnetic heterostructures," *Adv. Opt. Mater.,* **6**, 1800430 (2018).
[6] X. Wang, et al., "Ultrafast spin-to-charge conversion at the surface of topological insulator thin films" *Adv. Mater.* **30**, 1802356 (2018).

Der Gast wird betreut von Prof. Dr. B. Hillebrands
GÄSTE SIND HERZLICH WILLKOMMEN!



Hyunsoo Yang obtained the bachelor's degree from Seoul National University and the PhD degree from Stanford University. He worked at C&S Technology, Seoul; LG Electronics, San Jose, CA; and Intelligent Fiber Optic Systems, Sunnyvale, CA, USA. From 2004 to 2007, he was at the IBM-Stanford Spintronic Science and Applications Center, IBM Almaden Research Center. He is currently a GlobalFoundries chaired associate professor in the Department of Electrical and Computer Engineering, National University of Singapore, working on various magnetic materials and devices for spintronics applications. He has authored 180 journal articles, given 100 invited presentations, and holds 15 patents. Prof. Yang was a recipient of the Outstanding Dissertation Award for 2006 from the American Physical Society's Topical Group on Magnetism and Its Applications and the IEEE Magnetic Society Distinguished Lecturer for 2019.