

Electronic Supporting Material

Development of Pseudo 3D Covalent Organic Framework Nanosheets for Sensitive and Selective Biomolecule Detection of Infectious Disease

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Characterization

The morphology of the p-3D-COF-NSs was studied using field emission transmission electron microscopy (FE-TEM, FEI Tecnai F20). The sample was prepared by placing a drop of the p-3D-COF-NSs solution on to a non-coated copper grid and allowing the solvent to evaporate in the air at room temperature. HRTEM images were recorded using a Gatan K2 Summit direct-detection electron-counting camera at an operating voltage of 300 kV. The samples used for atomic force microscopy (AFM) were prepared using an ethanolic suspension of the p-3D-COF-NSs dropped onto piranha-cleaned Si/SiO₂, allowing the solvent to evaporate in air. The AFM images were recorded using a Dimension 3100 atomic force spectrometer equipped with a NanoScope_Analysis_v140r1sr2 controller (AFM, NanoscopeIIIa, Digital Instruments, Inc., USA) operated in the tapping mode under an air atmosphere. The sample used for X-ray diffraction (XRD) analysis was prepared using dried p-3D-COF-NSs placed on a clean glass substrate. XRD analysis was performed on a PANalyticalX'PertPRO MPD operated at 40 kV and 30 mA using Cu K α as the X-ray source ($\lambda=1.540598 \text{ \AA}$) over a 2θ angle range of 2° – 40° at a scan rate of $0.0262606 \text{ deg s}^{-1}$. Field emission scanning electron microscopy (FESEM) was carried out on a Hitachi S-4800 instrument. The samples were treated with 5 nm Pt sputtering before observation. Fourier transform infrared (FT-IR) spectroscopy was carried out on a PerkinElmer FTIR spectrometer in transmittance mode over the wavenumber range of 400 – 4000 cm^{-1} . UV–vis spectra were recorded on a UV–vis spectrophotometer (UV–vis, Optizen 3220, Double beam). Fluorescence spectrometry was carried out on a HITACHI F-7000 fluorescence spectrophotometer. Thermogravimetric analysis (TGA) was performed on a TA Instruments DSC-TGA, SDT-Q600 V20.5 Build 15 system, in the temperature range of 30 – $800 \text{ }^\circ\text{C}$ under a flow of N₂ (30 mL min^{-1}) at a heating rate of $10 \text{ }^\circ\text{C min}^{-1}$. The porosity and surface area of the p-3D-COF-NSs were measured using nitrogen adsorption/desorption analysis at 77 K using a Micromeritics ASAP 2000 instrument. Before the experiment, the sample was dried at $120 \text{ }^\circ\text{C}$ and evacuated for 8 h under a flow of argon at a flow rate of 60 SCCM at $140 \text{ }^\circ\text{C}$. The pore size distribution data were calculated based on the non-local density functional theory (NLDFT) by using the Micromeritics ASAP2020 software package.

