Table S1. Carbon nanomaterial-based conventional electrochemical sensors for infectious disease and tumor diagnosis

CNs (or hybrid)		Detection method	Biomarkers	Key application approaches	Linear range	LOD	Ref.
CNTs	With PAN and AuNPs	DPV	the IS6110 DNA sequence specific for *Mycobacterium tuberculosis*	Complexation of CNTs and signal probes as tracer labels; Hybridization with fragments of bulk capture probes on the electrode surface; Current signal measurement.	1 fM-10 nM	0.33 fM	70
GO	With SCX8	DPV	the RNA of SARS-CoV-2	Complexation of SCX8-RGO with label probes and auxiliary probes as tracer labels; Formation of capture probe/target RNA/label probe-auxiliary probe-SCX8-RGO complexes on the electrode surface; Current signal measurement.	0.1 aM-1 pM	3 aM	71
nano-C_{60}	With AuNPs and nitrogen-doped graphene nanosheet	DPV	the IS6110 DNA sequence specific for *Mycobacterium tuberculosis*	Complexation of nano-C_{60} and signal probes as tracer labels; Formation of the capture probe/target DNA/signal probe-nano-C_{60} complex on the electrode surface; Current signal measurement	10 fM-10 nM	3 fM	72
C_{60}	With PAMAM, MOF and AuNPs	DPV	miR-3675-3p	Complexation of C_{60} and signal probes as tracer labels; Formation of the capture probe/target DNA/signal probe-C_{60} complex on the electrode surface; Current signal measurement	11 fM-10 nM	2.99 fM	73
GO	With PANI and glutaraldehyde	ASV	K562 cells	Immobilization of Con A by GO on the electrode surface; Recognition of K562 cells by Con A and aptamer to form a sandwich complex (Con A-K562 cell-aptamer); Current signal measurement.	10^2-10^7 cells mL^{-1}	60 cells mL^{-1}	74
C_{60}	With MWCNTs, PEI, and Pqdot	DPV	Thrombin	Immobilization of specific aptamers by C_{60} on the electrode surface; Specific recognition and binding of thrombin by the aptamer; Current signal measurement.	50 fM-20 nM	6 fM	75
CNTs (MWCNTs)	With WO_3 and polymeric films of PM-AP	EIS	SARS-CoV-2 particles	In situ electrodeposition of PM-AP polymeric films on CNTs/WO_3 electrodes; Imprinting of intact viral particles on PM-AP polymeric membranes; Washing of the polymeric membrane to create complementary binding sites for viral particles; Specific binding of viral particles from the specimen on the electrode surface; Current signal measurement.	7-320 pg mL^{-1}	57 pg mL^{-1}	76
Graphene	With PI	DPV	SARS-CoV-2 NP, S1-IgM, S1-IgG and CRP	Immobilization of specific antigen/antibody on the electrode surface by graphene; Antigen-antibody specific binding on the electrode surface; Current signal measurement.	NP: 0-5000 pg mL^{-1}; S1-IgM and S1-IgG: 0-500 ng mL^{-1}; CRP: 0-50 ng mL^{-1}	-	77
GQDs	With AuNPs and GO	SWV	miRNA-21, miRNA-155 and miRNA-210	Immobilization of redox species and capture probes by GQDs on the electrode surface; Complementary pairing of capture probes and target miRNAs; Current signal measurement.	1 fM-1000 pM	miRNA-21: 0.04 fM; miRNA-155: 0.33 fM; miRNA-210: 0.28 fM	78

