CSU PHYSICS COLLOQUIUM

Controlling Materials at the Nanoscale with Ion Migration

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Refreshments at 3:45 PM
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Abstract

Ionic crystals play a crucial role in many well-established technologies as well as highly exotic, cutting-edge research materials. In ionic crystals, bonding between the (inter)metallic atoms and ions, such as oxygen or nitrogen, gives rise to interactions which then manifest new and interesting behaviours and control the fundamental properties of materials. Control over the ion distribution thus provides a powerful mechanism to tune the properties of these materials, including electrical and thermal conductivity, magnetism, optical, and mechanical properties. The very nature of ionic crystals - with net charges on the constituent atoms - unlocks the potential for electric field control, and thus is attractive for low-power device applications. Furthermore, ion migration is typically non-volatile, making ionic devices attractive, for example, for memory applications such as the memristor. In this talk, I will introduce the emerging field of magneto-ionics, in which the magnetic properties of materials are tuned by controlling the ionic distributions using both electric field and chemical control mechanisms. Highlighted in this work, I demonstrate control over magnetic interfaces [1] and magnetic films with bulk-like properties [2,3]. I then show that, in similar systems, the magnetism can be directly controlled using electric fields through the magneto-ionic effect [4]. Neutron scattering and x-ray spectroscopy are demonstrated as optimal tools for probing the oxygen migration and the unexpected magnetic ramifications. These works together present significant opportunities for a new class of device technologies.

[1] Gilbert *et al.*, *Nature Commun.* **7**, 11050 (2016).
[2] Grutter *et al.*, *Appl. Phys. Lett.* **108**, 082405 (2016).
[3] Gilbert *et al.*, *Under Review*
[4] Gilbert *et al.*, *Nature Commun.* **7**, 12264 (2016).