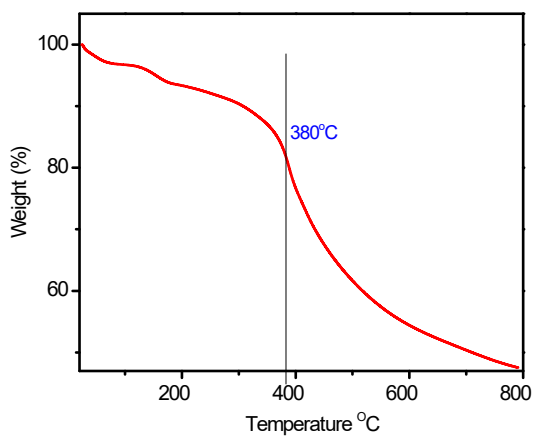


Figure S1. TGA-TDA spectrum of p-3D-COF-NSs

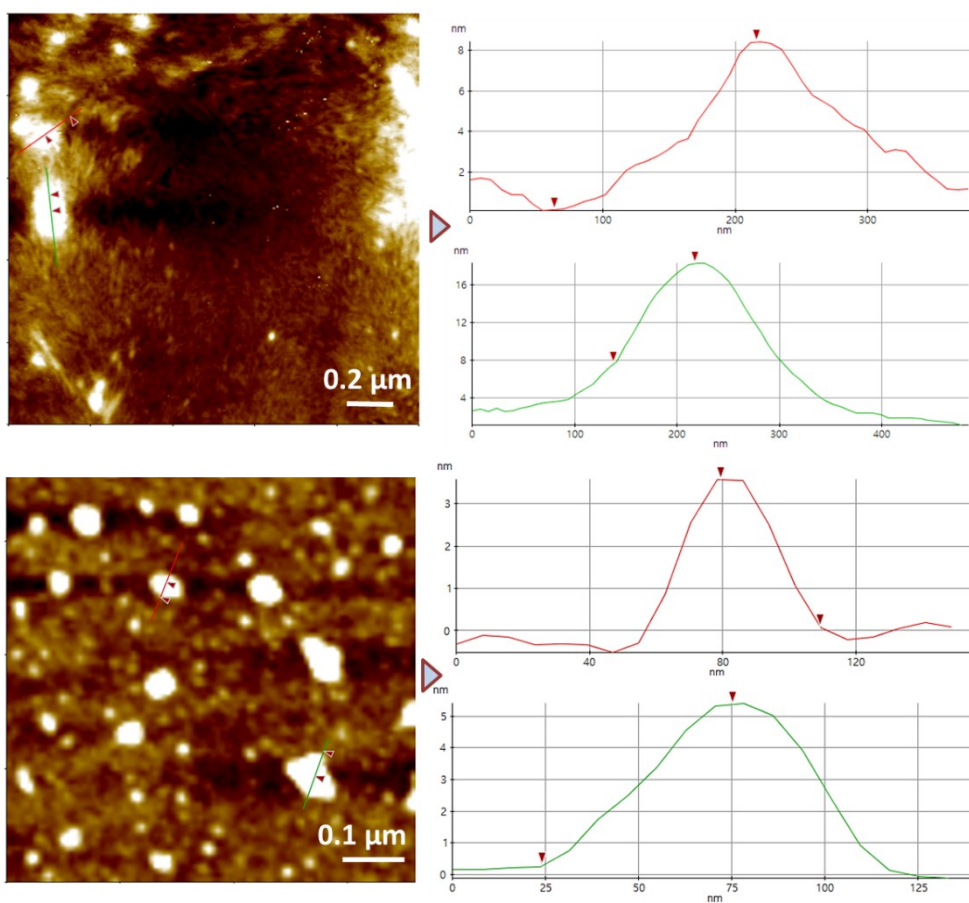


Figure S2. AFM images of the p-3D-COF-NSs, confirming the sheet-like morphology. Thickness distribution of p-3D-COF-NSs.

