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**Time-Dependent Structural Phase Transitions of Two-dimensional Intercalated Layered Oxides** KRISTIE KOSKI, Department of Chemistry, Brown University, PHILIP ZUCKER, Department of Physics, Brown University, BRYAN REED, Physical and Life Sciences Directorate, Lawrence Livermore National Laboratory — We demonstrate time-dependent phase transitions in metal-intercalated 2D layered $MoO_3$. Copper metal atoms are chemically intercalated into ultrathin 2D nanocrystalline $MoO_3$ using a novel method we developed to intercalate high densities of zero-valent atomic species. In-situ transmission electron microscopy (TEM), operating on a timescale of seconds, and Dynamic TEM, operating on nanosecond time scales show that unique, time-dependent phase transitions can be driven in these two-dimensional layered oxide nanoribbons. Very different structures arise on different time scales, indicating a competition between kinetics and thermodynamics in determining the resulting structure. Control experiments in pure $MoO_3$ show no such transitions, thus it appears that the copper intercalant is an essential part of the process. Measurements of the nanosecond-scale transformation are consistent with a local reordering of material within the original unit cell, while the slower transition is characterized by an incommensurate superlattice possibly associated with a charge density wave. This work opens new ground for accessing novel phases of matter in two-dimensional layered nanomaterials.

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