TUNABLE EXCITED STATE DYNAMICS OF NEUTRAL COPPER OXIDE CLUSTERS WITH SIZE AND OXIDATION

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Copper oxides exhibit several useful electronic attributes such as electron correlation effects, spin dynamics, magnon behavior, and high temperature superconductivity. The atomic precision and tunability of gas phase neutral clusters provides insights into the charge carrier excitation dynamics of strongly correlated bulk materials by revealing how their excited state dynamics change with subtle changes in stoichiometry, local geometry, and electronic density. I will present our recent measurements of the ultrafast relaxation dynamics of sub-nanometer neutral copper oxide clusters investigated with femtosecond pump-probe spectroscopy coupled with time-of-flight mass spectrometry and supported by theoretical calculations. The carrier dynamics of neutral copper oxides clusters can be tuned upon the addition/subtraction of each atom and is attributed to the ligand-to-metal charge-transfer (LMCT) character of the photoexcitation. The sub-picosecond excited state lifetimes decrease almost linearly upon sequential oxidation, for Cu_nO_x ($n \leq 7$), of $\sim$30-100 fs per oxygen atom. Stoichiometric clusters show an increase in excited state lifetimes as cluster size increases and is supported by DFT calculations attributing the trend to the localization of electrons in the excited state. Understanding the electronic properties and dynamics of copper oxide clusters promises to shape a new era of semiconductor and superconductor physics through development of new materials containing tunable properties.