Unlocking the Promise and Simplicity of Atomically Precise Synthesis for 4d- and 5d Metal Oxides through Hybrid MBE

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The ability to achieve atomically precise material synthesis has marked a profound advancement in the field of materials science. Yet, it is often the degree of ease and precision in the synthesis process that paves the way for groundbreaking application and discovery. Consider an element of periodic table that is hard to oxidize and also difficult to evaporate, how do we create an atomically precise thin films of such metals, metal oxides or their heterostructures? This has been a central question in the synthesis science for many decades. In this talk, I will present my group's effort to address this question. We have recently shown that both the low vapor pressure and difficulty in oxidizing a "stubborn" element can be addressed by using a solid metal-organic compound with significantly higher vapor pressure, and with the added benefits of being in a pre-oxidized oxidation state along with excellent thermal and air stability. Using this approach, we show, for the first time, the synthesis of Pt, RuO_2, $SrRuO_3$ and superconducting Sr_2RuO_4 films with the same ease and control as afforded by III-V MBE. Finally, I will present a detailed MBE growth study of $SrRuO_3$ films combined with structural and transport characterizations emphasizing the role of structural inhomogeneity on anomalous hump-like magnetotransport, which has long been interpreted as a signature of Skyrmions formation.