Revealing elementary interactions in transition metals by ultrafast solid state spectroscopy

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Elementary interaction processes in transition metals under optically-excited, non-equilibrium conditions occur in the range of few femtoseconds and comprise elastic and inelastic scattering process, transport phenomena, and changes in the electronic structure due to correlation effects. In this talk recent efforts in ultrafast experiments exploiting photoelectron and soft x-ray absorption spectroscopy will be discussed. Transport effects were analyzed in Au/Fe/MgO(001) heterostructures by means of optically excited hot electron propagation from Fe to the Au surface. Detection of photoelectrons in a Fe-pump / Au-probe configuration as a function of the Au layer thickness was essential to demonstrate sensitivity to Fe as buried media and to identify a super-diffusive electronic transport regime through Au [1]. Energy transfer and interfacial e-ph coupling were investigated with femtosecond soft x-ray spectroscopy by combining the element-specificity of the Fe L_3 and O K absorption edges to achieve a constituent- and site-specific analysis in Fe-MgO heterostructures. In this effort, we identified coupling of hot electrons to hot phonons at Fe-MgO interfaces [2,3]. Pronounced changes of the electronic structure upon optical excitation were identified in Ni by high energy resolution combined with femtosecond time resolution at the Ni $L_{3,2}$ absorption edges. By comparsion with DFT and TD-DFT calculations those changes are assigned to local electron correlations in non-equilibrium states of magnetically ordered, correlated materials.

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References

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