Transport and Optoelectronic Studies of Monolayer MoS$_2$ Homojunctions & Nanostructures Controlled By Ferroelectric Domain Patterning

ZHIYONG XIAO, JINFENG SONG, Univ of Nebraska - Lincoln, DAVID FERRY, Arizona State University, DAWEI LI, YONGFENG LU, STEPHEN DUCHARM, XIA HONG, Univ of Nebraska - Lincoln — Transition metal dichalcogenide (TMDC) monolayers such as MoS$_2$ have direct band gap and are promising for building nanoelectronic and optoelectronic applications. In this study, we have fabricated MoS$_2$ homo-junctions and nanostructures using the ferroelectric field effect combined with scanning probe controlled domain patterning. Monolayer MoS$_2$ field effect transistors (FETs) are fabricated on SiO$_2$/Si substrates, and a top gate of ferroelectric copolymer poly(vinylidene fluoride-trifluoroethylene) [PVDF-TrFE] are deposited using Langmuir-Blodgett approach. The extracted band mobility of our devices ranges from 1 to 10 cm$^2$V$^{-1}$s$^{-1}$ depending on the carrier density, which suggests charged impurity rather than phonon as the major scatters. Modeling the transfer characteristics in the two polarization states shows that the polarization switching does not affect the sample mobility. By patterning the top gate into half polarization up and half polarization down domains, we created a Schottky junction with a barrier height tunable by the back gate. We also create nanoscale conducting wire at the center of the channel sandwiched by two insulating regions. The optical response of the devices will be discussed.