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Voltage controlled spintronic structures

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Electron undoubtedly is one of the most important elementary particles that are intimately related to human activities. From radio, TV to smart phone, electronics has totally revolutionized our lives. Surprisingly, in most electronics to date we have only utilized the charge carried by electrons, while ignoring the other inherent property, the spin. In Spintronics we explicitly make use of the spin degree of freedom of electrons to achieve new functionalities. After a brief introduction, I will describe the spin-dependent effects controlled by magnetic field and electric current. I will then focus on the exploration of new spintronic phenomena that can be controlled by electric field via the applied voltage, driven by the premise that voltage-controlled switching would be far more energy efficient and compatible with the ubiquitous semiconductor devices. I will talk about the earlier effort in searching for room temperature magnetic semiconductors where the magnetism is mediated by charge carriers. Then I will describe the new development in exploiting the electric field effect in novel systems where the magnetic anisotropy or even the magnetism of the ultra-thin ferromagnetic films (˜1nm) can be completely controlled by the applied voltages, through both the electronic and ionic effects. This work was supported in part by NSF (ECCS-1310338) and by C-SPIN, one of six centers of STARnet, a Semiconductor Research Corporation program, sponsored by MARCO and DARPA.