World Health Organization

Pathogen X

Transistor Sensors for Rapid COVID-19 Testing

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Background

Rapid and precise COVID-19 testing is crucial for epidemic management.

Nucleic acid test (RT-PCR)

~2 hours ×

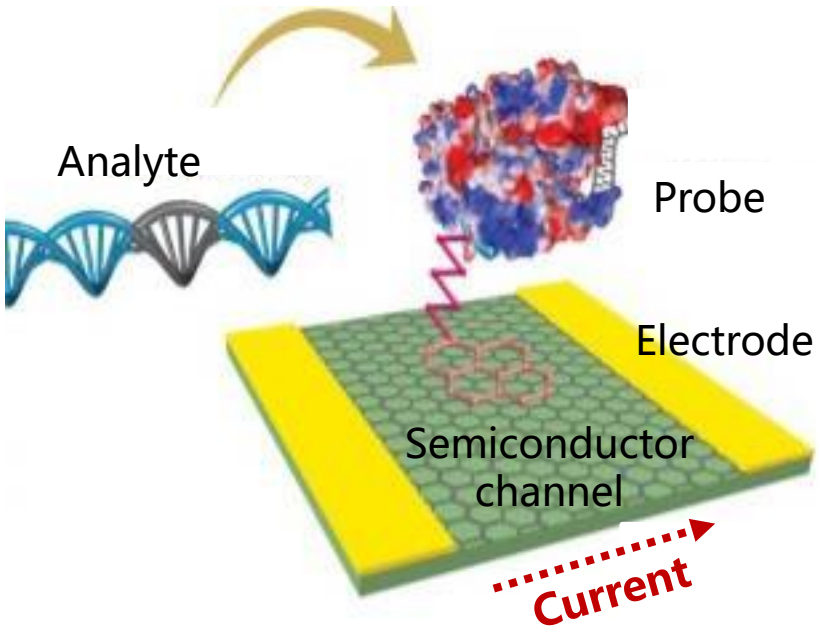
600~1000 copies/mL √

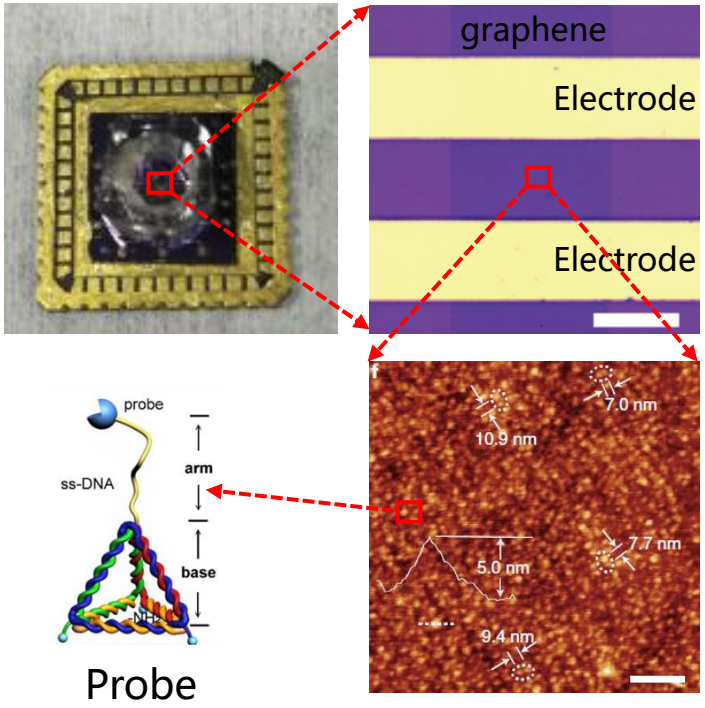
Antigen test (colloidal gold)

