Title: Exploring surface-chemistry driven effects in micro-scaled ferroelectrics

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Ferroelectric materials are polar oxides of the form ABO_3 that possess a spontaneous electric polarization which direction can be switched by applying an external electric field. The pockets of collective polarization are called domains, which switching dynamics are a key feature that largely determines ferroelectrics' functionality. Domain dynamics are driven by electrostatic boundary conditions and the polarisation of a ferroelectric domain has a significant effect on the surface properties, affecting adsorption energies, adsorption modes, and reaction rates of a variety of polar and non-polar molecules. This has led to an extensive research (experimental and theoretical) on the use of ferroelectrics for electrochemistry, where it is now well documented that the dipole moment of a polar molecule will interact with the polarization of some ferroelectric domains' surface. Moreover, polarisation gas adsorption has been demonstrated, for example, polarisation dependence on the reversible adsorption of CO_2 and CH_3OH on ferroelectric surfaces[1,2]. On the other hand, polarisation screening for different adsorbates has been also reported[3,4], providing a valuable insight into surface chemistry and screening dynamics.

The ability to manipulate dipole orientation in ferroelectric oxides holds promise as a method to tailor surface reactivity for specific applications. domain-specific surface chemistries may provide a method for fabrication of nanoscale devices.one of the most important factors determining the stability of nanoscale ferroelectricity is the compensation of polarization-induced surface charges. Incomplete screening of surface charges results in a depolarization field that opposes the bulk polarization, thus suppressing ferroelectricity

This works aims to investigate ferroelectric surface chemistry at the nanoscale with the purpose of finding tuning mechanisms for potential applications such as water splitting and catalysis. For this purpose, the project will use in-situ application of heating and atmosphere (gas) in the Transmission electron microscope. A substantial part of this project involves the development of sample preparation techniques and use of new image analysis methods. Furthermore, the project will be carried out in collaboration with world-leading advanced microscopy centres such as the Ernst Ruska-Centre (ER-C) in Germany, and leading experts in the ferroelectrics field.

Refences

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