Notes: CNs, carbon nanomaterials; LOD, limit of detection; CNTs, carbon nanotubes; PAN, polyaniline; AuNPs, gold nanoparticles; DPV, differential pulse voltammetry; GO, graphene oxide; SCX8, p-sulfocalix[8]arene; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SCX8-RGO, SCX8 functionalized graphene; nano-C_{60}, fullerene nanoparticles; C_{60}, fullerene; PAMAM, poly(amidoamine); MOF, metal-organic framework; PANI, polyaniline; ASV, anodic stripping voltammetry; Con A, knife bean protein A; MWCNTs, multi-walled carbon nanotubes; PEI, polyethylenimine; PQdot, polymer quantum dots; WO_3, tungsten oxide; PM-AP, poly(meta- aminophenol); EIS, electrochemical impedance spectroscopy; PI, polyimide; NP, nucleocapsid protein; S1-IgM and S1-IgG, specific immunoglobulins (Igs) against SARS- CoV-2 spike protein (S1); CRP, C-reactive protein; GQDs, graphene quantum dots; SWV, square wave voltammetry; miRNAs, microRNAs.

Table S2. Carbon nanomaterial-based FET, PEC and ECL sensors for infectious disease and tumor diagnosis

CNs (or hybrid)		Detection method	Biomarkers	Key application approaches	Linear range	LOD	Ref.
Graphene	With PBASE	FET	SARS- CoV-2 spike protein	Immobilization of SARS-CoV-2 spike antibody on the surface of graphene-modified electrodes by PBASE; Antigen-antibody specific binding on the electrode surface; FET signal measurement.	-	1 fg mL^{-1}	83
RGO	With AuNPs	FET	HepG2 cell-derived MVs	Immobilization of specific aptamers on the surface of RGO-modified electrodes by AuNPs; Specific recognition and binding of HepG2 cell-derived MVs by aptamers; FET signal measurement.	6×10^5-6×10^9 particles mL^{-1}	84 particles μL^{-1}	84
Graphene	With TWEEN 80	FET	IFN-γ, TNF-α, and IL-6	Immobilization of specific aptamers on the surface of electrodes (sensing channels) by graphene; Specific recognition and binding of target biomarkers by the aptamer in the sensing channel; FET signal correction between the sensing channel and the reference channel.	IFN-γ: 0.1-500 nM; TNF-α: 0.05-200 nM; IL-6: 0.05-20 nM	IFN-γ: 476 fM; TNF-α: 608 fM; IL-6: 611 fM	85
GO	With Sb_2Se_3	PEC	Dam MTase	Immobilization of hDNA on the electrode surface by Sb_2Se_3-GO; Cleavage of hDNA to ssDNA by Dam MTase and Dpn-I enzyme; Hybridization of ssDNA with AuNP-functionalized DNA; Competitive consuming of light and EET between Sb_2Se_3 and AuNPs; PEC signal measurement.	1 mU mL^{-1}-100 U mL^{-1}	0.6 mU mL^{-1}	89
GQDs	With zeolitic imidazolate framework-8 (ZIF-8) polyhedra	PEC	M.SssI MTase	Labeling SA on the surface of GQDs@ZIF-8 and acting as quenchers of PEC signals; Recognition of biotin-labeled ssDNA by SA; Formation of electrode-ssDNA1/biotin-ssDNA2/GQDs@ZIF-8-SA complexes; Cleavage of dsDNA formation from ssDNA1 and ssDNA2 by M.SssI MTase and Hpall enzyme; Partial freeing of GQDs@ZIF-8-SA in the electrolyte; PEC signal measurement.	5 mU mL^{-1}-150 U mL^{-1}	4 mU mL^{-1}	90
gC_3N_4	With CdS QDs and Chitosan	PEC	SARS-CoV-2 RBD	Immobilization of the specific aptamer onto the electrode surface by gC_3N_4; Specific recognition and binding of SARS-CoV-2 RBD by the aptamer; Blocking of the natural diffusion of ascorbic acid as an electron donor by the SARS-CoV-2 RBD-aptamer complex (PEC signal off); PEC signal measurement.	0.5-32.0 nM	0.12 nM	91
C_{60}	With AuNPs and MoS_2	PEC	ATP	Immobilization of capture probes by C_{60} on the electrode surface; Recognition and binding of ATP by aptazyme induces breakage of output S1 from the Pbs QD-labeled DNA linker; Recognition and binding of output S1 by the capture probe on the electrode surface; Consumption of light energy and electron donors by Pbs QDs in competition with C_{60}-AuNP@MoS_2; PEC signal measurement.	10 fM-100 nM	3.3 fM	92

