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Extraordinary sensitivity of nanoscale infrared spectroscopy demonstrated on Graphene and thin SiO_2 GREG ANDREEV, Z. FEI, UCSD, W. BAO, Z. ZHAO, C.N. LAU, UC Riverside, L.M. ZHANG, Boston U, M. FOGLER, G. DOMINGUEZ, M. THIEMENS, UCSD, F. KEILMANN, Max Planck, Garching, D. BASOV, UCSD — Infrared Spectroscopy is a powerful tool for characterizing materials by their vibrational mode fingerprint and/or electron conductivity. Its application to nanoscale resolved studies is highly desirable but remained challenging mainly for two reasons: a suitable source of intense, broadband infrared illumination was not widely available and the spatial resolution of conventional microscopes was limited by diffraction. We have resolved both issues by utilizing tunable External Cavity Quantum Cascade Lasers (EC-QCLs) as an intense illumination source for a scattering Scanning Near Field Optical Microscope (s-SNOM), capable of <10nm spatial resolution. With this combination of EC-QCLs + s-SNOM we demonstrate <10nm resolution imaging and spectroscopy of extremely thin materials: Silicon oxide layers (SiO_2) as thin as 2nm and even single atomic layers of Carbon (Graphene). The spectra register contrasts for volumes as small as 20x20x1nm^3 = 400 yoktoliters of SiO_2, and about 70 yl of Graphene over a broad spectral range: 1065-2250cm^{-1}. We explain the origins of this extraordinary sensitivity with an improved theoretical framework for calculating the near field response of a multilayer system.

Greg Andreev
UCSD

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