30 GHz optoelectronic mixing with graphene based coplanar waveguides

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Abstract

The richness of optical and electronic properties of graphene attracts enormous interest [1]. In particular, graphene exhibits ultra-high carrier mobility and absorption at telecom wavelengths. Due to these excellent properties, ultra-fast photodetection at 1.55 µm has been demonstrated [2,3]. The integration of electronic and optic graphene components on one chip is an attractive route to further increase the performance of optical data links [3].

We have demonstrated (up to) 30 GHz optoelectronic mixing within the same device, i.e. a graphene based coplanar waveguide (CPW). This CPW was fabricated on a thermally oxidized high resistivity silicon substrate (2µm thick SiO_2, silicon resistivity > 5 kOhm.cm). After transfer on this substrate, the (CVD grown) graphene film was patterned and gold based CPWs were realized.
Fig. 1 schematically shows the graphene based CPW structure and optoelectronic mixing. A modulated electrical signal (f_{el}) is injected in the CPW input and a modulated optical signal (f_{opt}) illuminates the graphene film. Two modulated electrical signals are generated in the CPW output ($f_{el} + f_{opt}$ and $f_{el} - f_{opt}$).
Fig. 2 shows the mixing of a low frequency (300 kHz) electrical signal with a 5 GHz optical signal. Two electrical signals at respectively 4.9997 GHz and 5.0003 GHz are generated in the CPW output.
Optoelectronic mixing using (up to) 30 GHz electrical signals and (up to) 30 GHz optical signals will be demonstrated. These experiments show that graphene is an attractive candidate to realize optoelectronic mixing functions in future high bandwidth communication links.

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References

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[2] F. Xia, Nature Nanotechnology 4, 839 (2009)
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Figures

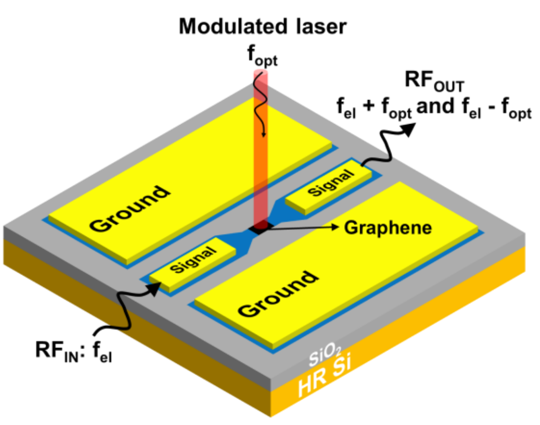

Fig. 1: Schematic drawing showing optoelectronic mixing with a graphene based coplanar waveguide.

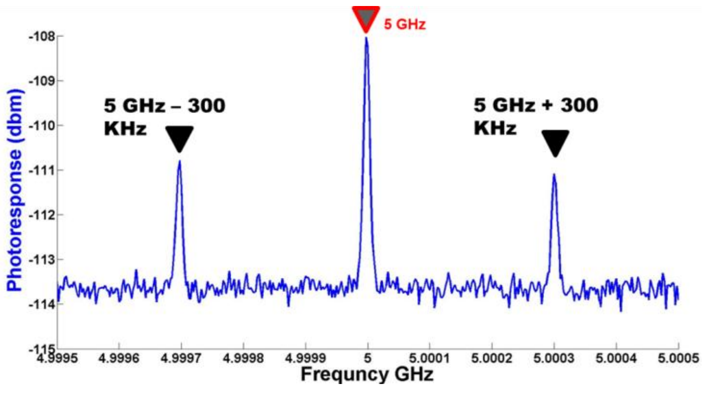

Fig. 2: Optoelectronic mixing of a 300 kHz electrical signal and a 5 GHz optical signal.