C_{60}	With $[Ru(dcbpy)_2dppz]^{2+}$, Rose Bengal dyes and Dep Au	PEC	A fragment sequence of p53 gene	Immobilization of capture probes by C_{60} on the electrode surface; Binding of target DNA and hairpin probe induces clipping of hairpin probe by Nt.BstNB I enzyme to form SiO_2 NPs-labeled DNA sequences (output); Recognition and binding of output by the capture probe on the electrode surface; Increased electrode surface steric hindrance by SiO_2 NPs inhibits the photoelectric conversion of $[Ru(dcbpy)_2dppz]^{2+}$ and Rose Bengal dyes; PEC signal measurement.	0.1 fM-1 nM	37 aM	93
C_{60}	With Dep Au	PEC	A fragment sequence of MTB	Immobilization of capture probes by C_{60} on the electrode surface; Binding of the target to the protection DNA drives DNA Walker to bind to the detection probe, providing a shear point for Nb.BvCI enzyme to form the product; Recognition and binding of product by the capture probe on the electrode surface; Insertion of MB into the double-stranded DNA formed by the capture probe-product and sensitization of C_{60}; PEC signal measurement.	10 fM-100 nM	3.3 fM	94
C_{60}	With Co_3O_4 and Dep Au	PEC	A fragment sequence of p53 gene	Immobilization of DNA Walker-protection DNA complexes and SiO_2-labeled signal probes on the electrode surface by C_{60}; Binding of target DNA and hairpin probe induces shearing of the hairpin probe by Nt.BstNB I enzyme to form output DNA; Binding of the output DNA to the protection DNA drives DNA Walker to bind to the SiO_2-labeled signal probe, providing a site for the Nb.BbvCI enzyme to shear the signal probe; Sheared SiO_2-labeled signal probes free into the electrode solution and reduced steric hindrance at the electrode surface; PEC signal measurement.	60 aM-1 × 10^5 aM	20 aM	95
Fullerenol	-	PEC	Mutant human p53 gene fragment	Fullerenol exhibits a photocurrent response; Quenching of the photocurrent response of fullerenol by hydrogen bonding between AuNPs-labeled probes and fullerenol; Complementary binding of target DNA to AuNPs-labeled probes and dissociation of AuNPs from the surface of fullerenols; PEC signal measurement.	1 fM-100 pM	0.338 fM	96
CNTs (MWCNTs)	With CS, PDDA, GQDs and AuNPs	ECL	Glucose	Modification of MWCNTs and GQDs on CBC can promote potential reduction reactions and increase the electron transfer rate between the cathode and the anode; GOD modified on the surface of CBA catalyzes the oxidation of glucose to H_2O_2; Involvement of H_2O_2 in the luminol electrochemiluminescence reaction; ECL signal measurement.	100 nM-5000 μM	64 nM	97
GO	With HBP, $Ru(bpy)_2(phen-NH2)^{2+}$ and NCND	ECL	CA19-9	Immobilization of $Ru(bpy)_2(phen-NH_2)^{2+}$-NCND and CA19-9 antibody 1 on the electrode surface by GO; $Ru(bpy)_2(phen-NH_2)^{2+}$ as luminescent label and NCND as luminescent coreactant agent; Formation of electrode-CA19-9 antibody 1/CA19-9 antigen/CA19-9 antibody 2-MoS_2 sandwich complexes; Resonance energy transfer from $Ru(bpy)_2(phen-NH_2)^{2+}$ to MoS_2 nanosheets; ECL signal measurement.	2 mU mL^{-1}-50 U mL^{-1}	0.25 mU mL^{-1}	98

