Metal-insulator transitions in double quantum wells of $SrVO_3$

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We report on the in-plane conductivity control of $SrVO_3$ double quantum wells by a magnetic field or an electric field. First, we describe metal-insulator transitions in $SrVO_3$ single quantum wells confined with a band-insulator of $SrTiO_3$. Thick films of SVO are a Pauli paramagnetic metal with a quite low residual resistivity. Confinement turns $SrVO_3$ from correlated metal to Mott insulator and electron doping as $Sr_{1-x}La_xVO_3$ recovers metallicity at around x=0.17 [1, 2]. We attempted to control this phase transition by external fields with employing double quantum wells. By employing a magnetic insulator barrier $EuTiO_3$ between $SrVO_3$ quantum wells, hybridization of wave functions could be controlled by a magnetic field. Application of magnetic field lowers effective barrier hight due to exchange splitting of Ti 3*d* conduction bands induced by the ferromagnetic alignment of Eu^{2+} ions. Back gating could control the relative position of quantized levels in two quantum wells separated by $SrTiO_3$, leading to switching of hybridizations. In addition to conventional accumulation/depletion actions in field effect transistors, stepwise drops of conductivity with hysteresis are observed in both positive and negative bias voltages. This switching is ascribed to on-off of resonant tunnelling between two quantum wells. These examples are metal-insulator transitions controlled not by filling but by effective bandwidth through the resonant tunnelling.

References:

[1] K. S. Takahashi, Y. Tokura, and M. Kawasaki, Metal-insulator transitions in dimensionality controlled $La_xSr_{1-x}VO_3$ films, APL Mater **10**, 111114 (2022).
[2] K. S. Takahashi, J. Iguchi, Y. Tokura, and M. Kawasaki, Metal-insulator transitions in strained single quantum wells of $Sr_{1-x}La_xVO_3$, Phys Rev B **109**, 035158 (2024).