

# Ultrafast phenomena probed with time-resolved photoelectron spectroscopy

Uwe Bovensiepen

*Universität Duisburg-Essen, Fakultät für Physik, Lotharstraße 1, 47048 Duisburg,  
Germany*

Femtosecond time- and angle-resolved photoemission using ultrashort laser pulses is well established for the analysis of excited states and their relaxation in the time domain. This approach has been very successfully applied to metal and semiconductor surfaces, as well as interfaces between adatoms or molecular layers on metal substrates. In order to investigate electron dynamics in the bulk of materials and to profit from spectral and momentum resolution of photoelectron techniques transport effects of the optically excited charge carriers have to be considered. In this talk exemplary approaches using time-resolved photoelectron spectroscopy that aim at bulk dynamics are presented and the current status of results will be presented. (i) Epitaxial growth of metallic layers on semiconductor substrates of 1 to 20 monolayer thickness facilitate within the substrate's band gap a spectral window to analyze electron dynamics in the metal layer with suppressed transport effects. (ii) Layered materials like cuprates or tritellurides can be cleaved in vacuum and the obtained surfaces can give good estimates for bulk dynamics. Such materials furthermore present various cooperative phenomena like superconductivity and charge density wave formation, which become thereby accessible to photoelectrons in time-resolved experiments.

The experimental results reported here have been obtained in close collaboration with R. Cortes, P. S. Kirchmann, L. Rettig, M. Wolf at the Freie Universität Berlin, which is gratefully acknowledged.