C_{60}	With BSA and luminol	ECL	Insulin	Immobilization of aptamer 1 on the electrode surface by $C_{60;}$ Formation of electrode-aptamer I/insulin/Fc@aptamer II sandwich complexes; Catalysis of the luminol-H_2O_2 electrochemiluminescence reaction by Fc; ECL signal measurement.	0.1 pg mL^{-1}-1000 ng mL^{-1}	0.04 pg mL^{-1}	99
GQDs	With AuNPs and PEI	ECL	PSA	Complexation of GQDs and antibody 2 as chemiluminescent labels; Formation of electrode-antibody 1/PSA/antibody 2-GQD sandwich complexes; Electrochemiluminescence reaction of GQDs; ECL signal measurement.	1 pg mL^{-1}-100 ng mL^{-1}	0.44 pg mL^{-1}	100
CQDs	With silver ions and PNS-PEI	ECL	HCG	Complexation of AgCQDs and antibody 2 as chemiluminescent labels; Immobilization of antibody 1 on the electrode surface by rGO; Formation of electrode-antibody1/PSA/antibody2-AgCQD sandwich complexes; Electrochemiluminescence reaction of AgCQDs; ECL signal measurement.	0.001 mIU mL^{-1}-500 mIU mL^{-1}	0.33 mIU mL^{-1}	101

Notes: CNs, carbon nanomaterials; LOD, limit of detection; PBASE, 1-pyrenebutyric acid N-hydroxysuccinimide ester; FET, field-effect transistor; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; RGO, reduced graphene oxide; AuNPs, gold nanoparticles; MVs, microvesicles; IFN, interferon; TNF, tumor necrosis factor; IL, interleukin; GO, graphene oxide; Sb_2Se_3, antimony selenide; PEC, photoelectrochemically; MTase, DNA methyltransferase; hDNA, hairpin probe DNA; ssDNA, single-stranded DNA; EET, exciton energy transfer; GQDs, graphene quantum dots; SA, streptavidin; gC_3N_4, graphitic carbon nitride; CdS, cadmium sulfide; QDs, quantum dots; RBD, receptor-binding domain; C_{60}, fullerene; MoS_2, molybdenum(IV)sulfide; ATP, adenosine triphosphate; PbS QDs, PbS quantum dots; Dep Au, AuNPs layer; SiO_2 NPs, SiO_2 nanoparticles; MTB, *Mycobacterium tuberculosis* ; MB, methylene blue; Co_3O_4, cobaltosic oxide; CNTs, carbon nanotubes; MWCNTs, multi-walled carbon nanotubes; CS, chitosan; PDDA, poly(diallyldimethylammonium chloride); ECL, electrochemiluminescence; CBC, cathode of closed bipolar electrode; GOD, glucose oxidase; CBA, anode of closed bipolar electrode; H_2O_2, hydrogen peroxide; HBP, hyperbranched aromatic polyamide; NCND, nitrogen-doped carbon nanodots; CA19-9, carbohydrate antigen 19-9; BSA, bovine serum albumin; Fc, ferrocenecarboxylic acid; PEI, poly(etherimide); PSA, prostatespecific antigen; CQDs, carbon quantum dots; PNS, polymer nanospheres; HCG, human chorionic gonadotropin; rGO, reduced graphene oxide.

