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Structural response to non-thermal melting of a charge density wave.

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Recent developments in time resolved techniques such as angle resolved photo emission Spectroscopy and x-ray diffraction have opened new opportunities to probe directly dynamics of the electronic and structural order on femtosecond time-scales. Charge Density Waves (CDW) comprise a class of collective phenomena arising from a correlation between the electron density and the underlying lattice. 1T-TiSe2 is one example of CDW materials. It has a quasi two-dimensional structure where Ti atoms are sandwiched between two layers of Se atoms. Below 200 K, it undergoes a second order structural phase transition into a commensurate CDW state with a (2a x 2a x 2c) superlattice.

The origin of this phase transition, although extensively studied both experimentally and theoretically, is not yet unambiguously determined. Lack of parallel areas in the Fermi surface at 2kF points eliminates FS nesting as a possible scenario for the CDW formation. There exist several competing hypotheses for the mechanism driving the CDW formation in 1T-TiSe2. One of the most successful of these is the condensation of excitons, which becomes possible due to a low free carrier density and a consequently poorly screened Coulomb interaction. An alternative is the band Jahn-Teller effect: a lowering of the average energy of the valence and conduction bands in the vicinity of the Fermi surface as a result of lattice distortion.

Here we apply time-resolved optical reflectivity and x-ray diffraction with femtosecond resolution to study the dynamics of the structural order parameter of the charge density wave phase in TiSe2. We find that the energy density required to melt the charge density wave phase non-thermally is four times lower than for thermal suppression of the superlattice. These results lend support to models suggesting that the charge density wave in TiSe2 is driven by the exciton condensation.

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