Supplementary Material

Graphene Oxide Coated Tapered Microfiber Acts as a Super-sensor for Rapid Detection of SARS-CoV-2 †

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S1. Preparation of tapered optical fiber by fusion method

The microfibers were fabricated by the fusion method. This method is simple and flexible to prepare the tapered optical fiber. It can control the progress of the experiment at any time, and the preparation period is short. The experimental equipment is shown in the Fig. S1A. The oxyhydrogen flame locally heats the tapered fiber and the stepping motor stretches both ends of fiber at the same time. The high temperature of the oxyhydrogen flame can make the silica molten, and the product of combustion is water, which is relatively clean and will not pollute the optical fiber and the environment. The air outlet of the oxyhydrogen flame generator is equipped with a pressure valve for free adjustment of the airflow size. Two electric displacement platforms with the same parameters are fixed on the optical platform, and at the same time, a controller is used to define the motor movement.By controlling flame temperature and motor speed, it is possible to ensure that the optical fiber maintains similar dimensions in a small area.

Constant temperature and stepping speed can avoid the fragility of tapered fibers. To obtain a stable and repeatable tapered fiber with a cladding diameter of about 10 μm, the pressure of the air valve was kept at 20 Pa, with a stepper motor speed of 2 mm/min and stretching size of 5000 μm. The fabricated tapered fibers could exhibit very less stress and strain with an optimum fabrication parameters.[1] During the stretching process, the spectrum was monitored in real time. Broadband light source with a wavelength range of 1250-1650 nm was selected and input to the optical fiber, while the fiber output part was connected to an optical spectrum analyzer, which could monitor the wavelength selectivity by measuring the transmittance of the tapered optical fiber. As shown in Fig. S1B, T1, T2 and T3 are three different microfibers, but their size (the cladding diameter are 10.38, 10.36, 10.78 μm) and spectra are similar, showing a good repeatability.

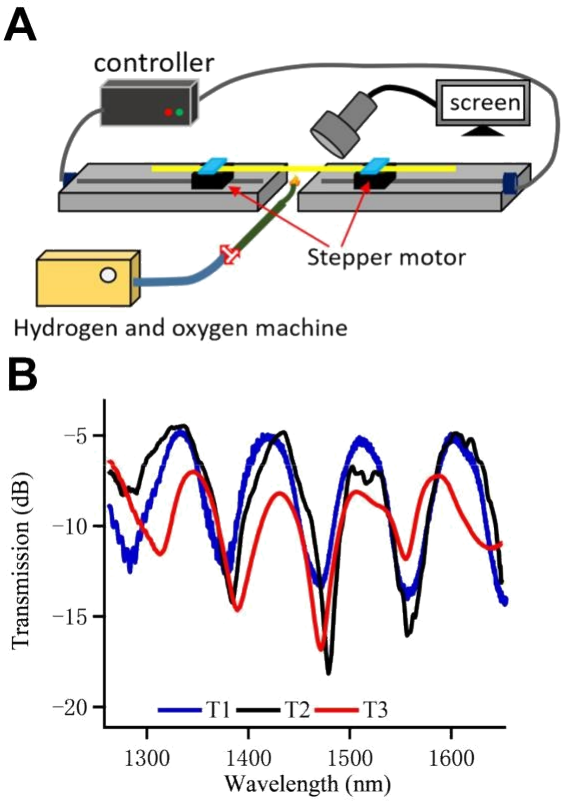

Fig.S1 (A) Experimental equipment for preparing tapered fiber. (B) Spectrum of the three tapered fibers.

S2. Detect N protein in the liquid pool

After preparing the tapered fiber, a self-made U-shaped fiber holder is used for fixing, the fiber is attached on a holder with the help of UV glue to prevent from breaking during the process of functionalization and movement. In order to maintain stability during the biological test, a liquid pool was used in the experiment[2], as shown in Fig. S2. It not only saves reagents, but also provides a relatively stable environment. During the process of capturing N protein by the functionalized optical fiber of the probe aptamer molecule, the spectrometer repeatedly scans until the spectrum is stable. The total measurement time is about 3 minutes.

