Contribution ID: **47**

Type: **Oral Presentation**

INVITED SPEAKER: From 2D to 3D and 1D: Manipulating charge and spin at oxide heterointerfaces

Wednesday, 13 July 2016 10:15 (30 minutes)

Abstract content
   (Max 300 words)
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Special chars

Advances in thin film growth techniques, which allow for the precise layer-by-layer growth of epitaxial materials, have opened the door to numerous discoveries which were not previously achievable through bulk synthesis techniques. Pertinent examples include emergent phenomena at perovskite oxide heterointerfaces such as two-dimensional electron gases, interfacial superconductivity and novel magnetic properties. In this presentation, I will discuss the use of first principles calculations to explore how chemical identity, interface density and overlayer nanostructuring can be used to modulate the density, dimensionality and mobility of charge carriers as well as magnetism at oxide heterostructure interfaces. For example, using first principles simulations, we demonstrate that in La δ-doped SrTiO₃ (STO) superlattices with relatively thin STO layers, three-dimensional conductivity can be achieved in a transparent oxide material. This 3D transparent conductivity is a direct result of the appreciable overlap of the quantum mechanical wavefunctions between neighboring δ-doped layers with negligible changes to the STO electronic band structure. Furthermore, I will discuss our efforts to understand how nanostructured patterning of the LaAlO₃ overlayer can be used to create a 1 dimensional electron gas. Finally, I will discuss how the injection of charge at the interface between two antiferromagnetic oxides fosters the emergence of interfacial ferromagnetism. Together, these results demonstrate an unprecedented control over charge and spin at an interface thus opening the door for the use of these materials in a wide range of applications. This work was supported by the U.S. Department of Energy, Basic Energy Sciences, Materials Sciences and Engineering Division through the Office of Science Early Career Research Program.

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Session Classification: Parallel Track B