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Coupling THz Pulses to a Scanning Tunneling Microscope

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Probing ultrafast processes over subpicosecond and picosecond time scales provides fundamental insight into the nature of materials. We have experimentally demonstrated terahertz (THz)-pulse-induced tunneling in a scanning tunneling microscope (THz-STM) to image surfaces with simultaneous nanometer spatial resolution and subpicosecond time resolution.However, the exact mechanism by which THz radiation couples to the scanning probe tip of the STM is not completely understood. THz radiation can excite surface plasmon polaritons (SPPs), which propagate as Sommerfeld waves along a metal wire waveguide with low loss and dispersion. For metal wires with a sharp taper, electromagnetic fields are enhanced due to the localization of SPPs at the apex. Here, we simulate THz-pulse-coupling to a STM tip in THz-STM as a near-field THz microscopy technique. COMSOL Multiphysics is used to set up finite-element time-domain simulations for the coupling of THz pulses to an STM tip in a modeled THz-STM geometry. Simulation results show THz scattering, waveguide propagation and near-field enhancement. The simulations provide insight into the nature of THz pulse coupling to the scanning probe tip in THz-STM, which may lead to improvements in coupling efficiency, and help in modeling the THz modulation of the STM junction bias and the resulting THz-induced tunneling emission.

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