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Tailoring oxide quantum materials by ion beam

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Complex oxides host a multitude of novel phenomena in condensed matter physics, such as various forms of multiferroicity, colossal magnetoresistance, quantum magnetism and superconductivity. Defect engineering via ion irradiation can be a useful knob to control these physical properties for future practical applications. Two prominent effects are disorder and uniaxial strain. Particularly, the uniaxial strain, manifesting as the elongation of the out-of-plane lattice spacing, is not limited to available substrates. In this contribution, we will take SrRuO3 thin films as an example to show the emerging properties upon defect engineering by ion irradiation. The irradiated SRO films exhibit a pronounced topological Hall effect in a wide temperature range from 5 to 80 K. It can be attributed to the emergence of Dzyaloshinskii–Moriya interaction as a result of artificial inversion symmetry breaking associated with the lattice defect engineering. Ion irradiation has been well developed for semiconductor-chip technology and is readily applicable for all kinds of oxide quantum materials.

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