~10 min √

Low accuracy ×

Transistor sensor

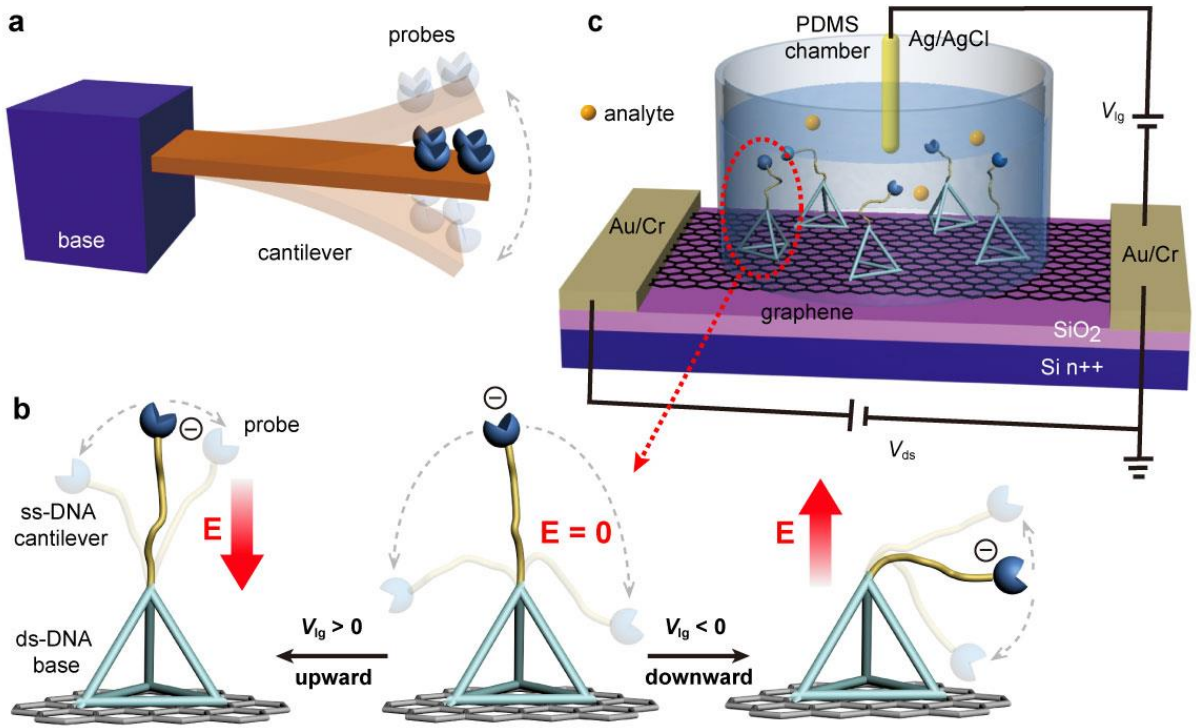




Wei*, et al. *Chem. Rev.* 2022, 122, 10319–10392

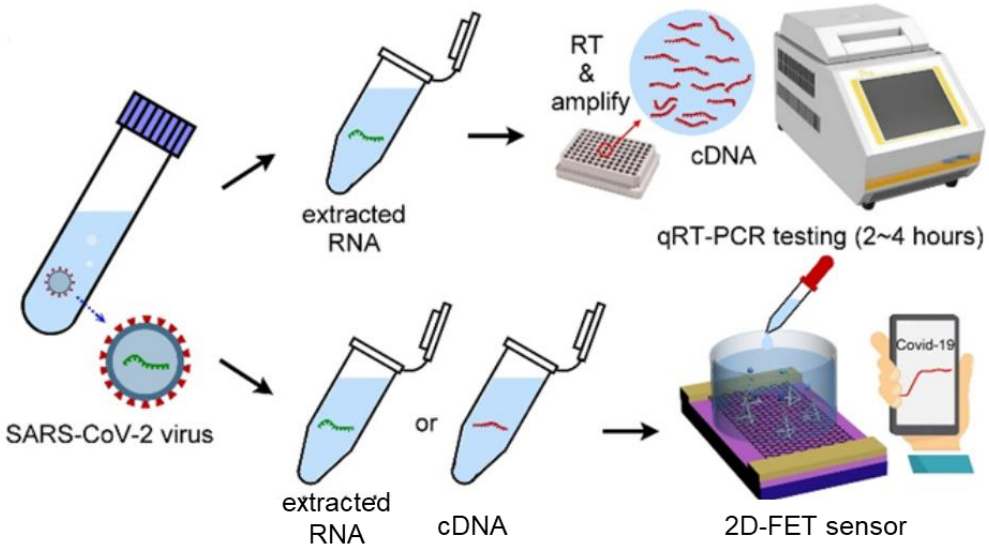
Field-effect transistor is a basic component in integrated circuits, which functions as a current switch. The probes are immobilized on the semiconductor channel. When the probe recognizes the analyte, the doping effect will change the current in the channel.

