**ULTRAFAST DYNAMICS OF HOT ELECTRONS AND HOLES**

**BY FEMTOSECOND PHOTOELECTRON 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 interactions in non-equilibrium states. It is well known, that excited charge carriers in metals and semiconductors relax on a femto- to picosecond timescales due to electron-electron  
(e-e) and electron-phonon (e-ph) scattering. Here we want to discern the relaxation by such local inelastic processes and non-local transport. To analyze the ultrafast dynamics of charge carriers, femtosecond time-resolved linear photoelectron spectroscopy was applied and this work is a continuation of previously performed two-photon photoelectron spectroscopy experiments [1]. Here we provide complimentary data above and below the Fermi energy *E*F. By comparing results obtained in our pump-probe experiments by front side as well as back side pump excitation, we can separate the contribution of non-local transport effects from local effects, like electron-electron (e-e) and electron-phonon (e-ph) scattering. Here, we report on first experimental results obtained by using 1.55 eV pump and 6 eV probe photons on an Au/Fe/MgO(001) epitaxial heterosystem. In case of the back side pump configuration, hot electrons are excited in the Fe layer, which are injected into the Au layer and propagate to the surface, where they are probed by photoelectron emission spectroscopy with 6 eV photons. In the back side pump data, we observe a positive shift in the time delay of the intensity built-up and maximum in comparison to the front pump data. We attribute this difference to transport effects due to propagation of the hot electrons through the Au layer. Since the transport occurs on similar timescales as the e-e scattering, we conclude on a (super)-diffusive transport regime. We will present an energy *E* and Au thickness *d*Au dependent analysis of the propagation and relaxation times τ(*E*,*d*Au) of electrons and holes above and below *E*F. We observe a larger τ(*E*,*d*Au) for thicker Au films, which can be explained by the presence of an Fe layer exhibiting a much shorter bulk relaxation time τ than Au. For thicker Au films this Fe-Au interface contribution recedes and τ(*E*,*d*Au) increases. Furthermore, a slow decaying intensity component after 500 fs in the vicinity of *E*F, which persists at longer time delays up to 2 ps, is assigned to effects of e-ph coupling. In this poster the difference of local relaxation and non-local transport mechanisms will be discussed.

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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