Reflection Phase Tuning of Graphene Plasmons by Substrate Design

Authors : Xiaojie Jiang, Wei Cai, Yinxiao Xiang, Ni Zhang, Mengxin Ren, Xinzheng Zhang, Jingjun Xu

Abstract : Reflection phase of graphene plasmons (GPs) at an abrupt interface is very important, which determines the plasmon resonance of graphene structures of deep sub-wavelength scales. However, at an abrupt graphene edge, the reflection phase is always a constant, $\Phi R \approx \pi/4$. In this work, we show that the reflection phase of GPs can be efficiently changed through substrate design. Reflection phase of graphene plasmons (GPs) at an abrupt interface is very important, which determines the plasmon resonance of graphene structures of deep sub-wavelength scales. However, at an abrupt graphene edge, the reflection phase is always a constant, $\Phi R \approx \pi/4$. In this work, we show that the reflection phase of GPs can be efficiently changed through substrate design. Specifically, the reflection phase is no longer $\pi/4$ at the interface formed by placing a graphene sheet on different substrates. Moreover, tailorable reflection phase of GPs up to 2π variation can be further achieved by scattering GPs at a junction consisting of two such dielectric interfaces with various gap width acting as a Fabry-Perot cavity. Besides, the evolution of plasmon mode in graphene ribbons based on the interface reflection phase tuning is predicted, which is expected to be observed in near-field experiments with scattering-type scanning near-field optical microscopy (s-SNOM). Our work provides another way for in-plane plasmon control, which should find applications for integrated plasmon devices design using graphene.Specifically, the reflection phase is no longer $\pi/4$ at the interface formed by placing a graphene sheet on different substrates. Moreover, tailorable reflection phase of GPs up to 2π variation can be further achieved by scattering GPs at a junction consisting of two such dielectric interfaces with various gap width acting as a Fabry-Perot cavity. Besides, the evolution of plasmon mode in graphene ribbons based on the interface reflection phase tuning is predicted, which is expected to be observed in near-field experiments with scattering-type scanning near-field optical microscopy (s-SNOM). Our work provides a new way for in-plane plasmon control, which should find applications for integrated plasmon devices design using graphene.

Keywords : graphene plasmons, reflection phase tuning, plasmon mode tuning, Fabry-Perot cavity
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