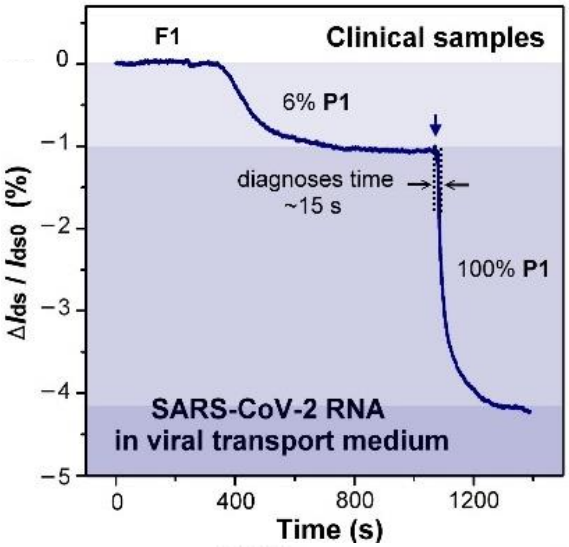
➢ COVID-19 nucleic acid testing

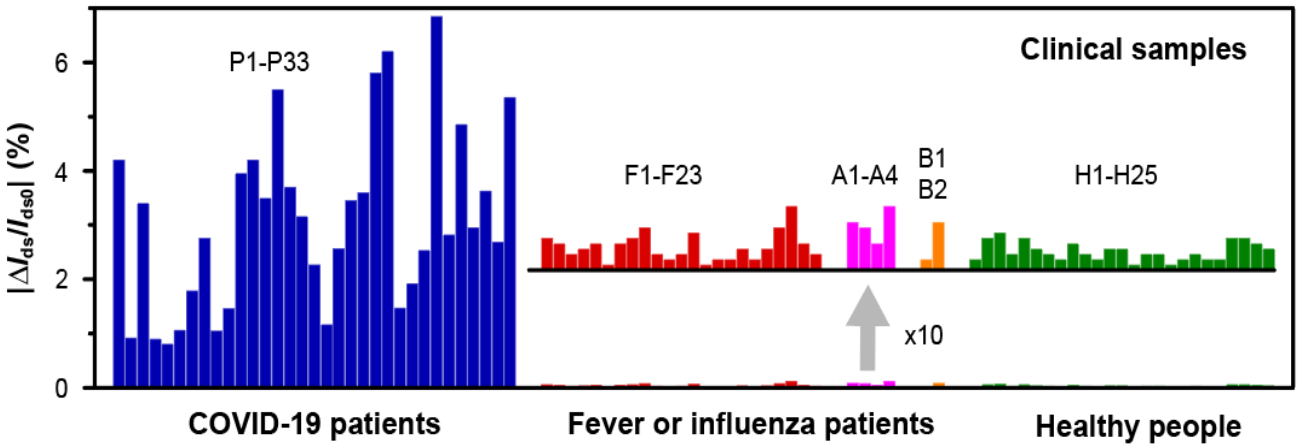


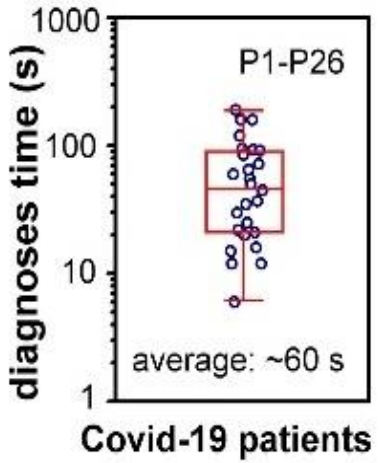
Wei*, et al. *Nat. Biomed. Eng.* 2022, *6*, 276–285