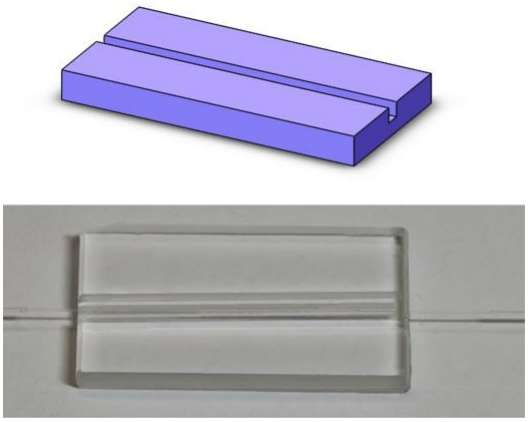

Fig. S2 Schematic diagram of liquid pool device.

S3. Serological assays for SARS-CoV-2 detection

Our sensing platform is compared with commercial serological trials and similar sensors in the following. The performance parameters are shown in Table S1, such as analysis principle, target molecule, assay time, portability, user experience requirements, sensitivity to false results and LOD for new sensor.

Reverse transcription polymerase chain reaction (RT-PCR) is a reliable method to detect the genome of SARS-CoV-2 at the early stage of the infection.[3] Due to the errors in sampling and testing, false-negative results on RT-PCR for SARS-CoV-2 are very common in clinical settings. Enzyme linked immunosorbent assays (ELIA) and enzyme Immunoassay (EIA) can deliver accurate results but a little expensive and requiring trained operators and longer assay time. Electrochemiluminescence Immunoassay (ECLIA) offer comparable assay time (20-30 min) with quantitative information.[4]

Table. S1 also lists 4 similar sensors: opto-microfluidic chip (OMC) biosensor platform[4], cobalt-functionalized TiO_2 nanotubes (Co-TNTs)-based electrochemical sensor[5], molecularly imprinted polymers (MIPs) sensor[6] and field-effect transistor (FET)-based biosensing.[7] They have the characteristics of portability, low user operation requirements and short detection time. Compared with these sensors, our sensor has a lower detection limit, a short detection time and a low price.

Table S1: Comparison with commercial and similar COVID-19 serological assays

Serology test	Target	Assay time	Process type	Portability	Experienced operators	Susceptible to false negatives	LOD	Linear range
RT- PCR	RdRp+, E or N+	4h	Cartridge	No	Yes	Yes	-	-
ELISA	IgG, IgM	2-4 h	Plate	No	Yes	No	-	-
EIA	IgG, IgM	2h	Plate	No	Yes	No	-	-
ECLIA	IgG, IgM	20 min	Plate	Yes	No	N/A	-	-
OMC	IgG, IgM	30min	LSPR optomicrofluidic device	Yes	No	No	5×10^{-13} M	6.5×10^{-13} - 6.5×10^{-7} M
Co-TNT	Spike-RBD	30s	Plate	Yes	No	No	14×10^{-9} M	14×10^{-9} - 14×10^{-7} M
MIPs	Nucleocapsid	15min	Plate	Yes	No	No	15×10^{-15} M	2.22×10^{-15} - 1.11×10^{-13} M
FET	Spike	1h	Plate	Yes	No	No	1 fg/mL	1.6×10^{1} - 1.6×10^{4} Pfu/mL
Our work	Nucleocapsid	3 min	Spectrograph	Yes	No	No	6.25×10^{-19} M	6.25×10^{-19} - 6.25×10^{-7} M

Legend:

RT- PCR - Reverse transcription polymerase chain reaction
ECLIA - Electrochemiluminescence Immunoassay
ELISA - Enzyme linked immunosorbent assays
EIA - Enzyme Immunoassay
OMC - Opto-microfluidic chip
Co-TNT - Cobalt-functionalized TiO_2 nanotubes
MIPs - Molecularly imprinted polymers
FET - Field-effect transistor

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