Implementation of Fiber-Coupled Terahertz source to a Low-Temperature Scanning Tunneling Microscope

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Scanning tunneling microscopy (STM) combined with terahertz (THz) radiation offers atomic spatial resolution with sub-picosecond temporal resolution, enabling the study of transient electronic states and non-equilibrium dynamics at the surface. THz-STM implementation relies on amplified laser systems and complex free-space optical setups, which limit its use to specialized laboratories (1, 2).

In this work, we present a compact THz-STM implementation based on a commercial femtosecond fiber laser (100 MHz) and a fiber-coupled photoconductive antenna (3). The generated THz pulses are injected into an STM operating under ultra-high vacuum and at low temperature via diamond windows. The sharp tip confines and enhances the THz pulses, converting their transient field into localized nonlinear rectification of the tunnelling current (1). Initial measurements performed on an Ag(111) surface reveal a reproducible modulation of the tunnel current under THz illumination. Polarization-dependent measurements demonstrate coupling of the THz electric field to the STM junction through antenna-enhanced field confinement at the tip apex (1, 4). At the same time, a pump-probe electronic system is being developed to study ultrafast charge dynamics within molecular systems deposited on the surface.

This approach makes THz-SPM studies of surface systems in ultra-high vacuum accessible to a much wider scientific community.

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