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Title:Ultrasensitive and Wide-bandwidth Thermal Measurements of Graphene at Low Temperatures
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Abstract:At low temperatures, the electron gas of graphene is expected to show both very weak coupling to thermal baths and rapid thermalization, properties which are desirable for use as a sensitive bolometer. We demonstrate an ultrasensitive, wide-bandwidth measurement scheme based on Johnson noise to probe the thermal-transport and thermodynamic properties of the electron gas of graphene, with a resolution of 2 mK/Hz and a bandwidth of 80 MHz. We have measured the electron-phonon coupling directly through energy transport, from 2-30 K and at a charge density of 2×10¹¹ cm⁻². We demonstrate bolometric mixing and utilize this effect to sense temperature oscillations with a period of 430 ps and determine the heat capacity of the electron gas to be 2×10⁻²¹ J/(K·μm²) at 5 K, which is consistent with that of a two-dimensional Dirac electron gas. These measurements suggest that graphene-based devices, together with wide-bandwidth noise thermometry, can generate substantial advances in the areas of ultrasensitive bolometry, calorimetry, microwave and terahertz photo-detection, and bolometric mixing for applications in fields such as observational astronomy and quantum information and measurement.
Number of references:52
Inspec controlled terms:bolometers - electron-phonon interactions - graphene - specific heat - thermal noise - two-dimensional electron gas
Uncontrolled terms:ultrasensitive thermal measurement - wide-bandwidth thermal measurement - graphene - thermal bath - rapid thermalization - bolometer - Johnson noise - thermal-transport properties - thermodynamic properties - electron-phonon coupling - energy transport process - charge density - bolometric mixing - temperature oscillations - heat capacity - two-dimensional Dirac electron gas - wide-bandwidth noise thermometry - ultrasensitive calorimetry - microwave detection - terahertz photodetection - quantum information - bandwidth 80 MHz - temperature 2 K to 30 K - C

Inspec classification codes:A6540E Lattice and electronic heat capacity of solids - A7320D Electron states in low-dimensional structures - A7138 Polarons and electron-phonon interactions - A7270 Noise processes and phenomena in electronic transport
Numerical data indexing:bandwidth 8.0E+07 Hz;temperature 2.0E+00 3.0E+01 K
Chemical indexing:C/el
Treatment:Theoretical or Mathematical (THR); Experimental (EXP)
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