We immobilize DNA nanostructures on transistor, and the probes are electromechanically actuated downwards, enhancing the current response compared with the sensor with ss-DNA probes.







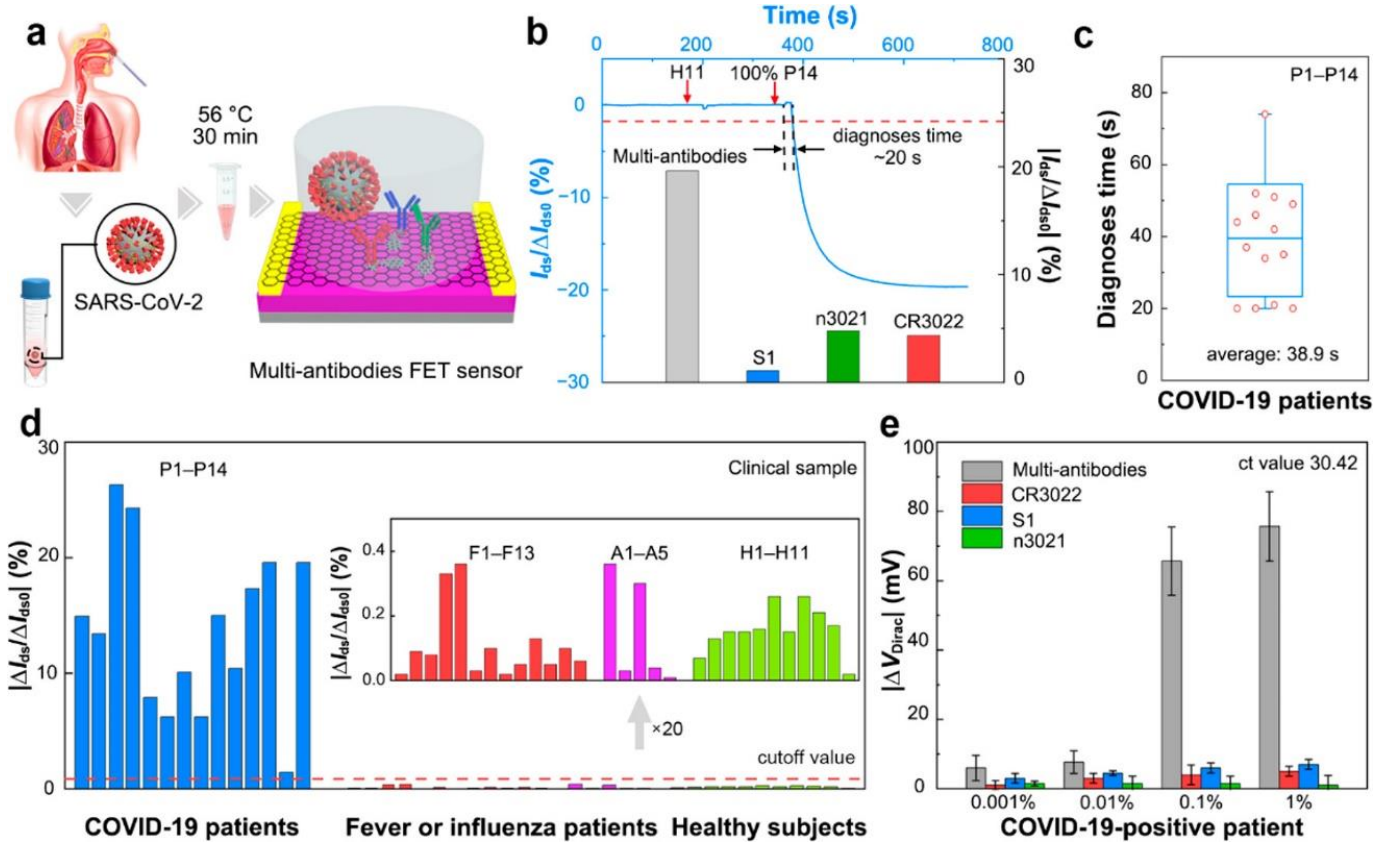


Clinical sample: nasopharyngeal swab **Response time:** **< 4 min**

Limit of detection (LoD): **~20 copies/mL**

No amplification, direct electrical read-out, easy operation

