

ULTRAFAST RELAXATION DYNAMICS OF HOT ELECTRONS AND HOLES BY FEMTOSECOND PHOTOELECTRON EMISSION SPECTROSCOPY IN AU/FE/MGO(001)

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Optically excited electrons and holes are of particular interest in modern solid state physics because they allow a microscopic understanding of the respective interactions in non-equilibrium states. Excited charge carriers in metals and semiconductors relax on a femto- to picosecond timescale due to electron-electron(e-e) and electron-phonon(e-p) scattering. Here we want to discern the relaxation by local inelastic processes and non-local transport.

To analyze the ultrafast dynamics of charge carriers, femtosecond time-resolved photoelectron spectroscopy was applied. In our pump-probe experiments front side as well as back side pump excitation was used. By comparing the obtained results, we can separate the contribution of transport effects **from local electron-electron(e-e) and electron-phonon(e-ph) scattering.**

This work is a continuation on previously performed two photon photoelectron emission experiments [1] and provides complimentary data above and below the Fermi energy E_F .

Here, we report on our first experimental results regarding linear photoelectron emission experiments with a 6 eV probe beam and a 1.55 eV pump beam on an Au/Fe/MgO(001) epitaxial heterosystem. In case of the back-side configuration, the pump beam excites hot electrons in the iron layer, which are injected into the gold layer in which the excited charge carriers propagate to the surface and are probed in photoemission spectroscopy by 6 eV probe photons.

By direct comparison of back and front side pumped spectra we analyze transport of hot charge carriers with respect to E_F .

By measuring different thicknesses of gold, we can analyze the particular decay channels in the different constituents gold and iron.

There is a distinct difference in the decay times of front and back pump experiments showing an indicator for electron transport effects through the gold layer. This thickness dependent change in the relaxation rate is more pronounced for the back-side geometry than the front-side geometry.

Furthermore, a slow decaying intensity component after 500 fs, which persists at longer time delays, can be seen and is assigned to effects of electron-phonon coupling.

In this poster the difference of local relaxation and transport mechanisms will be discussed. It will highlight the differences between front and back side geometry, showing a **slower** relaxation rate for back side excitation. Quantitative analysis of the data is not yet complete and to be done. The Poster will feature a energy and thickness dependent analysis of the propagation and relaxation times of electrons and holes above and below the fermi energy E_F . As well as an analysis of the electron-phonon coupling occurring at later times.

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[1] Y. Beyazit, J. Beckord, P. Zhou, J. Meyburg, F. Kühne, D. Diesing, M. Ligges, U. Bovensiepen;
<https://arxiv.org/abs/1910.14309>