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Observing photo-induced dynamics in the charge density wave compound 4HB-TaSe₂ by means of femtosecond electron diffraction

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Abstract content
   (Max 300 words)

Layered transition metal dichalcogenides MX₂ (M=Ta, Ti, Nb …, X=S, Se…) are quasi-two-dimensional crystals consisting of strongly bound 3 atom thick planar layers of X-M-X which are weakly bonded to each other by van der Waals forces along the c-axis. Due to strong electron correlation in these compounds, the electron density is not uniform throughout the compound but rather modulated with a periodicity different to that of the crystal lattice. This modulation is accompanied by an induced lattice distortion with the same periodicity. The modulation in the electron density together with the periodic lattice distortion (PLD) is referred to as a charge density wave (CDW) and only develops below a corresponding phase transition temperature. In reciprocal space the CDW manifests into a superstructure in the diffraction pattern with CDW peaks between the lattice Bragg peaks.

The CDW and its associated PLD can be disturbed or destroyed by introducing energy into the system by means of photons. Depending on the applied fluence the CDW is either only weakened for a short period of time or the transition to a higher temperature phase is driven, from which it might require longer time to return into the ordered state.

Here we investigate the photo induced dynamics of the host lattice and the CDW/PLD in 4HB-TaSe₂ by means of femtosecond electron diffraction (FED), which has proven to be a powerful technique to observe structural dynamics in crystalline material with atomic temporal and spatial resolution: a femtosecond laser pulse deposits energy into the sample, initiates the dynamic process and defines time zero; a succeeding sub-picosecond electron pulse is diffracted off the sample at an optically defined and variable time t and monitors the instantaneous structure of the sample. Successive recordings of diffraction patterns for varying t produces an atomic-level 'movie' of the crystal dynamics.

We will present the wealth of dynamical information retrieved from the femtosecond electron diffraction experiment, and discuss its interpretation in the context of CDW/PLD in TaSe₂.

Apply to be
 consider for a student
   award (Yes / No)?

Yes

Level for award
 (Hons, MSc,
   PhD)?

PhD

Main supervisor (name and email)
and his / her institution

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Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?

No

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