Table S3. Carbon nanomaterial-based optical sensors for infectious disease and tumor diagnosis

CNs (or hybrid)		Detection method	Biomarkers	Key application approaches	Linear range	LOD	Ref.
CNTs (SWCNTs)	-	Colorimetry	Exosomes	Enhanced peroxidase activity of CNTs with adsorption of aptamers by π-π stacking; Specific recognition and binding of exosomes by aptamers; Dissociation of aptamers from the surface of CNTs leading to diminished peroxidase activity; Catalysis of the TMB-H_2O_2 chromogenic reaction by CNTs; Colorimetric measurement.	1.84×10^6 particles μL^{-1}-2.21×10^7 particles μL^{-1}	5.2×10^5 particles μL^{-1}	104
CNTs (SWCNTs)	With POMOF	Colorimetry	L-Cys	Enhanced peroxidase activity by the binding of CNTs to POMOF; Catalysis of TMB-H_2O_2 chromogenic reaction by CNT-POMOF; Inhibition of the oxidation of TMB by L-Cys; Colorimetric measurement.	1 μM-80 μM	103 nM	105
CDs	With MnO_2	Colorimetry	GSH	Enhanced peroxidase activity by the binding of CDs to MnO_2; Catalysis of TMB-H_2O_2 chromogenic reaction by CD-MnO_2; Inhibition of the oxidation of TMB by GSH; Colorimetric measurement.	0.1 μM-10 μM	95 nM	106
GO	With AuNPs	Colorimetry	Breast cancer-associated *BRCA1* mutation	Complexation of GO with signal probes to form detection probes; Formation of Au-coated silicon-capture probe/target DNA/signal probe-GO sandwich complexes; Reduction of 4-NP catalyzed by abundant AuNPs on the GO surface; Colorimetric measurement.	-	-	107
GO	With AuNPs	Colorimetry	*Escherichia coli*	Adsorption of bulk aptamers by GO through π-π stacking; Recognition of *Escherichia coli* by aptamers; Recognition process inducing the transition of AuNPs from dispersion to aggregation; Colorimetric measurement.	10^1 cells mL^{-1}-10^8 cells mL^{-1}	10 cells mL^{-1}	108
GO	With Fe_3O_4 NPs	Colorimetry and photothermal detection	PSA	Complexation of GO with c-DNA as signal probes; Formation of streptavidin@biotin-aptamer/signal probe complexes (without PSA); Formation of streptavidin@biotin-aptamer/PSA complexes (with PSA); Partial freeing of signal probes into solution and conversion of the remaining Fe_3O_4 NPs to PB NPs under acidic conditions; Prussian blue reaction of PB NPs-$K_3[Fe(CN)_6]$; Photothermal phenomena produced by irradiation of PB NPs with 808 nm laser; Colorimetric and photothermal measurements.	1 ng mL^{-1}-128 ng mL^{-1}	0.31 ng mL^{-1}	109
CNTs	With AuNPs	Colorimetry	CEA	Immobilization of detection antibodies on the surface of CNTs as detection probes; Competition for antibody-CNTs by CEA in the sample and by CEA immobilized in the test area of the cotton thread; Aggregation of antibody-CNTs on cotton threads; Colorimetric measurement.	5 ng mL^{-1}-500 ng mL^{-1}	2.32 ng mL^{-1}	110
CNTs	-	Colorimetry	Ferritin antigen	Immobilization of monoclonal capture antibody 2 on the surface of CNTs as detection probes; Formation of cotton thread-antibody 1/ferritin antigen/antibody 2-CNTs sandwich complexes; Aggregation of antibody 2-CNTs on cotton threads; Colorimetric measurement.	100 ng mL^{-1}-5000 ng mL^{-1}	50 ng mL^{-1}	111

