Artificial Crystal

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Artificial crystals synthesized by atomic-scale precision epitaxy is a suitable platform for exploring, controlling, and understanding the quantum mechanical regime of solid state. A judiciously designed dimensional crossover from a 3D to 2D system can be realized using the monolayer control, which is frequently employed in transition metal oxides. Emergent quantum phenomena such as magnetoelectric coupling, Mottronics, and topological electronics have been shown for the artificial systems. Among them, atomic thickness dependents metal-insulator transition (MIT) is a one of the key topics for the atomic-scale electronics, which let us assess the low dimensional behavior of a material, which is typically intertwined with spin ordering in transition metal oxides.

In this presentation, we demonstrate the dimensional crossover-induced MIT of $SrRuO_3$ (SRO) in atomically designed SRO/$SrTiO_3$ (STO) superlattices (SLs) using Pulsed Laser Epitaxy (PLE). The alignment of O-2*p* bands across the SRO/STO interface lead to the absence of the electronic reconstruction, which usually prevails in most oxide heterostructures. The absence of the charge transfer across the interface enable us to study an intrinsic dimensional crossover effect of SRO. Indeed, an intrinsic MIT of SRO was clearly revealed with a combined magnetic phase transition, from a ferromagnetic metallic phase to an antiferromagnetic insulating phase. Furthermore, we will discuss a dimensional instability for the 2 u.c. of SRO layers, indicative of a strong coupling between spin and charge ordering.

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