Master Thesis Topic

Surface Acoustic Waves in Semiconductor Heterostructures Containing 2D Materials

Background and Motivation

There is an increasing interest in coupling the dynamic strain of surface acoustic waves (SAWs) to electrical excitations in semiconductor heterostructures containing 2D materials to acoustically manipulate their optoelectronic properties. While optical phenomena in 2D nanostructures can be conveniently mapped by photoluminescence, local probing of mechanical properties remains challenging. This task can, nevertheless, be assisted by high-frequency (GHz) SAWs, which are particularly suitable for probing very thin objects due to their micron-size wavelengths and their confinement near the surface.

Objective

The goal of this project is to spatially probe the SAW profile in semiconductor heterostructures containing 2D materials using atomic-force microscopy (AFM). The key objectives are:

1. Characterization of the efficiency of SAW transfer onto stamped 2D flakes such as BN and transition-metal dichalcogenides.
2. Exploration of the interaction between SAWs and 2D materials either stamped of epitaxial.

Methodology

The project will involve a combination of clean-room, RF characterization and AFM scanning probe techniques. The key tasks include:

1. **Sample fabrication:** Sputtering of piezoelectric films such as ZnO or AlN, and patterning of interdigital transducers (IDTs) for the excitation and detection of SAWs. Transfer of 2D flakes.
2. **RF characterization of SAW resonators:** Measurement of the reflection and transmission coefficients of the IDTs.
3. **SAW imaging using AFM:** spatial mapping of the SAW profile in the substrates and 2D materials.

Expected Outcomes

The expected main results of the project are

- Fabrication of the integrated system.
- Detailed study of SAW transfer efficiency in 2D materials, mapped with AFM.
- Detection of acoustoelectric or acoustooptical effects.

Skills and Requirements

- Background in solid state physics, materials science, or related fields.
- Experience or interest in clean-room technology, electrical measurement or optical spectroscopy techniques.
- High motivation, excellent interpersonal and project management skills.

Opportunities and Benefits

- Modern labs with a wide range of experimental techniques.
- Supportive environment with experts for various scientific sub-fields.
- International and culturally diverse community.
- Location in the heart of Berlin with excellent public transport connections.
- Subsidized travel ticket.

Contact

Dr. Mingyun Yuan
+49 30 20377-503
yuan@pdi-berlin.de

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