Epitaxial Semiconductor, Metal, and Superconductor Heterostructures for Photonic, Plasmonic, and Quantum Applications

Shangjr Gwo (果尚志)
Department of Physics, National Tsing-Hua University, Hsinchu 300044, Taiwan
*E-mail: gwo@phys.nthu.edu.tw

Epitaxy is a crystal growth method, in which crystalline layers are formed with well-defined orientations with respect to the dissimilar crystalline structures of substrates (i.e., wafers). In electronic, photonic, and optoelectronic device applications, such as transistors, light-emitting diodes, and lasers, semiconductor heterostructures (quantum wells, nanostructures, and quantum dots) formed by epitaxy have been widely deployed as the high-performance device fabrication approach. In comparison, metal and superconductor structures used for plasmonic and quantum applications are typically made via less sophisticated material deposition methods. In the past decade, we have explored tunable and excellent material properties for plasmonic and quantum applications by using crystalline metallic and superconducting epitaxial films grown by molecular-beam epitaxy. In this talk, I will highlight the results of plasmonic metasurfaces and surface-enhance Raman spectroscopy substrates based on epitaxial metal films, including silver, aluminum, and titanium nitride. Furthermore, recent results of transition-metal and group-III nitride epitaxial structures consisting of superconductors, semiconductors, and metals, will be presented. Due to their exceptional and tunable properties, these epitaxial heterostructures can play a key role for demanding photonic, plasmonic, and quantum applications.