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UNIVERSITÄT DUISBURG ESSEN

Open-Minded

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Transient core-hole screening in photoexcited ZnO investigated by time-resolved X-ray absorption spectroscopy

Dr. Thomas Rossi

Helmholtz-Zentrum Berlin

Understanding the ultrafast electronic and lattice response of photoexcited semiconductor materials at the atomic level is crucial for the realization and optimization of devices. In this talk, we report on the picosecond dynamics of atoms and photoexcited charge carriers above the optical band gap of ZnO in oriented nanorods [1] and thin films by picosecond X-ray absorption spectroscopy (XAS) at the Zn K-edge. The transient signal is composed of overlapping signals coming from lattice heating (dominant in the EXAFS) and non-local screening of the core-hole potential by photogenerated electron-hole pairs (dominant in the XANES). State-of-the-art calculations with the Bethe Salpeter equation can reproduce the spectral features and the non-linear effect of the core-hole screening on the transient with the excitation density. We will highlight the generality of the effects hereby observed to other photoexcited semiconductors and at other absorption edges. This work highlights the simultaneous sensitivity of time-resolved XAS to incoherent atomic motions and delocalized photoexcited carriers with chemical element sensitivity, which opens new perspectives for the study of photoexcited semiconductors in complex materials or in optoelectronic devices.

[1] Rossi, T. C. et al. Charge Carrier Screening in Photoexcited Epitaxial Semiconductor Nanorods Revealed by Transient X-ray Absorption Linear Dichroism. Nano Letters **21**, 9534–9542 (2021).

Contact: Prof. Dr. Björn Sothmann, Faculty of Physics
Phone: +49 (203) 37-93330 / Mail: bjoerns@thp.uni-due.de