High frequency photodetection and optoelectronic mixing in CVD graphene

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Abstract

Graphene exhibits very high carrier mobility, photocarrier short lifetime and broadband absorption. As graphene technology is CMOS compatible, graphene devices offer a viable low cost alternative for high frequency electronic and optoelectronic devices [1].

Thanks to low propagation losses, electromagnetic immunity and large bandwidth operation, optical signals are advantageously coupled with electrical signals for high-rate communication systems on optical fibers. This leaded to the large development of optoelectronic devices based on 3-5 semiconductors and operating at 1.55 µm telecom wavelength.

We have fabricated a high frequency optoelectronic device that operates with optical signals at 1.55 µm and with microwave electrical signals (see figure and [2]). This is a coplanar waveguide integrating a CVD graphene layer that is passivated with an atomic-layer-deposited Al_2O_3 film. As a consequence the graphene Fermi level can be easily controlled with the silicon substrate bias even if the graphene layer and the substrate are separated by a 2 µm thick SiO_2 layer.

We operated this device as a high frequency photodetector and demonstrated a flat response up to 40 GHz. Moreover, using up to 30 GHz optical signals at 1.55 µm and up to 30 GHz microwave signals, we showed optoelectronic mixing. Thanks to this feature, a high-frequency intensity-modulated optical signal at frequency f_{opt} can be photodetected and mixed with an electrical carrier at frequency f_{ele}. It produces up and down-converted signals, at frequencies $f_{opt} + f_{ele}$ and $| f_{opt} – f_{ele} |$, respectively.
These results open interesting prospective in the domain of low cost telecommunication systems.

References

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DOI: 10.1021/acs.nanolett.5b05141

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