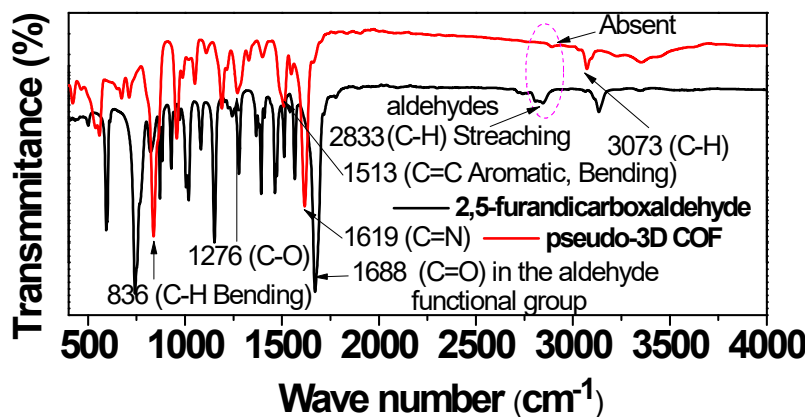


Figure S3. FTIR-spectrum of p-3D-COF-NSs and 2,5-furandicarboxaldehyde

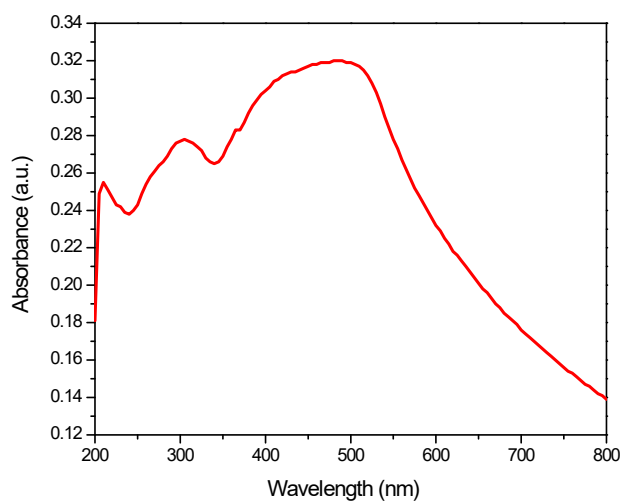


Figure S4. UV spectrum of p-3D-COF-NSs

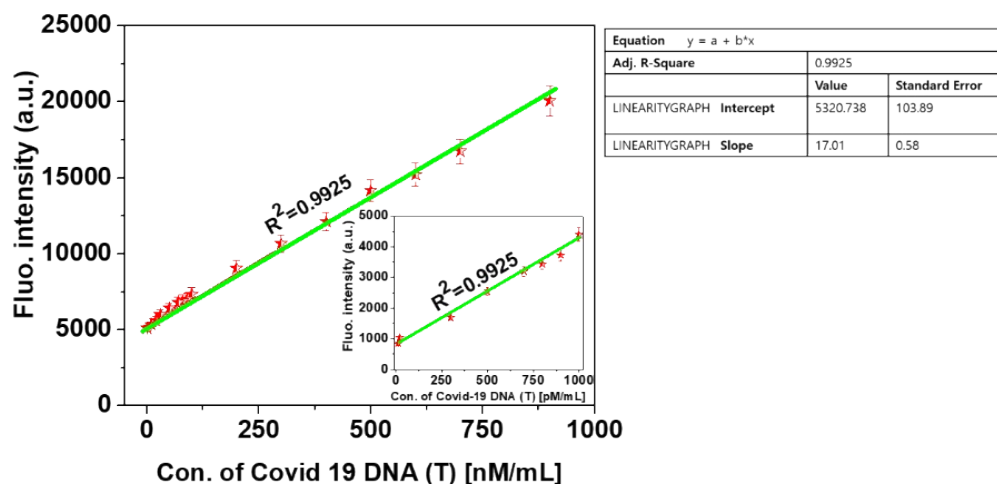


Figure S5. Linearity curve of COVID-19 DNA (T) detection concentrations with presence of p-3D-COF-NSs and ssDNA. The excitation wavelength is 590 nm, and the monitored emission wavelength is 612 nm. The detection limit of T (Corona Virus DNA in this study) using p-3D-COF-NSs sensor is determined from the following equation: $DL = K \times SD/S$, where $K = 3$, SD is the standard deviation of the blank solution, and S is the slope of the calibration curve. $DL = K \times SD/S = 3 \times 13.05/17.01 \text{ pM} = 2.301 \times 10^{-12} \text{ M}$ (therefore, finally limit of detection=2.301 pM).

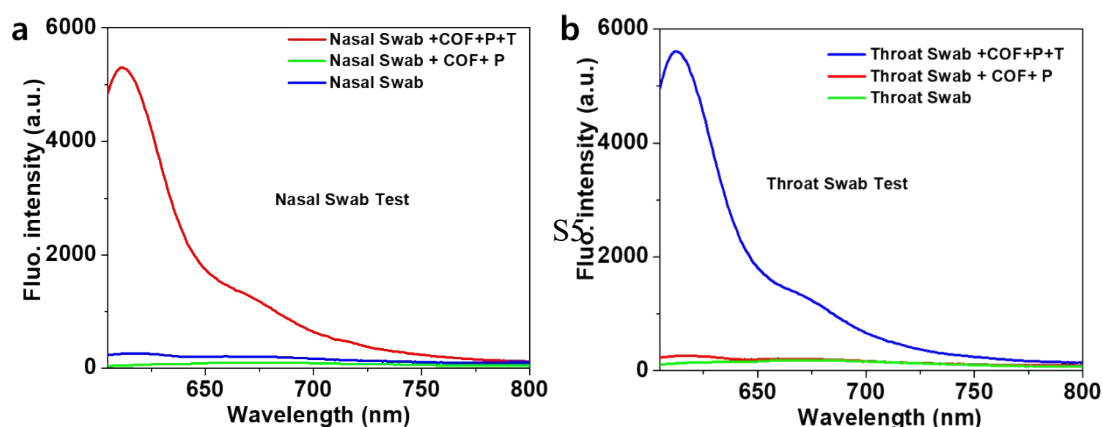


Figure S6. Comparison of real spectrum a) Nasal swab and b) Throat swab under different conditions

