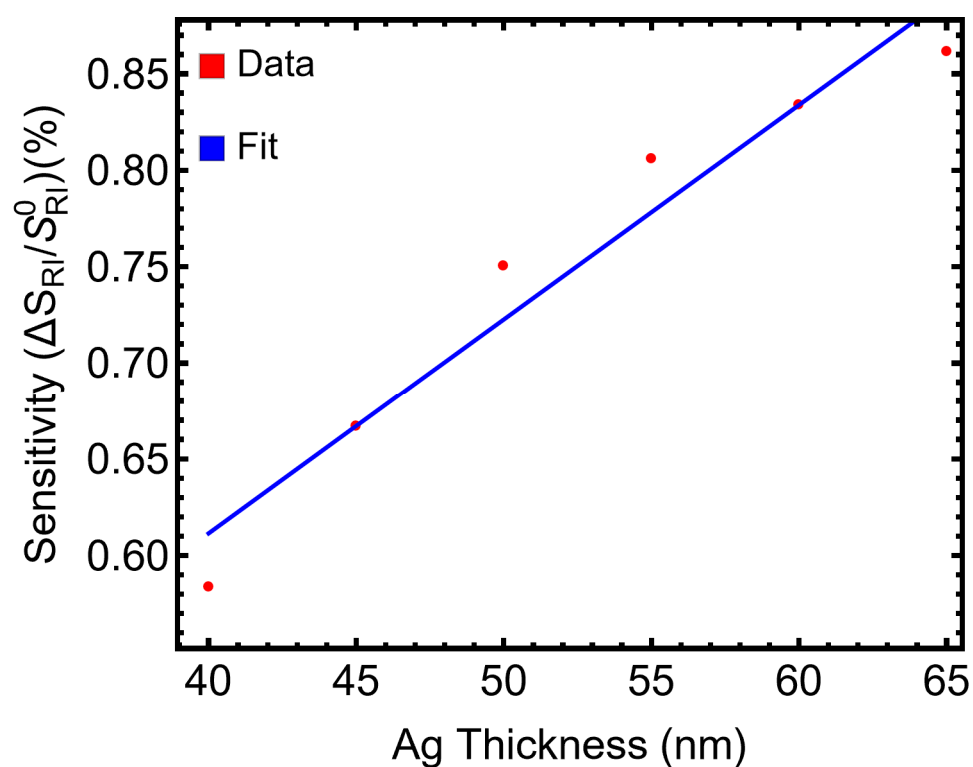


Supplementary

# Multilayer SPR Biosensor Based on Bilayer MoS<sub>2</sub> for SARS-CoV-2 sensing

Supplementary Figures



**Figure S1.** Linear fit of the sensitivity enhancement data.

