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Enhancing reliability of graphene biosensors for monitoring loop-mediated isothermal amplification and biomarker detection

G. Flexible, stretchable and printable electronic materials for sustainable healthcare, sensing and actuation, energy applications and interconnections

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Abstract

Graphene-based field effect transistors (GFETs) are among the most promising technologies for next-generation electronic biosensors[1]. These devices can detect biomarkers, including molecules and pathogens, by measuring changes in electrical signals due to variations in the electronic environment around the transistor channel. GFET-based biosensors have demonstrated several advantages, such as high sensitivity, rapid response, real-time monitoring, low power consumption, and reduced noise levels. Here we report progress with functionalized commercial GFETs (graphene/nanoparticle hybrid devices) for loop-mediated isothermal amplification (LAMP) detection. This approach enables the detection of amplification products through Dirac point shifts using a differential scheme on compact electronic boards, making it well-suited for point-of-care testing.

Building upon this foundation, further advancements have been made in the field. In this study, we explore the use of functionalized GFETs for detecting various RNA chains and analyze the impact of different protocols on device performance. By systematically varying RNA sequences and amplification conditions, we aim to establish a robust database of electronic responses. Additionally, we investigate the potential of these devices for testing RNA immunity conditions, examining their sensitivity and specificity under diverse environmental and biological scenarios. We

also focus on optimizing the procedure to achieve detection times faster than benchmark LAMP protocols, further enhancing the practicality of this approach[2].

These advancements represent a significant step toward the development of a comprehensive GFET-based biosensing platform capable of adapting to a wide range of diagnostic applications. Our findings highlight the versatility of GFETs in biosensing and their potential to revolutionize point-of-care testing with compact, efficient, and intelligent diagnostic tools.

[1] Wasfi, A., Awwad, F., Qamhieh, N. et al. Sci. Rep. 12, 18155 (2022)

[2] Alhamid, G., Tombuloglu, H. and Al-Suhaimi, E. Sci Rep 13, 5066 (2023)