slits where the field is significantly enhanced. Then, we expect that the adsorbed molecules will modify the polarizability of the graphene monolayer, affecting thus the shape and position of the metamaterial resonances. We argue that adsorption of much less than a single atomic layer can be detected by monitoring transmission. Due to the strong field concentration in the slits only molecules adsorbed at the slit area matter. However, the area of the slits is less than 10% of the total surface of the metamaterial unit cell. Assuming a 100 μm^2 area at the micro-spectrometer focal spot, we can expect that the adsorbent needs only to cover an area smaller than 10 μm^2. On the other hand, by appropriate geometrical design, the Fano resonance can be shifted to any given frequency in the visible and the infrared parts of the spectrum to match the resonances of the adsorbed molecule thus increasing sensitivity even further. We plan to exploit the potential of metamaterials with graphene as a superstrate in sensing applications and test these expectations in the near future. We also intend to extend our studies to include multilayer graphene superstrates. Finally we plan to explore the effects, if any, of the periodic perturbation to the graphene layer due to the periodic patterning of the metamaterial and the oscillation potential that it presents at resonance.

In summary, we have demonstrated that trapped-mode metamaterial arrays constitute ideal substrates to enhance the transmission visibility of graphene in the optical part of the spectrum. The observed experimental ratios can exceed 250% with an absolute transmission level of about 10% at a specific wavelength that can be tuned in a broad spectral range by appropriate scaling of the metamaterial structure. This provides a very robust and simple method of detecting graphene and suggests optical sensor applications based on graphene-metamaterial systems.

Acknowledgement

The authors would like to acknowledge the financial support of the Engineering and Physical Sciences Research Council (U.K.) and the Royal Society.

#123616- $15.00USD Received1 Feb2010;revised23 Mar 2010;accepted23 Mar 2010;published6 Apr 2010