Magneto-Ionics and 3D Nanowire Networks

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Currently, the energy consumption in Information and Communications Technologies already accounts for over 10% of the world's total energy usage and is projected to exceed 20% by 2030. The energy efficiency in today's electronics has become a bottleneck, leading to the coming end of the famous Moore's law. To address such a grand challenge, many approaches are being keenly pursued, including the use of electric field to control magnetism, in contrast to the conventional charge current and the associated Joule heating effects. In this talk I will discuss an emerging field called magneto-ionics, which has shown promise for energy-efficient nanoelectronics. I will illustrate that ionic migration can be used to achieve atomic scale control of interfaces in magnetic nanostructures, and in turn modulate a wide variety of functionalities. In particular, I will show that less than one atomic layer of oxygen or hydrogen adsorbed on the surface of certain magnetic films can qualitatively change the topological character of magnetic domain walls in such films. These effects can be readily implemented in solid state magneto-ionic devices. They are also relevant for 3D information storage, such as in interconnected nanowire networks.