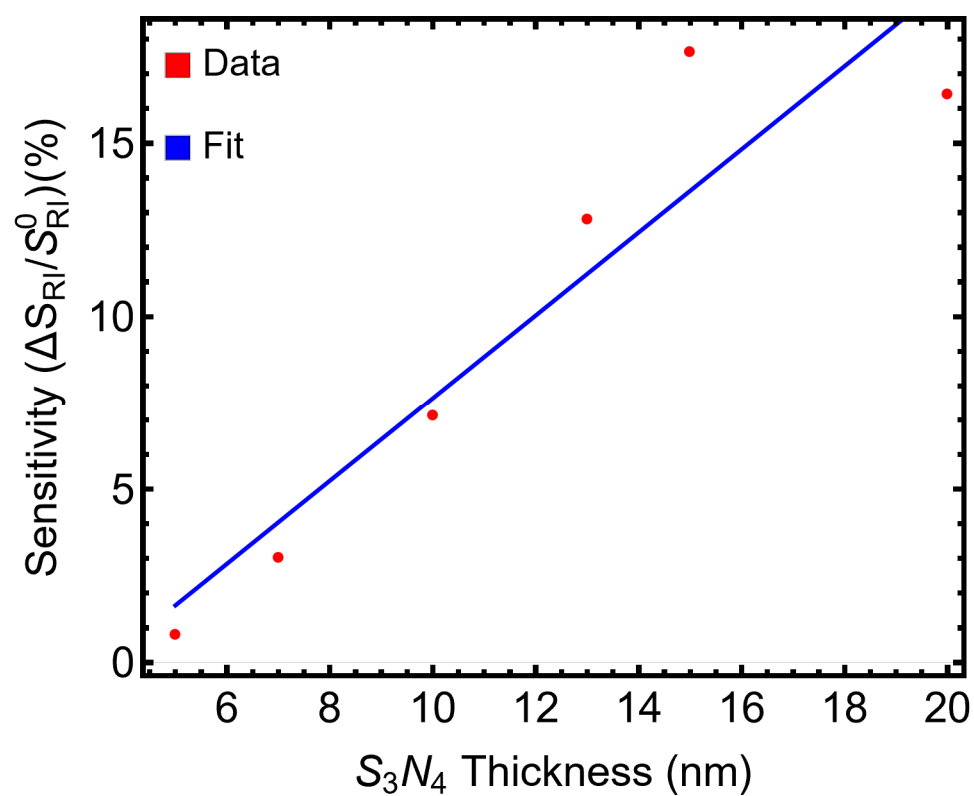


Figure S2. Linear fit of the sensitivity enhancement data.

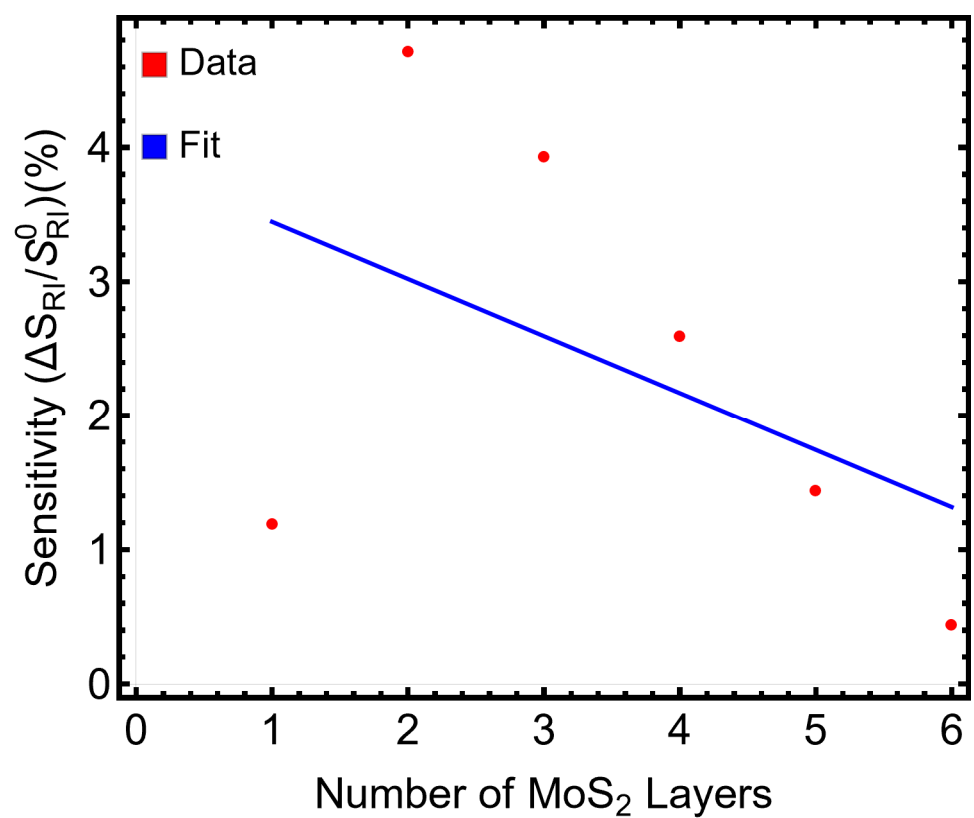


Figure S3. Linear fit of the sensitivity enhancement data.

