Tuning the two-dimensional electron liquid at oxide interfaces by buffer-layer-engineered redox reactions

Polar discontinuities and redox reactions provide alternative paths to create two-dimensional electron liquids (2DELs) at oxide interfaces. Herein, we report high mobility 2DELs at interfaces involving SrTiO$_3$ (STO) achieved using polar La$_{7/8}$Sr$_{1/8}$MnO$_3$ (LSMO) buffer layers to manipulate both polarities and redox reactions from disordered overlayers grown at room temperature. Using resonant x-ray reflectometry experiments, we quantify redox reactions from oxide overlayers on STO as well as polarity induced electronic reconstruction at epitaxial LSMO/STO interfaces. The analysis reveals how these effects can be combined in a STO/LSMO/disordered film trilayer system to yield high mobility modulation doped 2DELs, where the buffer layer undergoes a partial transformation from perovskite to brownmillerite structure. This uncovered interplay between polar discontinuities and redox reactions via buffer layers provides a new approach for the design of functional oxide interfaces.

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