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Distinct substrate effects on the gate-induced metallic states in VO_2 thin films MASAKI NAKANO, University of Tokyo, DAISUKE OKUYAMA, Tohoku University, MASAICHIRO MIZUMAKI, SPring-8, HIROYUKI OSUMI, RIKEN SPring-8 Center, MASARO YOSHIDA, TAKAHISA ARIMA, University of Tokyo, MASAKI TAKATA, RIKEN SPring-8 Center, MASASHI KAWASAKI, University of Tokyo, YOSHINORI TOKURA, RIKEN Center for Emergent Matter Science (CEMS), YOSHIHIRO IWASA, University of Tokyo — The idea of utilizing electric-double layers for controlling electronic phases of condensed matters by external voltages, namely EDLT, has attracted growing attention. Of particular interest is EDLT based on VO2, enabling electrical control of "bulk" electronic phases over the electrostatic screening length, as proven by transport, optical, and structural measurements [1-3]. We attributed this unique feature to electrostatic effects, but there are other models proposed from electrochemical viewpoints. Here we show that the reversibility of the device operation strongly depends on the substrates, suggesting a governing mechanism can differ depending on the substrates. We found that EDLT with VO2 films grown on lattice-matched TiO2 substrates show reversible gating effects, whereas those on hexagonal Al2O3 substrates become irreversible, although in both cases metallic states can be induced electrically. X-ray absorption spectra taken before and after the gating experiments also indicated distinct substrate effects on the valence states of vanadium at the gate-induced metallic states.

[1] Nature 487, 459 (2012);
[2] Appl. Phys. Lett. 103, 153503 (2013);
[3] Appl. Phys. Lett.104, 023507 (2014).

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