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Stabilization of ferroelectric phase in HfO2-based materials via He ion beam irradiation

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Continuous advancement in nonvolatile and morphotropic beyond-Moore electronic devices requires integration of ferroelectric and semiconductor materials. The emergence of HfO2-based ferroelectrics that are compatible with atomic-layer deposition has opened interesting and promising avenues of research. However, the origins of ferroelectricity and pathways to controlling it in HfO2 are still mysterious. In this presentation, I will present how we are able to stabilize ferroelectric orthorhombic phase in these materials by defect engineering via local He ion beam irradiation and discuss the possible competing mechanisms for resulted highly enhanced ferroelectricity [1]. We first examine feasibility of defect engineering via local He ion beam irradiation using prototypical two-dimensional (2D) transition metal dichalcogenides (TMD) MoTe2. Then, we investigate how controlled irradiation influences on the ferroelectric phase in HfO2-based materials. Our piezoresponse force microscopy results indicate that the amplitude of piezoresponse in the ion irradiated region increased by approximately twofold compared with that in the pristine region and the scanning transmission electron microscopy results show a homogeneous distribution of oxygen vacancies and a phase transition to the ferroelectric phase. These findings both reveal the origins of ferroelectricity in this system and open pathways for nano-engineered binary ferroelectrics.

Paper submission Plan

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