MS16-1-1 Photoinduced charge-density wave phase in 1T-TaS_2: growth and coarsening mechanisms #MS16-1-1

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Abstract
Charge-density wave (CDW) states are broken symmetry states of metals arising from electron-phonon interactions, which are characterized by a periodic modulation of both atomic positions and electron density. Diffraction techniques are especially well adapted to studying such compounds, since the structural modulation gives rise to so-called satellite peaks those intensity is proportional to the square of the atomic displacement amplitude.
The CDW states are gapped, which makes those sensitive to excitations with infrared laser pulses. In the two-dimensional tantalum disulfide 1T-TaS_2, we found that an intense laser pulse can induce a phase transition between two distinct CDW states, namely the incommensurate (I) and nearly commensurate (NC) CDW states. A detailed description of the NC → I photoinduced phase transition was achieved using pump-probe X-ray diffraction measurements **[1,2]**. Above the threshold fluence for the NC → I transition, the NC-CDW melts within 400 fs. A broad satellite peak corresponding to the photoinduced I phase (denoted I*) could be detected 2 ps after laser excitation. The analysis of its intensity and width allows identifying a nucleation/growth mechanism of the photoinduced I* phase (**Fig. 1a**). At a pump-probe delay of 100 ps, the photoinduced I* phase has fully developed at sample's surface. However, it is fragmented into several small domains (< 30 nm) corresponding each to a given phase Φ of the I-CDW modulation. The dynamics observed in the 100 - 500 ps pump-probe delay range is dominated by the coarsening of this domain pattern (**Fig. 1b**). The latter result was confirmed by low-energy electron diffraction **[3]**.
It can be further shown that the photoinduced I*-CDW phase differs from the I-CDW phase at equilibrium not only by its limited correlation length, but also by a larger period of the CDW modulation (shorter wave vector of the CDW) **[4]**. We propose that the increased period of the I*-CDW modulation would be due to a smaller number of conduction electrons involved in the collective CDW state, some of them being trapped at CDW-dislocation sites.

References
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Fig.1 - (a) Nucleation/Growth. (b) Coarsening