Robust optical absorption of graphene-polymer heterostructures for GHz electromagnetic radiation versus defects

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Abstract

Graphene-PMMA heterostructures present good shielding efficiency against GHz electromagnetic radiations [1]. Theory and experiments demonstrate that there exist an optimum number of seven graphene sheets separated by thin polymer spacers to obtain maximal absorption. This is explained by an arithmetic addition of graphene sheet conductivities for small number of layers. In the present work, reflectivity, transmittance and absorbance of multilayered material are obtained using Rigorous Coupled Wave Analysis (RCWA) and compared to experimental measurements realized in the $K_a$ band.

When the material properties are no longer uniform in the directions parallel to the surface, absorption properties may be affected. For instance, the graphene layers produced by CVD present microscopic holes or microscopic dots (embryos of a second layer). Numerical calculations show that the absorption of the optimum graphene/PMMA sandwich is robust in the sense that it does not depend strongly on graphene defects to first order in concentration (Figure 1). This property is not true when the number of layers deviates from the optimum value $N=7$. We also demonstrate that grain boundaries in graphene do not compromise the good shielding efficiency of the proposed absorption device.

This research was supported by a Marie Curie International Research Staff Exchange Scheme Fellowship within the 7th European Community Framework Programme (MC-IRSES proposal 318617 FAEMCAR project). It has also received funding from the European Union Seventh Framework Programme under grant agreement No 604391 Graphene Flagship.

References


Figures

Figure 1: Reflexion, transmission and absorption properties of graphene-PMMA heterostructures ($N = 7$ layers) versus filling fraction of random holes that may be present in graphene sheets.