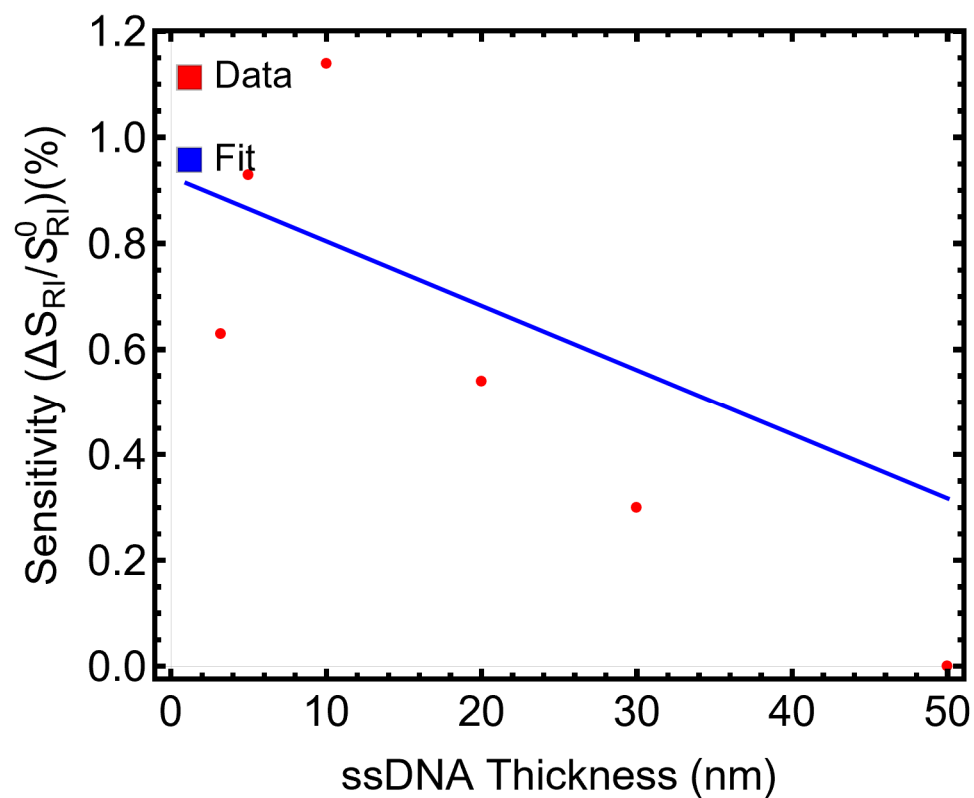


Figure S4. Linear fit of the sensitivity enhancement data.

