Highly sensitive hot electron bolometer based on graphene quantum dots

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Abstract

We studied graphene quantum dots patterned from epitaxial graphene on SiC and from chemical vapor deposition of Graphene Films on SiO2/Si with a resistance strongly dependent on temperature. The combination of weak electron-phonon coupling and small electronic heat capacity in graphene makes these quantum dots ideal hot-electron bolometers. We characterized the response of these quantum dot bolometers to THz radiation as a function of dot size, with sizes ranging from 30 to 700 nm and from 2.5 to 80 K temperature range. We show that quantum dots exhibit a variation of resistance with temperature higher than 430 MΩ/K below 6 K, leading to electrical responsivities for absorbed THz power greater than 1 × 10^{10} V/W. The power dependence of the responsivity was also investigated. The high responsivity, the potential for operation above 80 K and process scalability demonstrate that graphene quantum dot THz detectors hold great promise for practical applications.

References

[1] A. El Fatimy, R.L. Myers-Ward, A. K. Boyd, K. M. Daniels, D. K. Gaskill, and P. Barbara, Nature Nanotechnology, DOI: 10.1038/NNANO.2015.303 (2016).
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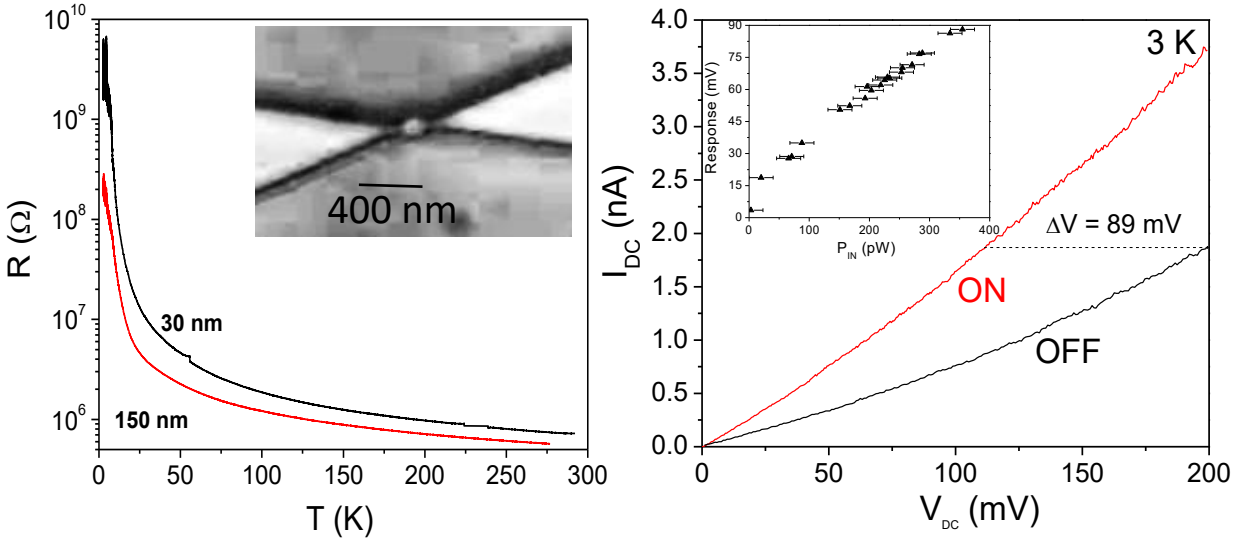
Figures



Temperature and THz power dependence of graphene quantum dots. a, Resistance *vs.* temperature for two quantum dots with different diameter at V_{DC} = 5mV. **b**, Current-voltage characteristic with (red) and without (black) of 0.15 THz radiation and the response as function of THz power absorbed for a 200-nm dot at 3K.