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Transparent conducting oxides: A δ-doped superlattice approach[1]
VALENTINO COOPER, Oak Ridge National Laboratory, SUYOUN LEE, Korea Institute of Technology, SUNG SEOK SEO, University of Kentucky, JUN SUNG KIM, Pohang University of Science, WOO SEOK CHOI, SATOSHI OKAMOTO, HO NYUNG LEE, Oak Ridge National Laboratory — Interfaces between dissimilar insulating oxides have been shown to exhibit intriguing phenomena such as metallic states, superconductivity and magnetism. Despite tremendous progress in understanding their origins, very little is known about how to control the conduction pathways and the distribution of charge carriers. Using first principles simulations we examine the effect of $SrTiO_3$ (STO) spacer layer thickness on the physical and chemical properties of La δ-doped STO superlattices. In superlattices with relatively thin STO layers, we predict that three-dimensional conduction would occur due to appreciable overlap of the quantum mechanical wavefunctions between neighboring δ-doped layers. Experimentally these superlattices remain highly transparent to visible light; a direct consequence of the appropriately large gap between the O $2p$ and Ti d states. These results highlight the potential for using superlattice thickness as a means for tuning the properties of oxide heterostructures with demonstrated importance for optoelectronic devices; providing a unique route for creating transparent conducting oxides.

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