

Ultrafast charge density wave dynamics in 1T-TaS₂ investigated using ultrafast electron diffraction

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Recent developments in the control of charge density wave (CDW), i.e. a combined periodic modulation of the electron density and a periodic lattice distortion, with either current or laser pulses could open the way to novel electronic devices.[1-4] The 1T polytype of TaS₂ displays a rich phase diagram, with a metallic normal phase above 545 K, an incommensurate (I) CDW phase above 350 K, a nearly commensurate (NC) CDW above 180 K, an insulating commensurate (C) CDW phase below and a metallic metastable hidden phase (H) accessible by either current or laser pulses.[3,4] While CDW systems are essentially thought as 2 dimensional systems, it is speculated that the insulating C-phase and conducting NC-phase properties are driven by the layer stacking order in the 3rd dimension.[5] How and on which time scale does the stacking order evolves upon femtosecond laser excitation ? Using the 3 MeV electron diffraction setup at SLAC,[6] we investigated the ultrafast dynamics of the C to I phase transition upon excitation by a femtosecond 800 nm wavelength laser pulse. Taking advantage of the nearly flat Ewald sphere displayed by 3 MeV electrons, we measured simultaneously a complete set of CDW satellites reflections, evidencing an unexpected different behavior between the layer stacking order and partial disorder.

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