➢ COVID-19 antigen/antibody testing



Wei*, et al. *J Am Chem Soc* 2021, 143, 19794; Wei*, et al. *Nano Lett* 2021, 21, 7897

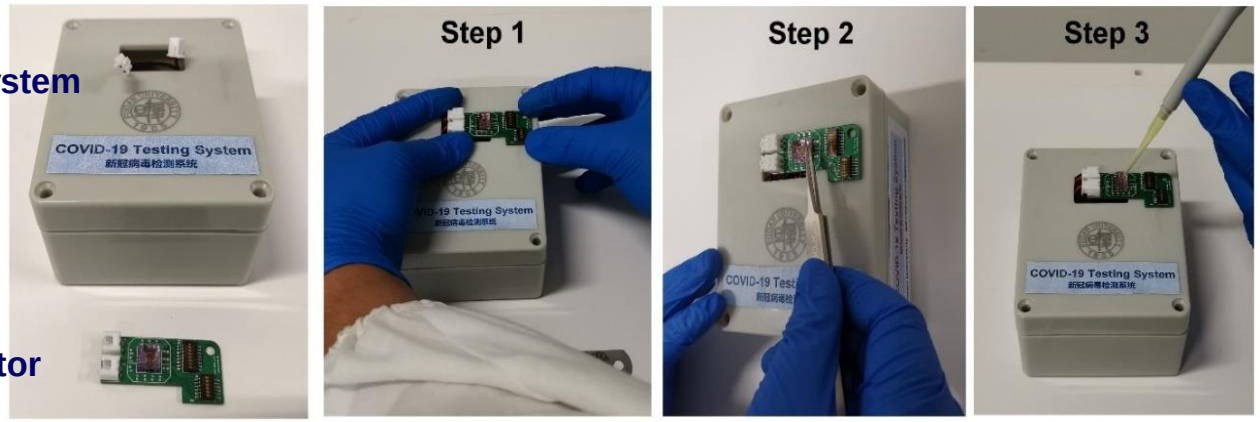
Clinical sample: nasopharyngeal swab, serum

Antigen testing: response time **~1 min**, LoD **~10^{-17} g mL^{-1}**.

Antibody testing: response time **~5 min**, LoD **~10^{-16} g mL^{-1}**.

