Graphene-Based High-Speed Photodetectors with Enhanced Photoresponsivity via Ambipolar Modulation

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Abstract

High-speed photodetectors are essential for advancements in environmental monitoring, telecommunications, medical diagnostics, and sensing applications [1]. Among emerging materials, graphene has attracted significant attention as a leading candidate for high-performance photodetection due to its outstanding electronic and optical characteristics [2]. Despite these advantages, the intrinsically low optical absorption of two-dimensional graphene limits its photoresponsivity [3]. Nevertheless, graphene's exceptionally high carrier mobility and its unique ambipolar behaviour enabling continuous modulation of charge carriers between electrons and holes through gate voltage modulation make it highly suitable for next-generation, high-speed photodetectors [4]. Moreover, integrating graphene with a high-responsivity material offers a promising strategy to overcome its absorption limitation and further enhance its photodetection performance.

In this work, we fabricated a graphene field-effect transistor (GFET) and characterized its ambipolar behaviour, which can be finely tuned using an external bias. In combination with a semiconductor material, we further aim to investigate the photoresponsivity, response–recovery time, spectral response, and temperature stability of the GFET-based photodetectors. Detailed insights into the device architecture, along with comprehensive performance metrics, will be discussed in the presentation.

Keywords: *Graphene field-effect transistor (GFET), High-speed photodetectors, Ambipolar behaviour, Photoresponsivity.*

Reference

[1] Jinhua Li et.al., Adv. Mater. (2014) **26**, 5225 – 5574.
[2] Haixin Chang et.al., Adv. Funct. Mater. (2013) **23**, 1984 – 1997.
[3] Chao Xie et.al., Adv. Funct. Mater. (2017) **27,** 1603886.
[4] Seunghyun Lee et.al., Nanoscale. (2014) **6**,13283.

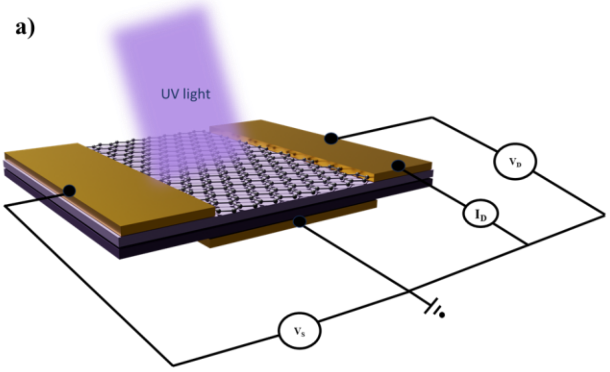

Fig a): Graphene Field Effect Transistor

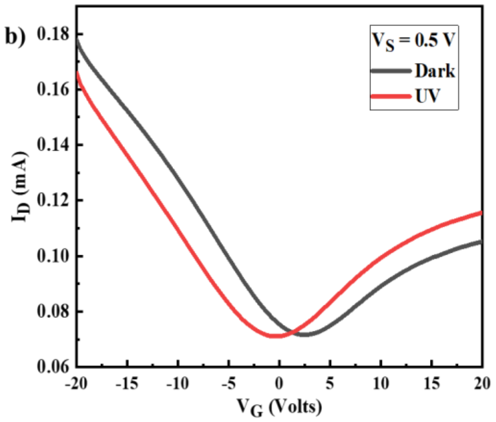

Fig a): Ambipolar behaviour of GFET under dark and UV.