Seminar announcement

Tuesday, July 22, 2025
1:30 am
WSI, Seminar room S 101
Exclusively in person

"Surface acoustic waves in nanostructures"

Surface acoustic waves (SAWs) are mechanical vibrations traveling along the surface of a solid. They can be envisioned as earthquakes on a chip. Celebrated for their essential part in radio-frequency telecommunication, SAW devices also play versatile roles in hybrid nanostructures thanks to their high-frequencies, affinity to the surface, and the dynamic nature of their strain fields and piezoelectric potential.

In this talk, I will present two illustrative examples of SAW control and probing in nanostructures. The first is the acoustic manipulation of excitons in GaAs/(Al,Ga)As double quantum wells, which is a promising pathway towards electromechanical control of single photon sources. The dynamic deformation caused by SAWs modulates the bandgap and creates a moving potential that captures and transports free excitons, which are electron-hole pairs bound by the Coulomb force. Additionally, isolated impurity centers are identified for the storage of single excitons. SAW-propelled "flying" excitons enable the remote pumping of these single centers. Time-resolved measurements reveal that the SAW pumping leads to a very high single-photon emission rate, desirable for quantum communication applications in quest of high data rate. This work paves the way for on-chip transfer and manipulation of single excitons, which has natural interconversion to single photons, ideal for long-range information exchange.

The second example is the determination of phonon density of states and substrate coupling in hybrid nanostructures using high-resolution atomic-force microscopy (AFM) images. They capture the vertical displacement of high frequency SAWs. Dynamic strain images of a stamped material, a multilayer hexagonal Boron Nitride (hBN) flake on piezoelectric $LiNbO_3$, show clear spatial inhomogeneities revealing local variations in adhesion quality. Images of monolayer graphene epitaxially grown on SiC and overlaid with piezoelectric ZnO thin film, in contrast, show few spatial variations and near perfect strain transfer. Furthermore, the enhanced acoustic intensity in the graphene region indicates a waveguiding effect, with graphene serving as an atomically thin acoustic waveguide. In addition to revealing sample quality, this precision mapping of the acoustic fields can effectively guide the acoustic manipulation of optoelectronic properties in low-dimensional systems such as 2D materials and nanomechanical membranes.

Through this seminar the audience will be introduced to the complex interplay of SAWs in a variety of nanostructures and the targeted exploration of optical-mechanical-electrical coupling in many different materials.

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