Graphene for detection and creation of terahertz light

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The interaction between low-energy photons in the terahertz (THz) spectral range and graphene gives rise to a number of interesting physical phenomena that will likely become technologically relevant. As a first example, I will show our recent results on using graphene for detecting THz light [1]. We have demonstrated that the dominant mechanism that gives rise to a THz-induced photoresponse is the photo-thermoelectric effect: absorbed THz light leads to carrier heating in graphene, and if this happens at a pn-junction with an asymmetry in the Seebeck coefficients, this gives rise to an electrical photoresponse. We have developed a simple analytical model to describe this effect, and have used this to design and fabricate a novel, antenna-integrated, graphene THz photodetector. The detector (see Figure 1) exhibits excellent sensitivity (noise-equivalent power <100 pW/Hz1/2), and a very short switching time (<30 ns, setup-limited). Furthermore, it operates at room temperature and for a range of THz frequencies that is only limited by the antenna. These specifications make the device already commercially competitive. As a second example, I will mention the recent demonstration of highly efficiently generated THz harmonics (up to 7th order) [2].

References

Figures

Figure 1: (Left) Schematic layout of the main part of the THz photodetector, showing an H-shaped graphene channel on top of the central part of the antenna, with the antenna gap. Voltages \( V_L \) (\( V_R \)) are applied to the left (right) antenna branch, thus creating the pn-junction with asymmetric Seebeck coefficients (\( S_1 \) and \( S_2 \)), leading to a photo-thermoelectric photocurrent \( I_{PTE} \). (Right) Measured photocurrent, scanning the device through a THz focal plane. The observation of multiple fringes of the Airy pattern illustrates the high sensitivity of the device.