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Title:Intraband conductivity response in graphene observed using ultrafast infrared-pump visible-probe spectroscopy
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Abstract:Graphene, a truly two-dimensional material with a unique linear energy-momentum dispersion, demonstrates novel photonic properties such as universal absorption and conductivity, with applications including terahertz lasing, broadband midinfrared detectors, and tunable ultrafast lasers. Understanding the ultrafast nonequilibrium dynamics of photocarriers in graphene's unique relativistic band structure is important for the development of such high-speed, graphene-based photonic devices, as well as from a fundamental point of view. Here, our experiments indicate the relativistic nature of a nonequilibrium gas of electrons and holes photogenerated in a graphene monolayer as early as 100 fs after photoexcitation. We observe a nonlinear scaling in the Drude-like optical conductivity of the photocarriers with respect to their density, in striking contrast to the linear scaling expected from conventional materials with parabolic dispersion relations. Our measurements also indicate that hot photocarriers cool on a sub-100-fs time scale via interactions with optical phonons. These results elucidate the unique nature of the ultrafast dynamics of photocarriers in a relativistic material, in contrast to conventional materials, and provide a way to manipulate graphene's optical conductivity for applications in photonics and plasmonics.
Number of references:36
Inspec controlled terms:band structure - dispersion relations - electron gas - graphene - high-speed optical techniques - hot carriers - infrared spectra - monolayers - optical conductivity - phonons
Uncontrolled terms:intraband conductivity response - ultrafast infrared-pump visible-probe spectroscopy - 2D material - linear energy-momentum dispersion - photonic properties - universal absorption - universal conductivity - terahertz lasing - broadband midinfrared detectors - tunable ultrafast lasers - photocarrier ultrafast nonequilibrium dynamics - graphene relativistic band

structure - high-speed graphene-based photonic device development - relativistic nature - nonequilibrium electron gas - nonequilibrium hole gas - graphene monolayer - photoexcitation - nonlinear scaling - photocarrier Drude-like optical conductivity - parabolic dispersion relations - hot photocarriers - time scale - optical phonons - photocarrier ultrafast dynamics nature - relativistic material - graphene optical conductivity - plasmonics - time 100 fs - C

Inspec classification codes:A7820D Optical constants and parameters (condensed matter) - A7830G Infrared and Raman spectra in inorganic crystals - A7847 Ultrafast optical measurements in condensed matter - A7865V Optical properties of fullerenes and related materials (thin films/low-dimensional structures) - A6322 Phonons in low-dimensional structures and small particles - A6817 Monolayers and Langmuir-Blodgett films - A7110C Electron gas, Fermi gas (condensed matter) - A7220H High-field transport and nonlinear effects (semiconductors/insulators) - A7230 High-frequency effects; plasma effects in electronic transport - A7320D Electron states in low-dimensional structures - A7360T Electrical properties of fullerenes and related materials (thin films/low-dimensional structures)

Numerical data indexing:time 1.0E-13 s

Chemical indexing:C/el

Treatment:Experimental (EXP)

Discipline:Physics (A)

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