Tailoring Ferroelectric Surfaces For Demanding Applications from the Bottom up

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Ferroelectric surfaces present unique platforms for the control of chemical reactions, in particular photocatalytic water splitting, or charge doping of 2D materials such as graphene. Our research on these topics has lead us to the understanding that surface morphology, termination and composition are equally as important as characteristics such as the magnitude of the polarization and the stability of domain structures within the artificially layered $PbTiO_3/SrTiO_3$ superlattices that we use as a high flexible and tunable ferroelectric for these applications.

In this presentation I will describe how producing the right surface for an application begins at the level of substrate preparation, continues with finely tuning the growth parameters of the $SrRuO_3$ electrodes that lies beneath the substrate and then maintaining the underlying surface through the growth of the $PbTiO_3/SrTiO_3$ superlattice and subsequent cooling of the sample.

In the context of photocatalysis we carried out a proxy reaction for photocatalytic water splitting which resulted in the deposition of Ag on active sites that can then be identified by atomic force microscopy. Comparison of the reaction on $SrTiO_3$ with spatially segregated areas of SrO and TiO_2 terminations and $PbTiO_3/SrTiO_3$ superlattices with regions that had been poled using an electrically biased AFM tip, combined with ab-initio molecular dynamics simulations, revealed important insights in to the role that termination and polarization can play in these reactions.

In the context of control of 2D materials, the morphology of the ferroelectric surface plays a critical role in achieving direct charge doping of a 2D material. When this can be achieved it is then possible to directly control the charge doping of the 2D material in a local, non-volatile and reversible fashion using an AFM tip, which we demonstrate on a $PbTiO_3/SrTiO_3$/graphene device.

Acknowledgement: This work supported by the National Science Foundation under DMR-1055413 and DMR-1334867.