Electrical probing of SARS-CoV-2 spike protein via a graphene field-effect transistor

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Graphene is a two-dimensional material with excellent electronic properties and chemical stability. We combined the unprecedented sensitive graphene field effect transistor (Gr-FET) with highly selective antibody/antigen interaction to develop immunosensors towards facile and fast detection of SARS-CoV-2 (and potentially SARS-CoV). It uses a field effect transistor structure with graphene as the channel material and body fluid environment as the liquid gate. The graphene surface is combined with SARS-CoV spike glycoprotein S1 subunit antibody (CSAb) or human angiotensin converting enzyme 2 (ACE2) through non-covalent crosslinking[1]. During the test, the spike glycoprotein S1 antigen (including receptor binding threshold, RBD) of the SARS-CoV-2 binds to the CSAb and ACE2 on the graphene surface[2,3], inducing a change in the source-drain conductance of the Gr-FET via field effect.

At present, the lowest detection limit concentrations we have achieved is 0.2pM (CSAb) and 0.1nM (ACE2) in the laboratory stage. If assuming a linear sensing response, we may deduce a limit of detection (LOD) as low as ~10fM at a signal-to-noise ratio of 1. Therefore, our developed Gr-FET-based antigen/antibody biosensors provide an alternative to resolve early diagnosis, as well as rational design of neutralizing antibody locking methods to resolve this ongoing public health crisis.

REFERENCES

[1] Fu W, Nef C, Tarasov A et al, Nanoscale, 5(2013), 12104-12110
[2] Menachery VD, Yount BL, Jr., Debbink K et al, Nat Med, 21(2015), 1508-13
[3] Tian X, Li C, Huang A et al, Emerging Microbes & Infections, (2020), DOI: 10.1080/22221751.2020.1729069

FIGURES

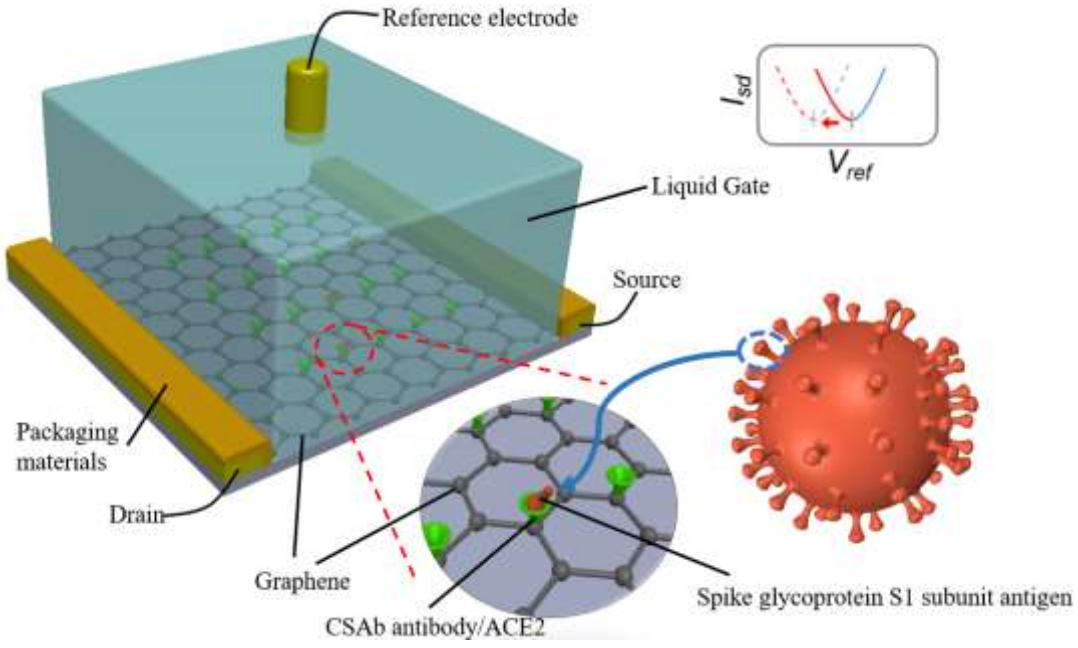

Figure 1: Schematic of GFET-based coronavirus antigen / antibody detection sensor