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Mapping of the photo-induced metastable and hidden phases in 2D electronic materials FARAN ZHOU, TIANYIN SUN, TZONG-RU HAN, Michigan State University, CHRISTOS MALLIAKAS, Northwestern University, PHILLIP DUXBURY, SUBHENDRA MAHANTI, Michigan State University, MERCOURI KANATZIDIS, Northwestern University, CHONG-YU RUAN, Michigan State University, MSU TEAM, NU TEAM — Using the ultrafast electron imaging techniques, we studied the light-induced phase transitions in transition-metal dichalcogenide materials. A succession of different phases was introduced transiently using femtosecond mid-infrared pulses and the local atomic scale charge-density-wave dynamics and morphological evolution of the long-range textured domains were *in situ* characterized using the ultrashort coherent electron pulses. The various metastable and hidden states emerging under the controlled nonthermal, nonadiabatic driving highlight the interaction-driven nature of these transitions with limited involvement of lattice entropy. The methodology introduced here can be generally applied to survey the complex energy landscape in strongly correlated electron systems, avoiding the difficulty of electrostatic gating or confounding effects due to defects and/or disorder. In particular, the observation of robust non-thermal switching at meso-scales and at ultrafast timescales, provides a platform for designing high-speed low-energy consumption nano-photonics and electronics devices.

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