Improving Specificity of GFET Biosensors for Virus Detection through Surface Passivation

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Viruses represent a persistent and evolving threat to public health, and their rapid transmission demands equally rapid, reliable, and scalable detection methods. The recent pandemic highlighted society's vulnerability to emerging pathogens and underscored the limitations of current sensing technologies. Existing methods often require complex infrastructure, long processing times, or lack the sensitivity and specificity needed for early-stage detection and mass implementation. These challenges have triggered intense interest in developing advanced biosensing platforms that can offer real-time, point-of-care diagnostics with high accuracy and minimal sample requirements.
Among the available rapid antigen detection methods, solution-gated graphene-based field-effect transistors (GFETs) stand out as highly promising biosensing platforms. Their advantages include exceptional sensitivity to biologically relevant molecules, compact size, and near-instantaneous results using minimal sample volumes. In this study, we present an antibody-based biosensor built on a semiconducting graphene surface, integrated into a miniaturized array of microGFETs. The graphene surface was functionalized with a target-specific antibody and passivated with bovine serum albumin (BSA) to block non-specific binding (Fig. 1). This surface passivation is critical to ensuring signal specificity.
Without passivation, the sensor exhibited non-specific responses across all tested concentration ranges, likely due to non-specific adsorption on the non-modified graphene. To mitigate this, we introduced a BSA passivation layer at a concentration of 150 nM after antibody conjugation. This step effectively reduced non-specific interactions without altering sensor performance. Importantly, the passivated sensors demonstrated specific and reliable responses to the receptor-binding domain (RBD) of SARS-CoV-2 Spike protein.

References

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Figures

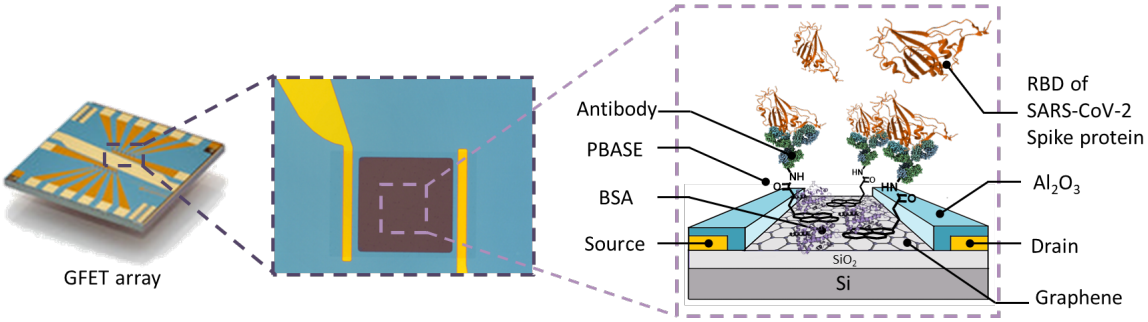

Figure 1: Schematic representation of the GFET array components and the surface modifications performed on the graphene channel.