Hybridized Silicon Metasurface with Monolayer Graphene

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Optoelectronics utilizing two-dimensional nanomaterials such as graphene and transition metal dichalcogenide (TMDC) has been emerging in recent years. Monolayer graphene can be applied to ultrafast optical modulators and detectors for its high electron mobility as well as flat optical absorptivity over a wide range of wavelength. However, a monolayer graphene has a weak interaction with photon, resulting in a low optical absorptivity of 2.3%. This is a drawback in device applications. We haves shown theoretically that perfect absorption of a monolayer graphene can be achieved in the near-infrared region by coupling the graphene in close proximity on an array of hollow-cuboidal Mie-resonator made of a crystalline silicon (c-Si) [1]. In this device, we carefully tuned the size of the resonator to meet degenerate critical coupling condition between Toroidal Electric Dipole (TED) and Magnetic Dipole in the resonator [2,3]. TEDs have extremely low radiative loss compared to dipoles, which is expected to open up new avenues for loss control and Q-value enhancement. We found that the metasurface significantly enhances the interaction between monolayer graphene and photon to achieve perfect absorption.

In this talk, I will talk about principles and recent progress in experimental study about hybridized system of monolayer graphene and c-Si metasurface. In addition, I will talk about hybridized system with TMDC for enhancement of excitonic absorption.

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References

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