Mechanoelectric properties and strain effects of 2D transition metal dichalcogenides

ECE Ph.D. Seminar
by
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Abstract
Mechanical energy is one of the most ubiquitous energy sources in the environments and is readily accessible from the human activities. Therefore, the conversion of mechanical energy into electricity offers an immediate, stand-alone power support for remote control systems, wearable electronics, wireless sensing and remote battery charging. Two-dimensional (2D) layered materials, such as transition metal dichalcogenides (TMDCs), have gained considerable attentions for mechanic and electronic applications. Their mechanical properties, possible applications in body movement, muscle stretching and blood vessel contraction, have attracted a great deal of interests. By using Virtual Nanolab ATK package, we investigate the strain effect on mechanic and electronic properties of MoS$_2$ and ReS$_2$ monolayer. We demonstrate novel 2D mechano-electric generators and sensors by using 2D TMDCs. PN junction and heterojunction structures are built to demonstrate significantly improved output voltage over the conventional power generators. The strain effect induced by dielectric layer on top of 2D TMDCs in field effect transistors (FETs) is also investigated. It indicates that due to the lattice mismatch, crystalized Al$_2$O$_3$ with 1.1 nm thickness can induce isotropic strain strength of 0.2% on MoS$_2$ monolayer along in-plane directions.