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Integration of functional oxides and semiconductors

ALEX DEMKOV, The University of Texas at Austin

The astounding progress of recent years in the area of oxide deposition has made possible the creation of oxide heterostructures with atomically abrupt interfaces. The ability to control the length scale, strain, and orbital order in these materials structures offers a uniquely rich toolbox for condensed matter physicists. Because the oxide layers are very thin, the physics is often controlled by the interface. The electronic properties of oxide interfaces are governed by a subtle interplay of many competing interactions such as strain, polar catastrophe, electron correlation, and Jahn-Teller coupling, as well as by defects and phase stability. It is not clear which, if any, of these newly discovered systems will find applications in future high-tech devices. However, they undoubtedly hold tremendous promise, particularly when integrated with conventional semiconductors such as Si. In this talk I will review our recent results in theoretical modeling and experimental realization of several epitaxial oxide heterostructures. I will set the stage with a brief discussion of extrinsic magnetoelectric coupling at the interface of a perovskite ferroelectric and conventional ferromagnet. I will then describe our recent successful attempt to integrate anatase, a photo-catalytic polymorph of TiO_2, with Si (001) using molecular beam epitaxy. In conclusion, I will talk about strain stabilized ferromagnetism in correlated $LaCoO_3$ (LCO) and monolithic integration of LCO and silicon for possible applications in spintronics. The integration is achieved *via* the single crystal $SrTiO_3$ (STO) buffer epitaxially grown on Si. Superconducting quantum interference device magnetization measurements show that, unlike the bulk material, the ground state of the strained $LaCoO_3$ on silicon is ferromagnetic with a T_C of 85 K.