Nanoscale characterization and applications of hybrid heterostructures based on carbon nanotubes and two dimensional materials

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In parallel to the synthesis of such nanomaterials as layered chalcogenides, graphene and carbon nanotubes (CNT), one important component driving the progress in nanosciences is the capability to understand and correlate function, morphology and composition at the nanoscale. In this talk, I will discuss our recent progress in the characterization of graphene, carbon nanotubes, gallium selenide, and molybdenum disulfide and their combination in hybrid heterostructures towards optoelectronic applications. Developments in the research going on in the Semiconductor Physics group of Technische Universität Chemnitz will be discussed in addition to advanced methods for nanoscale characterization such as tip-enhanced Raman spectroscopy (TERS) that we had intensively pursued for the last three years.

**Figure**: Examples of our research focus in GaSe. a) Nanoscale characterization with tip-enhanced Raman spectroscopy and related techniques such as current sensing AFM and b) Kelvin probe force microscopy with and without monochromatic illumination. Strong substrate/layer interaction can induce change in stacking and phase transition like illustrated here for the GaSe bubble on HOPG visible in the c) optical image. The Raman spectroscopy analysis d) shows differences in the two regions that can be attributed to defects and phase transition. The AFM image e) shows the curved bubble region of the flake.