TECHNISCHE UNIVERSITÄT WIEN

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EINLADUNG zum IFP-SEMINAR

Entering the metal age: Unlocking high thermoelectric performance in metallic alloys via inter-orbital carrier scattering

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Host: Ernst Bauer

Termin: Mittwoch, 15. Februar 2023, 16:00 Uhr

Ort: Institut für Festkörperphysik, TU Wien
Wiedner Hauptstraße 8-10, 1040 Wien
Seminarraum DC rot 07 (roter Bereich, 7. OG)

Abstract:

Thermoelectric (TE) materials seamlessly convert thermal into electrical energy and vice versa, making them interesting for applications such as power generation or cooling. An efficient TE material has a large Seebeck effect (voltage per temperature gradient) and electrical conductivity but low thermal conductivity, which is notoriously difficult to realize simultaneously.
Although historically the TE effect was first discovered in metals, they have been discarded from investigation in the past due to their small Seebeck effect. Instead, following the predictions of Abram Ioffe in the 1930s, state-of-the-art research focuses on doped semiconductors, where the TE performance is most effectively enhanced by reducing the lattice thermal conductivity, i.e., the phonon-glass electron-crystal concept [1-6].

In this talk, I will show how we achieved unprecedented TE performance in metals by tuning the electronic scattering rate. Screening simple binary transition metal alloys, we experimentally discovered ground-breaking power factors, vastly exceeding all the values reported so far for any material above room temperature. Crucially, the underlying physical mechanism responsible for the enhanced Seebeck effect is fundamentally different compared to semiconductors, where the charge carrier concentration is the decisive parameter. Our work challenges the common belief that good metals are bad thermoelectrics and presents an auspicious paradigm for achieving high TE performance through engineering electron-hole selective inter-orbital scattering. Due to their much superior functional properties, e.g., high ductility and mechanical strength, metallic alloys have a huge potential to expand the field of thermoelectric applications, especially if high-performance systems consisting of cheap and abundant elements can be identified.

[1] Nature 413, 597-602 (2001)
[2] Nature 451, 163-167 (2008)
[3] Nature 489, 414-418 (2012)
[4] Science 348, 109-114 (2015)
[5] Science 360, 778-783 (2018)
[6] Science 371, 830-834 (2021)