I. Physikalisches Institut (IA)
Physik neuer Materialien

RWTH AACHEN UNIVERSITY

I. Physikalisches Institut (IA)
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Topic for a Master Thesis

Investigating Topological Semimetals using Atom Probe Tomography

Chalcogenide-based compounds play a crucial role in numerous modern research fields, including phase change memories, photonics and spintronics. Interestingly, the group of metavalent bound phases shows a strong correlation with topological non-trivial phases. To investigate this correlation further, the first step requires the investigation of topological semimetals via atom probe tomography, as metavalent materials show a very special evaporation behavior. This becomes apparent though a high amount of so-called Multiple Events, in which multiple ions evaporate on the same laser pulse.

Atom probe tomography is a sophisticated method that combines mass spectrometry with the spatially resolved evaporation of single atoms, enabling three-dimensional characterization of features within a 100 nm sized prepared tip. It allows the determination of local stoichiometry changes at the edge of atomic resolution as well as the determination of the multiplicity.

Additionally, one of the indicators for metavalent bonding can be gathered from an acquisition. It serves as a parameter for a unique evaporation behavior known as the Probability of Multiple Events [2].

This master's thesis project aims to characterize topological semi metals using atom probe tomography to compare and classify them in respect to metavalent materials.

In the course of this thesis you will learn how to use a dual beam system consisting of Scanning Electron Microscope (SEM) & Focused Ion Beam (FIB) for the sample preparation and will be able to operate the Local Electrode Atom Probe (LEAP) independently.

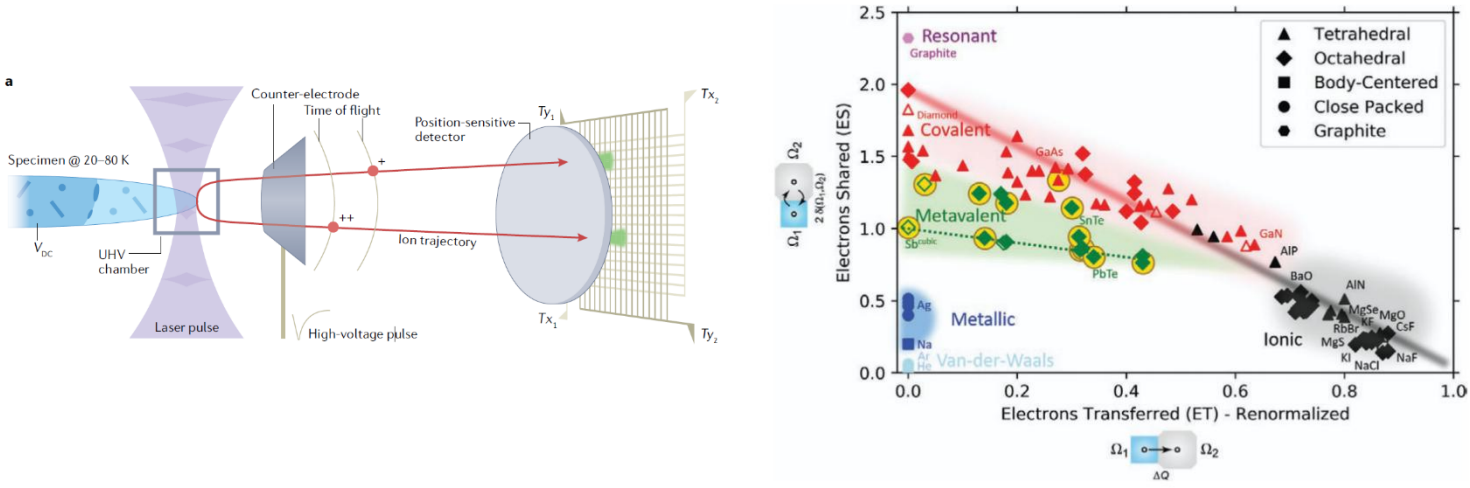

Figure 1: **A** The schematic setup of a Local Electrode Atom Probe. Using the effect of field evaporation, single atoms are evaporated and measured for its time of flight. Taken from [1]. **B** Correlation between metavalent bonding and the existence of a topological insulator phase in a map of Electrons Shared (ES) and Electrons Transferred (ET) [3].

[1] Gault et al. "Atom Probe Tomography", Nature Review Methods Primers, (2021).

[2] Cojocaru-Miredin et al. "Atom Probe Tomography: A Local Probe for Chemical Bonds in Solids", Advanced Materials, (2024).

[3] Kooi and Wuttig, "Chalcogenides by Design: Functionality through Metavalent Bonding and Confinement", Advanced Materials, (2020).

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