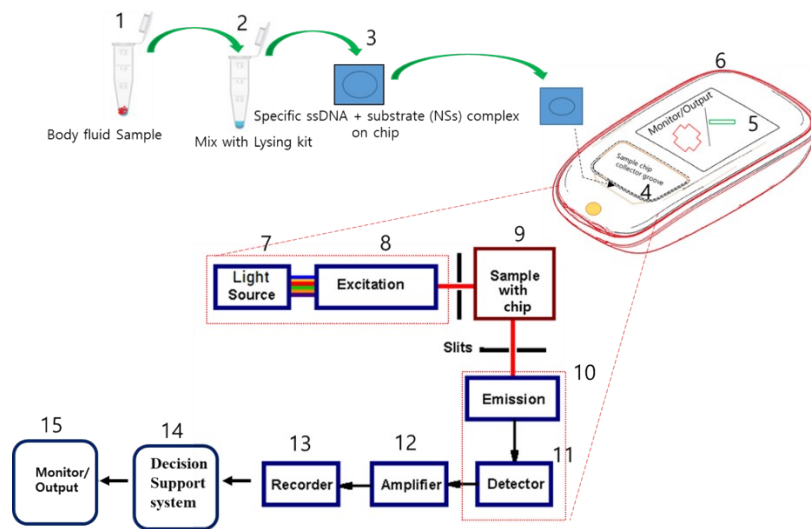


Figure S7. Based on this assay we proposed a prototype device to detect Covid-19 and as well as other diseases

Table S1. Crystallographic information of the p-3D-COF-NSs

Empirical formula	$\text{C}_{13}\text{H}_{16}\text{N}_2\text{O}$
Fw	216.28
Stacking model	slipped-AA
a (Å)	28.72002 ± 0.12638
b (Å)	30.27715 ± 0.13340
c (Å)	3.92065 ± 0.01755
α (degree)	90.17498 ± 0.00465
β (degree)	90.04307 ± 0.00793
γ (degree)	120.21208 ± 0.00744
Interlayer Distance (Å)	3.91903Å

Table S2. Atomic information for modeled p-3D-COF-NSs

C(1)	-14.786	0.299	-0.079
C(2)	-15.599	-0.726	0.193
C(3)	-15.064	-1.971	0.526
C(4)	-15.913	-3.041	0.810
C(5)	-17.296	-2.867	0.761
C(6)	-17.830	-1.622	0.429
C(7)	-16.982	-0.552	0.145
C(8)	-19.315	-1.435	0.377
C(9)	-13.056	2.032	-0.538
C(10)	-12.114	3.027	-0.802
C(11)	-12.535	4.312	-1.145
C(12)	-13.897	4.602	-1.224
C(13)	-14.838	3.607	-0.961
C(14)	-14.418	2.322	-0.617
N(15)	-15.269	1.424	-0.379
N(16)	-11.680	5.215	-1.384
C(17)	-15.339	-4.377	1.166
H(18)	-13.695	0.162	-0.041
H(19)	-13.973	-2.109	0.564
H(20)	-17.965	-3.711	0.985
H(21)	-17.403	0.430	-0.118
H(22)	-19.819	-2.394	0.631
H(23)	-19.615	-0.652	1.109
H(24)	-19.613	-1.120	-0.648
H(25)	-12.725	1.019	-0.267
H(26)	-11.040	2.798	-0.739
H(27)	-14.228	5.615	-1.495
H(28)	-15.913	3.836	-1.023
H(29)	-14.227	-4.320	1.153
H(30)	-15.682	-4.668	2.184
H(31)	-15.680	-5.136	0.428