CNTs (MWCNTs)	With Fe_3O_4 NPs	Colorimetry	Rabbit IgG	Immobilization of goat anti-rabbit capture antibody on the surface of CNTs as detection probes; Formation of rabbit IgG-detection probe complexes in whole blood and magnetic separation; Formation of test strip-goat anti-rabbit capture antibody/rabbit IgG/goat anti-rabbit capture antibody-CNTs sandwich complexes (test zone); Formation of test strips-donkey anti-goat capture antibody/goat anti-rabbit capture antibody-CNTs complexes (control zone); Colorimetric measurement.	10 ng mL^{-1}-200 ng mL^{-1}	10 ng mL^{-1}	112
GO-N_3	-	Fluorescence	CEA	Quenching of the fluorescence of CD-labeled ssDNA by GO-N_3; Specific recognition and binding of CEA by CD-ssDNA; Increased distance between CDs and GO-N_3 (fluorescence recovery); Fluorescence measurement.	10 pg mL^{-1}-1 ng mL^{-1}	7.32 pg mL^{-1}	116
GO	-	Fluorescence	SARS-CoV-2 spike RBD antibodies	Quenching of the fluorescence of FITC-labeled SARS-CoV-2 spike RBD recombinant protein (F-RBD) by GO; Specific recognition and binding of SARS-CoV-2 spike RBD antibodies by F-RBD; Increased distance between FITC and GO (fluorescence recovery); Fluorescence measurements.	3.9 pg mL^{-1}-400 ng mL^{-1}	3 pg mL^{-1}	117
C_{60}	With CdSe/ZnS core-shell QDs and MNPs	Fluorescence	ssDNA	Immobilization of C_{60}-labeled hairpin probes on the surface of CdSe/ZnS core-shell QDs; Fluorescence quenching of CdSe/ZnS core-shell QDs by C_{60}; Complementary pairing of the target DNA with the hairpin probe; Increased distance of C_{60} from CdSe/ZnS core-shell QDs (fluorescence recovery); Fluorescence measurement.	10 fM-100 nM	100 fM	118
GO	-	Fluorescence	RNase H	In the absence of RNase H, GO adsorbed hairpin probe H0, probe H1 and TAMRA-labelled probe H2, and quenched the fluorescence of H2; Degradation of H0 by RNase H and triggering of HCR between H1 and H2; Increased distance between TAMRA and GO (fluorescence recovery); Fluorescence measurements.	1 mU mL^{-1}–5 U mL^{-1}	0.7 mU mL^{-1}	119
GOQDs	-	Fluorescence	SARS-CoV-2 S antigen, N antigen, S-IgG/S-IgM, and N-IgG/N-IgM	Immobilization of specific antigen/antibodies on the surface of microfluidic chips by GOQDs; Specific binding of antigen-antibodies on the chip surface; Specific binding of antigen-antibody complexes by fluorescently labeled secondary antibodies; Fluorescence measurement.	10^0-10^5 pg mL^{-1}	0.3 pg mL^{-1}	120
gCNQDs	-	Fluorescence	Influenza A virus	Complexation of gCNQDs with antibody 1 to form fluorescent monitoring probes; Formation of gCNQDs-antibody 1/Influenza A virus/antibody 2-MP-MoO_3 QDs sandwich complexes; Magnetic separation to increase the detection concentration of sandwich complexes; Fluorescence measurement.	45 PFU mL^{-1}-25000 PFU mL^{-1}	45 PFU mL^{-1}	121

CDs	With AEAPTMS, SiO_2, and APTES	Fluorescence	SARS-CoV-2 NP	Immobilization of labeled antibodies to SARS-CoV-2 NP on the surface of CDs (red fluorescence) as detection probes; Formation of coated antibody to SARS-CoV-2 NP/SARS-CoV-2 NP/labeled antibody to SARS-CoV-2 NP-CDs sandwich complexes (test line); Formation of goat anti-mouse IgG capture antibody/Labeled antibody to SARS-CoV-2 NP-CDs complex (control line); Fluorescence measurements.	UV light detection mode: 100 pg mL^{-1}-1 μg mL^{-1}; Fluorescence microscope detection mode: 10 pg mL^{-1}-1 μg mL^{-1}	UV light detection mode: 100 pg mL^{-1}; Fluorescence microscope detection mode: 10 pg mL^{-1}	122
rPGO	With AuNPs	SERS and SWV	SARS-CoV-2 spike protein	Immobilization of SARS-CoV-2 spike protein antibodies on the surface of rPGO-modified electrodes by AuNPs; Specific antigen-antibody binding at the electrode surface; Enrichment of hot spots for SERS signals of SARS-CoV-2 spike protein by AuNPs; SERS signal and current signal measurements.	SERS techniques: 100 nM-1 pM; Electrochemical techniques: 100 nM-500 fM	SERS techniques: 75 fM; Electrochemical techniques: 39.5 fM	125
GO	With PDDA and GNS	SERS	Bilirubin	Adsorption of bilirubin by GO-GNS through electrostatic interaction and π-π stacking; Abundance of hot spots provided by GNS for bilirubin SERS signal; SERS signal measurement.	50 μM-150 μM; 150 μM-500 μM	0.436 μM	126
GO	With AuCu alloy	SERS	APE1	SERS activity of AuCu/GO is affected by DNA sequence length (short>long) and base ratio (T>C>G>A); Lack of APE1 and long target sequences caused a decrease in SERS activity of AuCu/GO; APE1 degradation of the target sequence to form small fragments and elevated SERS activity of AuCu/GO; SERS signal measurement.	2 mU mL^{-1}-20 U mL^{-1}	1 mU mL^{-1}	127

