Orbital engineering of carrier mobilities and densities at oxide interfaces

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Emergent phenomena at ABO_3 oxide interfaces, e.g. two dimensional electron gases (2DEGs)[1] are paramount to understanding critical behavior arising from electron confinement; like metal-insulator transitions,[2] novel magnetic effects[3] and superconductivity.[4,5] In this presentation we review our recent efforts to exploit the local chemistry and physics at oxide interfaces in order to enhance the fundamental properties at the interfaces. For this purpose, the chemically intuitive δ-doped system is used as a model system for exploring the physics at these interfaces. We explore three design concepts for manipulating the wavefunction and thus electronic configuration at oxides interfaces: (i) charge balance, (ii) dopant concentration and (iii) interlayer wavefunction overlap. Our results highlight the importance of relative population of the strongly localized d_{xy} orbital versus the more dispersive d_{xz} and d_{yz} orbitals; where increases in the fraction of the latter result in significant enhancements in carrier mobilities.[6] In addition, we show that an increase in charge imbalance at an interface, e.g. in $KXO_3/LaXO_3$ systems, can both decrease band effective masses (possibly enhancing mobility) and significantly increase the charge density at an interface.[7] Our results also suggest that by modulating the thicknessof the $SrTiO_3$ layers in La δ-doped systems that it is possible to achieve 3D conductivity; again possibly higher mobilities may be attainable in these materials due to changes in relative orbital populations. Together, these studies present routes toward enhancing 2DEG carrier mobilities and/or densities; thus having significance for exploring interfacial physics with consequences for novel device applications.

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