

Thin-film thermoelectric devices

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In recent years, the substantially improved performance of thermoelectric (TE) materials has attracted considerable interest in studying potential applications. Micro-TE (μ -TE) modules are essential components for smart energy autonomous devices and thermally integrated photonic systems. μ -TE devices cool down when an electric current is applied and can thus manage heat locally in microelectronic circuits. Operated in generation mode, these devices can power sensors. For that, they have to be combined with up-converters and ultra-low power electronics using for instance wake-up receivers and rigorous duty cycling. However, feasible and cost-effective μ -TE device technology that is compatible with the modern semiconductor fabrication industry still provides a challenge. μ -TE devices produced by an electrochemical deposition that is compatible with semiconductor back-end fabrication and that have a free-standing metal top contact, solve these issues. They have an extremely rapid response time and high stability and reliability. However, while such μ -TE devices already provide a path towards application, their thermoelectric figure of merit is still compromised compared to bulk TE devices. Potential ways of optimization are being discussed.

Prof. Gabi Schierning

Name: Gabi Schierning

Year of birth: 1978

Academic Education and scientific degrees

1997-2002	Studies of Material Science and Engineering, University of Erlangen-Nürnberg, Germany
2005	PhD, Material Science and Engineering, University of Erlangen-Nürnberg, Germany
2016	Venia Legendi, Electrical Engineering Materials, University of Duisburg-Essen, Germany



Professional career after graduation

Since 2020	Professor for Experimental Physics, Bielefeld University, Germany
2015 – 2020	Group leader at the Leibniz-Institute for Solid State and Materials Research (IFW Dresden), Germany
2009 – 2015	Group leader of an independent Young Researcher Group at University of Duisburg-Essen, Germany
2007 – 2015	Scientist at University of Duisburg-Essen, Germany
2005 – 2007	Post Doc at the Institute of Nanoscience, Karlsruhe Institute of Technology, Germany
2005	Post Doc at Darmstadt Technical University, Germany

Awards and Distinctions

2019	ERC Consolidator Grant (European Union)
2014	Award of Innovation of the State of North-Rhine Westphalia, Germany, in the category Young Researcher
2009	Independent Young Researcher Group, awarded by the State of North-Rhine Westphalia, Germany
2003	Award of excellence for the diploma thesis by the Bavarian Ministry of Education, Germany

Some recent papers

- P. Ying, R. He, J. Mao, Q. Zhang, H. Reith, J. Sui, Z. Ren, K. Nielsch, G. Schierning, *Towards tellurium-free thermoelectric modules for power generation from low-grade heat*, **Nature Communications**, Doi 10.1038/s41467-021-21391-1 (2021).
- R. He, T. Zhu, Y. Wang, U. Wolff, J.-C. Jaud, A. Sotnikov, P. Potapov, D. Wolf, P. Ying, M. Wood, Z. Liu, L. Feng, N. Perez Rodriguez, G. J. Snyder, J. C. Grossman, K. Nielsch, G. Schierning, *Unveiling the phonon scattering mechanisms in half-Heusler thermoelectric compounds*, **Energy & Environmental Science**, 13 (12), 5165-5176 (2020).
- L. Schnatmann, K. Geishendorf, M. Lammel, C. Damm, S. Novikov, A. Thomas, A. Burkov, H. Reith, K. Nielsch, G. Schierning, *Signatures of a Charge Density Wave Phase and the Chiral Anomaly in the Fermionic Material Cobalt Monosilicide CoSi*, **Adv. Electronic Mater.** 6 (2), 1900857 (2020).
- N. Pérez, A. Chirkova, K. P. Skokov, T. G. Woodcock, O. Gutfleisch, N. V. Baranov, K. Nielsch, G. Schierning, *Electronic entropy change in Ni-doped FeRh*, **Materials Today Physics** 9, 100129 (2019).
- R. He, W. Heyn, F. Thiel, N. Pérez, C. Damm, D. Pohl, B. Rellinghaus, C. Reimann, M. Beier, J. Friedrich, H. Zhu, Z. Ren, K. Nielsch, G. Schierning, *Thermoelectric properties of silicon and recycled silicon sawing waste*, **Journal of Materiomics** 5 (1), 15 (2019).
- G. Li, J. Garcia Fernandez, D. A. Lara Ramos, V. Barati, N. Pérez, I. Soldatov, H. Reith, G. Schierning, K. Nielsch, *Integrated microthermoelectric coolers with rapid response time and high device reliability*, **Nature Electronics** 1 (10), 555 (2018).