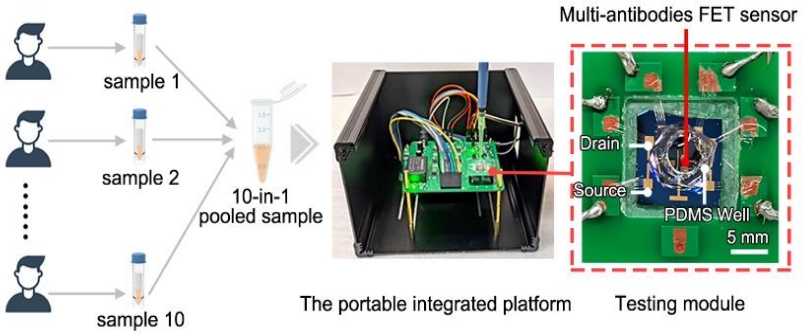
Portable COVID-19 testing system

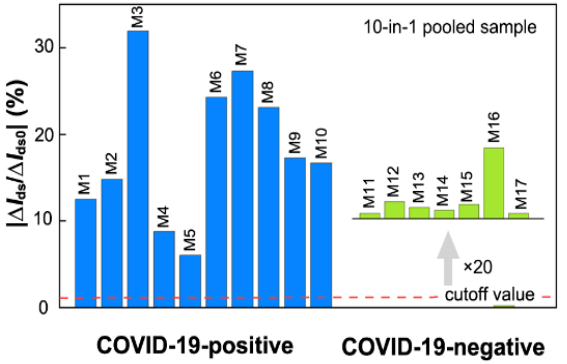
- **Size:** 12 cm x 9 cm x 6 cm
- **Weight:** <500 g
- **Analyte:** RNA、antigen、antibody
- **LoD:** **~50 copies/mL (RNA)**
- **Response time:** **< 4 min (RNA)**
- **Status:** Developing product prototype



➢ Summary: advantages

- ✓ Easy operation **without nucleic-acid extraction and amplification**
- ✓ Rapid response (within several minutes)
- ✓ High sensitivity with ultra-low LoD
- ✓ **10-in-1 pooled testing** for screening test

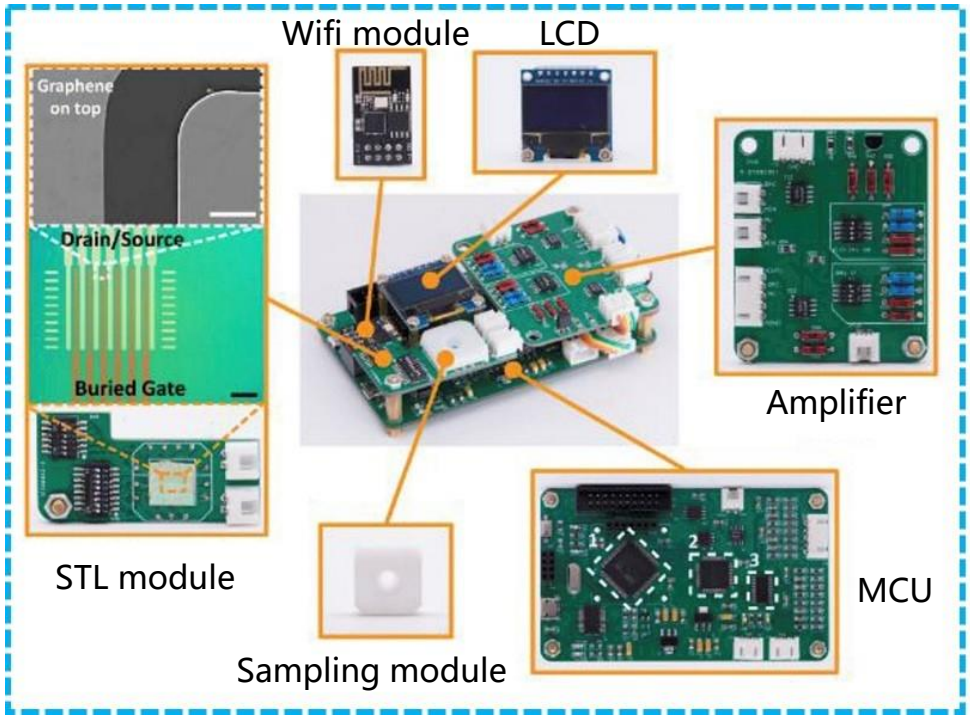




- ✓ Capability for **combined detection of RNA and antigen**
- ✓ High integration (tens of μm size for a transistor sensor)
- ✓ Portable system for POCT applications

➢ Summary: outlook

A new molecular diagnostic platform for Pathogen X



A portable system

Pathogens:

SARS-CoV-2, Influenza A virus, Influenza B virus, rhinovirus, tubercle tuberculosis, … …

Thanks for your attention!

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