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Terahertz Scanning Tunneling Microscopy in Ultrahigh Vacuum

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The terahertz scanning tunneling microscope (THz-STM) is a new imaging and spectroscopy tool that is capable of measuring picosecond electron dynamics at the nanoscale. Free-space THz pulses are commonly used for non-contact conductivity measurements, but they are diffraction limited to millimeter length scales. We can overcome this limit by coupling THz pulses to a sharp metal tip through propagating surface modes. At the STM junction, the THz pulse acts as a picosecond voltage transient which drives electron tunneling on an ultrafast timescale. This effect can be used to spatially and temporally probe the local conductivity of a surface after an excitation. Here we demonstrate THz-STM in an ultrahigh vacuum (UHV) environment for the first time. We have measured a THz-induced-tunnel-current over highly-oriented pyrolytic graphite (HOPG), and Si(111) in UHV. The experimental results agree well with our model, providing insight for the THz-STM mechanism. Recent progress towards atomic resolution and the nature of THz-induced-tunneling in an STM will be presented.

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