Title of the Talk: Hybrid Switching Devices

Abstract: In the era of artificial intelligence, the ever-increasing demand for performance is expanding the horizon of semiconductor memory devices. Emerging memory devices are researched rigorously to overcome the limitations of current baseline technologies. Resistive random-access memory (RRAM) is one of the most promising emerging candidates with simple structure, scaling possibilities, high-speed performance, multi-level storage, high endurance, and retention. The basic switching in RRAM depends on its defect properties. Therefore, defects are tremendous possibilities in RRAM. In a controlled way, it is useful for memory applications, and in an uncontrolled way, it can produce randomness for security applications. [1,2] This talk demonstrates a systematic approach to modulate the oxygen vacancy concentration in resistive switching devices and control the volatile and non-volatile switching through tuned nanoionics. [3] A synergistic effect of oxygen vacancy formation and metal ion migration generates several shades of storage behavior in the same matrices. Optimized vacancy engineering methodology is investigated to control the anatomy of filament formation. [4] More specifically, the impact of the preforming driven oxygen vacancy path is identified which successfully produces volatile threshold switching and non-volatile memory switching at the same compliance. [5] The nature of filamentary switching is modeled through physical analysis and density functional theory calculations. This work establishes the possibility to design highly efficient hybrid-filament-based devices through proper tuning of nanoionics, which can fulfill the need of futuristic devices.

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