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**Resonantly Enhanced Nonlinear Response of Graphene Plasmons**

MOHAMMAD M. JADIDI, Univ of Maryland-College Park, JACOB KNIG-OTTO, STEPHAN WINNERL, Helmholtz-Zentrum Dresden-Rossendorf, Germany, ANDREI B. SUSHKOV, H. DENNIS DREW, THOMAS E. MURPHY, MARTIN MITTENDORFF, Univ of Maryland-College Park — Sub-wavelength graphene structures support plasmonic resonances in terahertz and mid-infrared part of the spectrum. The strong field confinement at plasmon resonance significantly enhances the light-graphene interaction and can lead to a very strong nonlinear optical response. This feature of graphene plasmons can enable nonlinear optics with low field intensity in miniaturized sub-wavelength devices. However, to date, the nonlinear response of graphene plasmons and their energy loss dynamics have not been studied experimentally. Here we present an experimental and theoretical study of the nonlinear terahertz response of plasmon resonances and their energy relaxation dynamics in graphene nanoribbons. Using THz pump-THz probe measurements at the plasmon frequency (9.4 THz), we observe a strong saturation of plasmon absorption followed by a 10 ps relaxation time. The observed nonlinearity is found to be significantly higher than that of graphene with no plasmon resonance. We further present a thermal model for nonlinear plasmonic absorption in graphene nanoribbons that supports the experimental results.

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