Dynamic Control of Mid-IR light with Graphene-Plasmons metasurfaces

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Controlling the properties of light is one of the most fundamental aspects of light-matter interaction. When the complete attributes of a light wave, namely its amplitude and phase, can be precisely controlled, holograms can be created enabling numerous applications [1]. In recent years, the field of light-matter interaction has been revolutionized by the introduction of unique structures known as metasurfaces [7]. These enable to locally manipulate the amplitude and phase properties of an incident light wave, providing complete control over the wavefront properties at a single interface. However, once the metasurface is fabricated, its properties cannot be changed as the structure itself is fixed. The holy grail of such a device is to obtain a controllable 2π phase shift between the input and output beam, which cover the complete phase span of a light wave.

In this work, we numerically show that such a 2π phase shift can be achieved, for Mid-IR light, by using graphene plasmons (GPs). Owing to the tunable properties of graphene, a dynamic control over the phase shift is obtained by gating the graphene layer, which in turn changes the resonance condition of the GPs. The design, which is based on high-quality graphene, yields the results presented in Figure 1, which shows the obtained gating dependent GP resonance and its corresponding 2π phase shift.

Although this approach has been studied recently, only a π phase shift, or less, could be achieved [2, 3]. As graphene can be easily integrated with current metasurfaces technologies, this combination could lead to tremendous scientific impact on light-matter interaction research.

References

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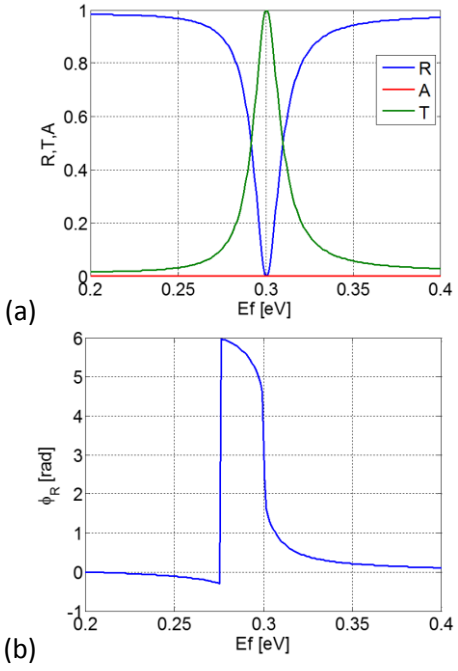

Figure 1: (a) Gate dependent (Ef) R, T and A of the structure, together with its obtained 2π phase shift (b).