Intercalation-tuned nonlinear transport in α-MoO_3 at millikelvin temperatures

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We report low-temperature electrical transport studies of pristine and metal-intercalated α-MoO_3, focusing on In- and Cu-intercalated samples measured down to the millikelvin regime. Current–voltage characteristics and differential resistance measurements reveal strongly nonlinear, bias-dependent transport. At temperature of 7mK, all investigated samples show pronounced peaks in differential resistance as a function of bias current, indicating a threshold-like transition between a highly resistive state and a more conductive nonequilibrium regime.

The strongest differential-resistance anomaly is observed in pristine MoO_3, while Cu intercalation significantly suppresses the peak amplitude. In-intercalated MoO_3 shows intermediate behaviour, preserving the threshold-like nonlinearity but with reduced resistance compared with the pristine material. These results suggest that intercalation modifies the localized transport landscape by introducing additional electronic states, changing carrier concentration, or altering the effective transport barriers.

The observed behaviour is interpreted in terms of field-assisted hopping, charge trapping and detrapping, and possible bias-induced redistribution of carriers in an inhomogeneous defect/intercalant landscape. The asymmetry of the differential-resistance peaks with respect to bias current further suggests a role of contact barriers or nonuniform intercalant distribution. Our results demonstrate that metal intercalation provides an effective route to tune low-temperature transport in α-MoO_3 and may be relevant for future studies of correlated, memristive, and quantum transport phenomena in van der Waals oxides.