Graphene-Based Biosensing of Antibody–Virus Interactions: From Optical to Electrical Detection

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Graphene-based biosensors are emerging as powerful platforms for label-free detection of biomolecular interactions with high sensitivity and scalability. In this work, we outline a pathway toward electrical graphene biosensors for antibody–virus interaction by combining established optical assays with emerging electronic platforms. We first build on a graphene-enhanced surface plasmon resonance assay, where antibody–virus interactions were established using adeno-associated virus as a model system. Integration of monolayer graphene significantly enhances sensor performance, enabling stronger signals and clear discrimination between target and control viruses compared to conventional gold interfaces [1]. This provides a robust benchmark for assay development in biologically relevant environments and forms the basis for further technological translation. Building on this validated assay, we consider the transfer of identical graphene-based biointerfaces to electrical devices. Previous work has demonstrated that such sensing layers can be implemented across both optical and electrical platforms, enabling direct translation of assay principles while preserving the underlying biological functionality [2]. Finally, we present preliminary results addressing device stability, a key challenge for electrical graphene sensors. We show that thermal annealing combined with buffer conditioning reduces hysteresis and stabilizes the charge neutrality point, leading to improved reproducibility across devices. This stabilization is essential for high-sensitivity applications such as virus detection and characterization. Overall, this work establishes a workflow from validated graphene-enhanced optical assays to stable electrical biosensors, enabling future applications in viral diagnostics and metrology.

References

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Figures

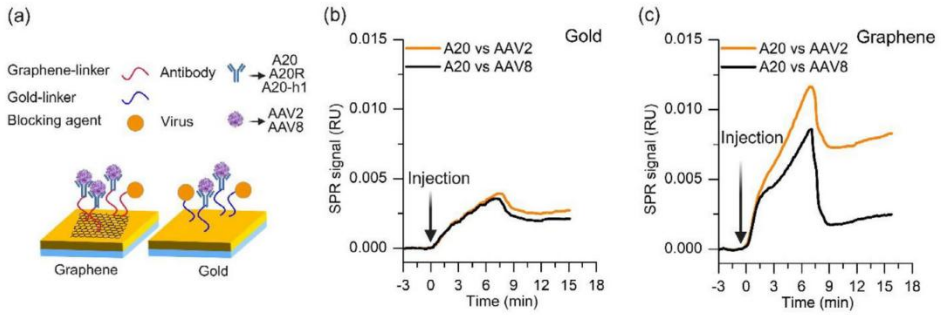

Figure 1: Graphene-enhanced detection of antibody–virus interactions using an optical biosensor. (a) Schematic of the assay. (b–c) Representative sensorgrams showing enhanced binding signals for target virus (AAV2) on graphene compared to gold, enabling clear discrimination from control virus (AAV8). (Reproduced from [1])