~~LOCAL AND NON-LOCAL RELAXATION~~ DYNAMICS OF HOT ~~CARRIERS~~ BY ~~LINEAR TWO PHOTON~~ PHOTOELECTRON ~~EMISSION~~

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Optically excited ~~electrons~~ are of particular interest in modern solid state physics because they allow a ~~deeper~~ understanding of ~~the~~ interactions ~~of electrons~~ 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 [1]. Here we want to discern the relaxation by local ~~effects~~ and non-local transport.
To analyze the ~~effects of optical excitation on~~ charge carriers, femtosecond ~~resolved optical~~ spectroscopy was applied. ~~By performing the optical spectroscopy~~ experiments ~~both, with a~~ front side and as well as back ~~side excitation,~~ we can separate the contribution of transport effects from different phenomena.
This work is a continuation on previously performed two photon photoelectron emission experiments ~~and brings~~ complimentary data ~~for a different energy regime close~~ to the Fermi ~~edge (0 to 1.55 eV above the fermi edge).~~
Here, we report on our first experimental results regarding linear photoelectron emission experiments with a 6 eV ~~pump beam~~ and a 1.55 eV ~~probe~~ beam on a MgO/Fe/Au(001) epitaxial heterosystem. In case of the back-side configuration, the pump beam excites hot electrons in the iron layer, which ~~then get~~ injected into the gold ~~(propagation~~ layer~~)~~ ~~where it~~ propagate~~s~~ to the surface ~~to be probed by the 1.55 eV beam.~~
Since we want to distinguish the non-local transport dynamics from the local relaxation, we apply in our linear photoelectron emission experiments a frontpump-frontprobe (FP/front-side) and a backpump-frontprobe (BP/back-side) approach to compare the results. 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, we can see for the first-time electron-phonon(e-p) scattering with optical phonons close to the Fermi level on the picosecond timescale.
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. Our energy resolved data gives insight into the different energy levels close to the fermi edge showing both an energy dependent difference of the relaxation time and a repopulation of lower excited states (<0.4 eV) by secondary electrons. Through our linear photoelectron emission experiments, we can show the creation of electron hole states through secondary electrons below the fermi level (<0.3 eV) and their subsequent decay by recombination with electrons of the corresponding excess energy. These holes as well have an energy dependent relaxation rate.

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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