Harnessing Charged Particle Beams to Tailor Defects by Design

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Ion irradiation has become a fundamental technique in materials science used for tuning material properties via the strategic introduction of defects. Among the array of instruments at our disposal, focused ion beam (FIB) microscopes excel in precision, enabling nanoscale site-selective irradiation and fine-tuning of material properties with unmatched control. The helium ion microscope (HIM) in particular, has emerged as a powerful instrument for defect engineering and device prototyping. Research groups from around the world have demonstrated tailoring of the electrical, magnetic, optical, chemical, mechanical and thermal properties of a range of materials using the HIM[1]. In fact, the scope of applications in this area rivals those associated with helium-FIB milling. In this talk I will present results from research conducted at Berkeley, where we have used the HIM for nanoscale tuning of the ferroelectric and thermal properties of thin films[2,3], and for the creation of single-atom and multi-atom vacancy defect structures in 2D materials[4,5]. The latter meticulously engineered sub-nanometer pores hold promise for applications in gas separation and selective ion transport, showcasing the potential of FIB-based atomic-scale material engineering for advancing functional material design.

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