Ferroelectric domain walls as building blocks for next-generation nanotechnology

D. Meier

Department of Materials Science and Engineering, Norwegian University of Science and Technology (NTNU), 7034 Trondheim, Norway

Ferroelectric domain walls are excellent candidates for the development of future nanoelectronics, exhibiting a thickness that approaches the unit cell level. Similar to 2D systems such as graphene, MoS_2 single layers, and the $LaAlO_3/SrTiO_3$ hetero-interface, they display unique electronic transport properties and large carrier mobilities. In addition to their transport properties, the ferroelectric domain walls are spatially mobile and can be injected and deleted on demand, which enables them to take an active role as reconfigurable elements in, e.g., memory, diode or memristor devices.

In my talk, I will present unique features that occur at improper ferroelectric domain walls in hexagonal manganites and discuss how these walls can be used to emulate the behavior of key electronic components. For our studies, we choose the p-type semiconductor $ErMnO_3$ as it naturally develops all fundamental types of ferroelectric domain wall at room temperature, namely neutral (side-by-side) as well as negatively (tail-to-tail) and positively charged (head-to-head) wall configurations. The walls are explicitly robust and, hence, represent an ideal template onto which the desired electronic behavior can be imposed. I will show how the electronic properties can be optimized and controlled, and discuss the possibility to use such walls for designing 2D digital switches and half-wave rectifiers, bringing us one step closer to domain-wall based devices and networks for next-generation nanotechnology.