Advances in Single-Particle Spectroscopy Using Fast Electrons

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In this poster we highlight our collaborative experimental/theoretical research in low-loss electron energy-loss spectroscopy (EELS) performed in a scanning transmission electron microscope (STEM). A detailed picture of energy flow at the nanoscale is obscured by the diffraction limit, and spatially-resolved measurements are increasingly difficult for low energy phenomena such as infrared (IR) plasmons and lattice vibrations. Using monochromated STEM-EELS comnbined with theoretical methods our team has been exploring plasmon and phonon interactions in resonant environments and observing energy transformation through a variety of dissipation pathways.

Emphasis will be placed on our recent efforts in studying the interaction of the fast electron probe with surface plasmon, surface phonon, and photonic cavity modes in individual metallic, dielectric, and semiconductor nanoparticles and their few-particle assemblies. Several topics ranging from energy transfer, weak-to-strong coupling, Fano antiresonances, magnetic plasmon hybridization, and carrier doped semiconductor photophysics will be presented. In particular we will highlight semiconductor oxide particles and their tunable surface modes and substrate mixing of lattice vibrations.

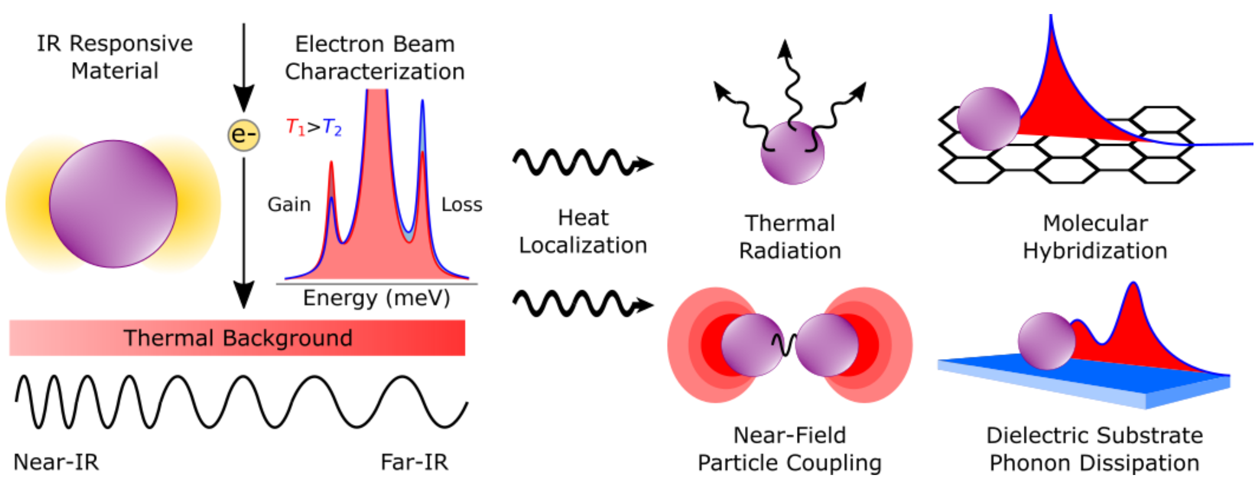
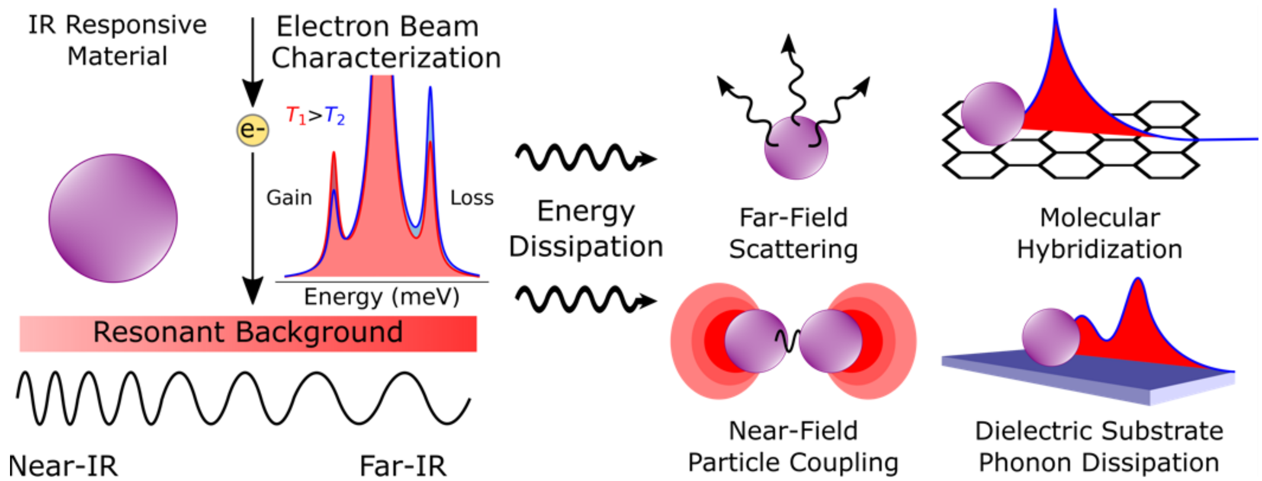


Figure 1. STEM-EELS provides a nanoscopic view of localized IR energy. Interactions betweenIR nanomaterials and their ambient thermalized material environment can, e.g., focus energy intomolecular bonds or liberate energy into blackbody radiation.


IR Responsive Material
Electron Beam Characterization
e-
T_1>T_2
Gain
Loss
Energy (meV)
Resonant Background
Near-IR
Far-IR
Energy Dissipation
Far-Field Scattering
Molecular Hybridization
Near-Field Particle Coupling
Dielectric Substrate Phonon Dissipation