Graphene field-effect transistors as room-temperature Terahertz photodetectors

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Graphene is nowadays attracting considerable attention for a variety of photonic applications, including fast photodetectors, transparent electrodes in displays and photovoltaic modules, and saturable absorbers [1]. Owing to its gapless spectrum and frequency-independent absorption coefficient, it has been recognized as a very promising element for the development of detectors and modulators operating in the Terahertz region of the electromagnetic spectrum (wavelengths in the hundred μm range), which is still severely lacking in terms of solid-state devices. We report the realization of THz detectors based on antenna-coupled single-layer and bilayer graphene field-effect transistors (FETs). The photodetection mechanism originates from the non-linearity of the FET response to the oscillating radiation field at the top gate electrode leading to a photoresponse proportional to the derivative of the conductance as a function of the gate voltage [2]. By analyzing the photoresponse at different chopping frequencies of the incident radiation we also identify an additional slower contribution. We ascribe this to a competing thermoelectric effect originating from the difference in the thermal diffusions of carriers in the p/n parts of the graphene junction defined by the top gate [3]. Already in this first implementation, room temperature operation at 0.3 THz is achieved, with promising noise equivalent powers of $\approx$ 10 nW/(Hz)$^{1/2}$.

References

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[2] M. Dyakonov and M. Shur, Physical Review Letters **71**, 2465 (1993)
[3] N.M. Gabor et al. Science **334**, 648 (2011)