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Ultrafast lattice dynamics in laser-excited solids probed with femtosecond X-ray diffraction

KLAUS SOKOLOWSKI-TINTEN, University of Duisburg-Essen, Germany

Ultrafast pulsed excitation of solids provides a unique way of depositing energy into materials and to create states of strong electronic excitation and high temperature and pressure. With the initial deposition of energy a complex chain of elementary physical processes is triggered which can lead to structural changes on very rapid time-scales, and often along unusual, non-equilibrium pathways. Due to the unique combination of *atomic-scale* spatial and temporal resolution, the recent progress in the development of ultrafast X-ray sources has provided new opportunities for studying such processes. This talk will discuss our recent work on ultrafast time-resolved X-ray diffraction using laser-driven as well as accelerator-based femtosecond X-ray sources. Examples include the non-thermal melting transition in semiconductors, the direct observation of large-amplitude coherent optical phonons, and studies of the energy relaxation in optically excited solids through measurements of the transient *Debye-Waller* effect.