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Graphene-based Golay THz arrayed detectors

Abstract:

TeraHertz (THz) is a non-ionizing, and thus safe, radiation, attracting a growing interest for its potentiality of non-destructive chemical imaging and sensing. Its application was hindered in the past for a dramatical lack of THz sources and detectors. Recently new technological approaches emerged in the field of THZ sources, while THz detector still rely on older approaches

THz imaging requires the development of miniaturized THz sensors built in dense arrays. Golay cells are formed by a gas chamber enclosed in flexible membranes: when the gas pressure is raised by IR or THz radiation absorption, the membrane curvature change may be detected by optical imaging. Since THz wavelength is larger than 30⊠m, the lateral resolution of the fabrication process is not a limiting factor. The critical component of a micron sized Golay cell is instead the flexible membrane, which must have both a high breaking strength and a low flexural rigidity. Graphene is the ideal material for this purpose because of its high strength and of its atomic thickness, in contrast with thicker polymeric membranes. Low flexural rigidity is critical to deflection sensitivity in response to temperature changes of the gas enclosed within a Golay cell scaled to the 10 μm to 100 μm scale. We recently develop a method to transfer clean graphene monolayers on micropatterned substrates. By graphene transfer in solution, we demonstrated that water remains trapped into micron sized graphene bubbles and that those bubbles are stable at temperatures much higher than 1000C.

Here we propose to develop arrays of graphene bubbles on transparent substrates as a THz detector. The bubbles will be filled with water-based solutions, to maximize absorbance in the THz region, and could be kept close to the liquid-vapor transition, in order to maximize the volume change upon THz absorption (i.e. the sensitivity).

For imaging purposes, spatially modulated THz radiation acts with different intensity on cells located at different positions locally so that the THz spatial distribution will be reflected in a pattern of cells curvature. The cells curvature patterns, properly demagnified, will be imaged through the transparent substrate with an ordinary CCD, providing THz spatially resolved images.

Just like color CCD are made color-filtering the nearest neighbors pixels, by filling nearest neighbors cells with water solution absorbing at different wavelength, we will produce a “color sensitive”THZ imaging detector.

Summary

Keywords:

TeraHerz Golay sensors, Teraherts imaging, Grafene sensors

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