Paul-Drude-Institut für Festkörperelektronik

Lattice dynamics in semiconductors: in-depth study by polarization angle resolved Raman spectroscopy

Background & Project Description: Raman spectroscopy has become a standard in many fields including quality control in the semiconductor or food industries, is widely used for drug or explosives screenings and finds its way into medical applications where e.g. non-invasively skin cancer tests can be carried out without taking tissue samples.
A strength of this method is to be sensitive to the symmetry of materials, i.e. the sample's (crystallographic) structure, and hence also be sensitive to changes in this material's property.
In recent years, we have been developing a method based on quantitative polarization resolved Raman scattering, capable of accessing the Raman tensor's relative numeric values, i.e. the respective scattering intensities – valuable to all investigations of properties including phononic processes (e.g. mechanical properties, heat transport, phonon mediated (hot) carrier relaxation and optical processes, …)
While this has been attempted previously by other groups, meaningfulness has been questioned as for some data was not reproducible.

The project is split into two parts: i) to finalize the finetuning of the metrology and develop a measure for its uncertainty and ii) to investigate different complex oxide-perovskites with chemical formula ABO_3, which can have phase transitions of different order (structural, spin, …). The aim of the second part is to further the understanding of the material's microscopic order, leading to macroscopic effects, such as magnetism or ferroelectricity.

The project will be accompanied by in-house DFT calculations, which may also be performed in part by the master's student.

Student's Role and Responsibilities:

- Research literature and provide summaries
- Perform diligent measurements and analysis of recorded data

Required Qualifications and Skills:

1. Good understanding of solid-state physics (requirement)
2. Sense for details and a precise way working

Opportunities and Benefits:

- Access to state-of-the-art facilities and experts in the respective fields to learn from
- Co-authorship of a scientific publication is highly likely
- Mater's students will be offered a one-year contract

Relevant Publications:

- Kranert et al., Scientific Reports 6, 35964 (2016): Raman tensor elements of β-Ga2O3
- Janzen et al., J. Mater. Chem. C, 9, 14175 (2021): Comprehensive Raman study of orthorhombic κ/ε-Ga2O3 and the impact of rotational domains

Contact Person:

Hans Tornatzky (supervision in German or English)
tornatzky@pdi-berlin.de

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For further details or clarification, please feel free to contact us. Lab tours are available for interested applicants.