Notes: CNs, carbon nanomaterials; LOD, limit of detection; CNTs, carbon nanotubes; SWCNTs, single-walled carbon nanotubes; TMB, 3,3',5,5'-tetramethylbenzidine; H_2O_2, hydrogen peroxide; POMOF, polyoxometalate-based metal-organic framework; L-Cys, L-cysteine; CDs, carbon dots; MnO_2, manganese dioxide; GSH, glutathione; GO, graphene oxide; AuNPs, gold nanoparticles; 4-NP, 4-nitrophenol; NPs, nanoparticles; PSA, prostate specific antigen; c-DNA, complementary DNA; $K_3[Fe(CN)_6]$, potassium ferricyanide; CEA, carcinoembryonic antigen; MWCNTs, multi-walled carbon nanotubes; GO-N_3, azide-functionalized graphene oxide; ssDNA, single-stranded DNA; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; RBD, receptor-binding domain; FITC, fluorescein isothiocyanate; C_{60}, fullerene; QDs, quantum dots; MMPs, matrix metalloproteinases; RNase H, Ribonuclease H; TAMRA, carboxytetramethylrhodamine; GOQDs, graphene oxide quantum dots; S antigen, spike RBD protein; N antigen, nucleocapsid protein; S-IgG/S-IgM, spike RBD IgG/IgM; N-IgG/N-IgM, nucleocapsid IgG/IgM; gCNQDs, graphitic carbon nitride quantum dots; MP-MoO3, magnetic-derivatized plasmonic molybdenum trioxide; AEAPTMS, N-β-(aminoethyl)-γ-aminopropyltrimethoxy; APTES, (3-aminopropyl) triethoxysilane; NP, nucleocapsid protein; rPGO, reduced porous GO; SERS, surface-enhanced Raman scattering; SWV, square wave voltammetry; PDDA, poly(diallyldimethylammonium chloride); GNS, gold nanostar; APE1, apurinic/apyrimidinic endonuclease 1.

Table S4. Carbon nanomaterial-based nucleic acid amplification technology for infectious disease and tumor diagnosis

