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Nitride Multilayers as a Platform for Parallel Two-Dimensional Electron-Hole Gases: MgO/ScN(111) ANTIA S. BOTANA, Argonne National Lab, VICTOR PARDO, Universidade de Santiago de Compostela, WARREN E. PICKETT, University of California Davis — At interfaces between insulating oxides $LaAlO_3$ and $SrTiO_3$, a two dimensional electron gas has been observed and well studied, while the predicted hole gas has not been realized due to the strong tendency of holes in O-2p orbitals to localize. Here we propose, via ab initio calculations, an unexplored class of materials for the realization of parallel two dimensional (2D), two carrier (electron+hole) gases: nitride-oxide heterostructures, with (111)-oriented ScN and MgO as the specific example. Beyond a critical thickness of five ScN layers, this interface hosts spatially separated conducting Sc-3d electrons and N-2p holes, each confined to about two atomic layers– the transition metal nitride provides both gases. A guiding concept is that the N^{3-} anion should promote robust two carrier 2D hole conduction compared to that of O^{2-}: metal mononitrides are mostly metallic and even superconducting while most metal monoxides are insulating. Our results, provide guidance for new exploration, both experimental and theoretical, on nitride-based conducting gases that should promote study of long sought exotic states viz. new excitonic phases and distinct, nanoscale parallel superconducting nanolayers[1]. [1]A.S. Botana, V. Pardo, W.E. Pickett, arXiv/1509.08518(2015)

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