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Beyond structural bottleneck: the nature of nonthermal optically induced ultrafast phase switching in VO_2[1] ZHENSHENG TAO, JILA, Univ of Colorado - Boulder, TZONG-RU T. HAN, FARAN ZHOU, Department of Physics and Astronomy, Michigan State University, DAVID TORRES, TONY WANG, NELSON SEPULVEDA, Department of Material Science Engineering, Michigan State University, CHONG-YU RUAN, Department of Physics and Astronomy, Michigan State University, CHONG-YU RUAN TEAM, NELSON SEPULVEDA TEAM —
Ultrafast manipulation of the electronic states of strongly correlated electronic crystals near room temperature, such as VO_2, encompasses enormous opportunities in high-speed electronics and photonics. However, its strong coupling to the first-order structural phase transition presents a bottleneck effect, which leads to cracking and various instabilities. Here, we show that repetitive ps or even sub-ps phase switching can be initiated by using mid-infrared photons where the rapid transformation is driven by instantaneous shift of chemical potential, rather than lattice or electronic heating. Using fs electron crystallography, we establish the cooperative doping-induced multi-step atomic pathway, which leads to a metal-insulator transition at a fractional energy dose.

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