CNs (or hybrid)		Detection method	Biomarkers	Key application approaches	Linear range	LOD	Ref.
CNTs (SWCNTs)	-	-	SARS-CoV-2 viral RNA	Immobilization of 10 unique SARS-CoV-2 ssDNA capture oligonucleotide sequences by SWCNTs; Complementary binding of SARS-CoV-2 viral RNA to ssDNA; Reversible aggregation of SWCNTs by adjusting the solution pH to acidic conditions; Dispersion of ssDNA-SARS-CoV-2 viral RNA-SWCNTs precipitates in PBS and heating to 95°C to isolate viral RNA from the surface of SWCNTs.	-	-	159
GO	-	Conventional PCR	Lambda DNA and FOXL2 gene	The specificity of error-prone multi-round PCR was effectively improved by 1 μg mL^{-1} GO.	-	-	160
GOQDs	-	qRT-PCR	DNA sequences of two different lengths (106 bp and 65 bp)	GOQDs can adsorb primers and TaqMan probes by π-π stacking and hydrogen bonding, thereby reducing the background fluorescence intensity of TaqMan probes, reducing the non-specific amplification in PCR reactions and improving the specificity of the detection.	10^4-10^{10} copies μl^{-1}	-	161
GO	-	qRT-PCR	miR-200b	The pre-adsorbing of the primers on the GO surface improves the efficiency of PCR amplification by increasing the efficiency of the primer template hybridization and reducing the non-specific amplification, thus increasing the sensitivity of qRT-PCR.	10^1-10^9 copies μl^{-1}	-	162
GO	With AuNPs	qRT-PCR	Serotype O-, A- and Pan-type FMDV genes	The citrate in AuNPs selectively binds the ssDNA by electrostatic attraction but not the dsDNA, enabling the nanocomposite of GO and AuNPs the interaction between primers and templates during DNA replication by acting like a single-stranded DNA binding protein (SSB).	100 fg-10 ng	100 fg	163
CNTs	With PEGDA	Multiplex qRT-PCR	*Acinetobacter baumannii, Escherichia coli, Klebsiella pneumoniae and Pseudomonas aeruginosa*	Adsorption of one of the specific pair of primers in the cPIN to the surface of the CNTs; Adsorption of the other primer in a prepolymer of PEGDA and acrylate; Increasing temperature during qRT-PCR induces primer dissociation from the surface of CNTs; The qRT-PCR reaction occurs to achieve multiplex detection of pathogenic bacteria.	1.6×10^2 copies μl^{-1}-1.6×10^8 copies μl^{-1}	1.6×10^2 copies μl^{-1}	166
GO	-	RCA	ATP	GO can adsorb three types of DNA (template DNA, signal DNA, and linker DNA), quenching the fluorescence signal of DNA by FRET. The specific binding of ATP to template DNA elicits the hybridization of the linker DNA with template DNA eventually triggered by RCA, quantifying ATP by the fluorescent signal generated from the hybridization of the RCA product with the signal DNA.	2×10^{-8} M-1×10^{-6} M	2×10^{-8} M	168
GO	-	LAMP	COX2 mRNA	GO adsorbs single-stranded primers and fluorescent dyes to enhance the specificity of LAMP by reducing non-specific hybridization and fluorescent background signals.	10^2 copies μl^{-1}-10^8 copies μl^{-1}	10^2 copies μl^{-1}	169
GO	-	RPA	HPV genotypes 16 and 18	GO in the RPA system completely suppresses and removes the analyzed products including primer dimers, non-specific products, non-target hybrids and non-standard folding, resulting in a high specificity of the analysis.	10^1 copies μl^{-1}-10^5 copies μl^{-1}	10^1 copies μl^{-1}	170

Notes: CNs, carbon nanomaterials; LOD, limit of detection; CNTs, carbon nanotubes; SWCNTs, single-walled carbon nanotubes;SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; PBS, phosphate buffered solution; GO, graphene oxide; PCR, polymerase chain reaction; GOQDs, graphene oxide quantum dots; qRT-PCR, real-timefluorescence quantitative polymerase chain reaction; AuNPs, gold nanoparticles; FMDV, foot-and-mouth disease virus; ssDNA, single-stranded DNA; dsDNA, double-stranded DNA; PEGDA, poly(ethylene glycol)-diacrylate; cPIN, composite microparticles of a primer-immobilized network; RCA, rolling circle amplification; ATP, adenosine triphosphate; FRET, fluorescence resonance energy transfer; LAMP, loop-mediated isothermal amplification; COX2, cyclooxygenase-2; RPA, recombinase polymerase amplification; HPV, human papillomaviruses.