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Ultrafast plasmonic behavior of graphene probed by infrared nanoscopy MARTIN WAGNER, ZHE FEI, ALEXANDER MCLEOD, ALEKSANDR RODIN, University of California San Diego, WENZHONG BAO, University of Maryland, College Park, ERIC IWINSKI, University of California San Diego, ZENG ZHAO, University of California Riverside, MICHAEL GOLDFLAM, MENGKUN LIU, University of California San Diego, GERARDO DOMINGUEZ, California State University San Marcos, University of California San Diego, MARK THIEMENS, MICHAEL FOGLER, University of California San Diego, ANTONIO CASTRO-NETO, National University of Singapore, CHUN NING LAU, University of California Riverside, SERGIU AMARIE, Neaspec GmbH, Germany, FRITZ KEILMANN, Ludwig-Maximilians-Universitaet and Center for Nanoscience, Munich, DIMITRI N. BASOV, University of California San Diego — Recent experiments using near-field spectroscopy (s-SNOM) have revealed the spectroscopic (Z. Fei et al., Nano Lett. 11, 4701 (2011)) and real-space characteristics (Z. Fei et al., Nature 487, 82 (2012)) of graphene plasmons and show that this technique is ideal for their investigation. Here, we discuss the time-dependent plasmonic behavior of graphene. Combining s-SNOM with ultrafast laser excitation we were able to perform near-infrared pump mid-infrared probe spectroscopy beyond the diffraction limit on exfoliated samples. We show picosecond ultrafast plasmon modulation by optical means with an efficiency comparable to electrostatic gating and also to other plasmonic materials such as metals. Modeling of our results reveals that pump-induced heating of carriers is responsible for the ultrafast change in Drude weight that s-SNOM is probing.

Martin Wagner
University of California San Diego

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