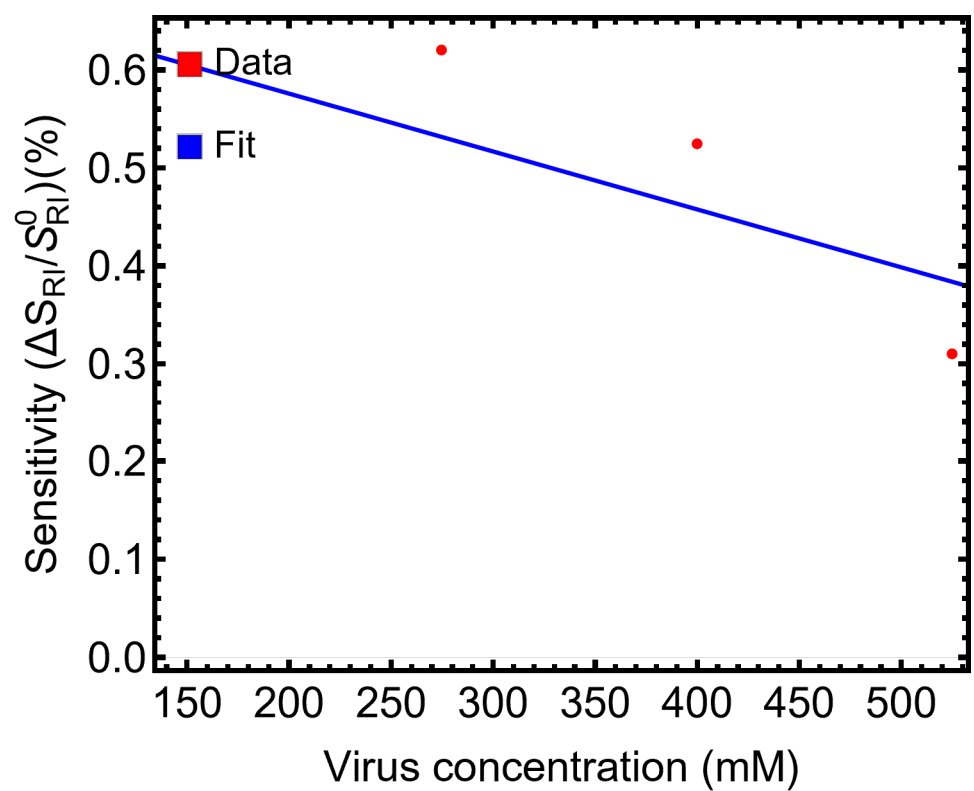
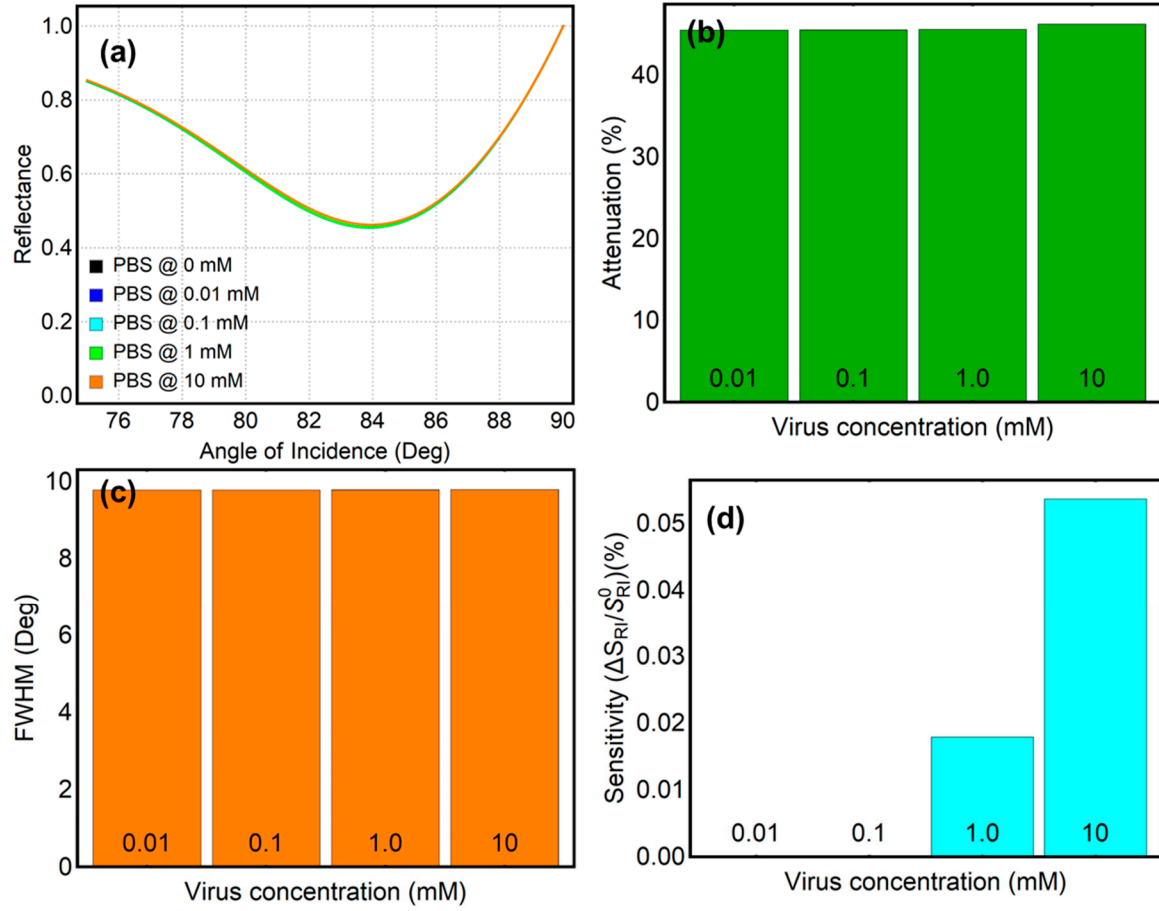
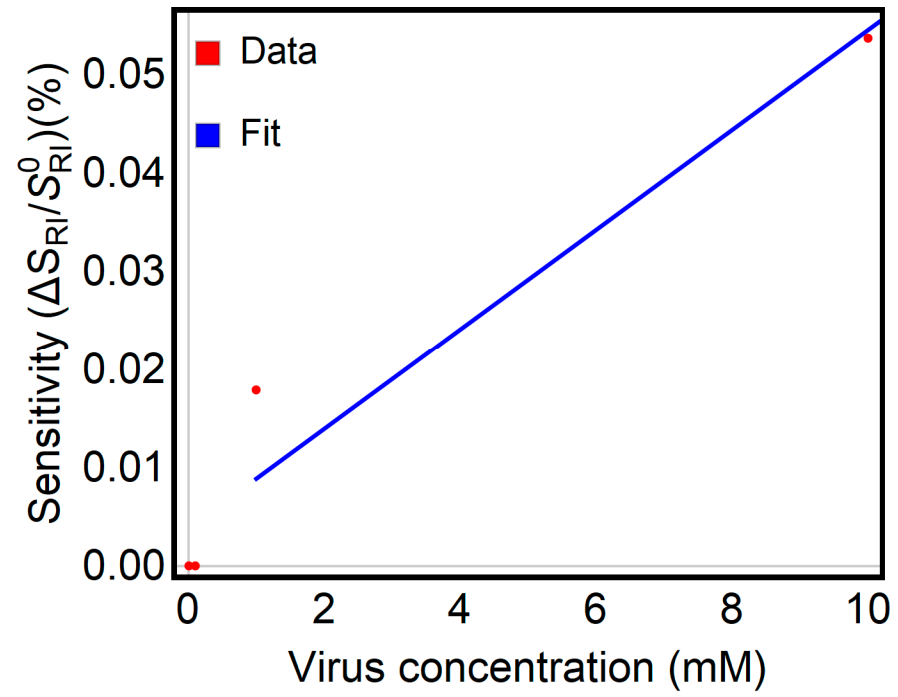


Figure S5. Linear fit of the sensitivity enhancement data.



**Figure S6.** Performance of the optimized SPR biosensor for SARS-CoV-2 detection at varying viral low concentrations from 0.01 to 10 mM. (a) SPR reflectance curves as a function of the angle of incidence, showing shifts in the resonance dip due to changes in refractive index at different SARS-CoV-2 concentrations. (b) Attenuation percentage, highlighting the effect of viral concentration on energy confinement within the biosensor. (c) Full-width at half maximum (FWHM) of the SPR resonance curves, demonstrating the resolution changes as the virus concentration increases. (d) Sensitivity enhancement relative to the baseline system ( $n = 1.334$  in PBS or 0 mM), validating the biosensor's capacity to detect and differentiate SARS-CoV-2 concentrations through refractive index variations.



**Figure S7.** Linear fit of the sensitivity enhancement data at very-low virus concentrations.

## Supplementary Tables

**Table S1.** The configuration of the systems analyzed in this study.

Sys No.	Code	Full Name	Nick Name
1	Sys <sub>0</sub>	Prism/Silver/Medium	P/Ag/M <sub>H<sub>2</sub>O</sub>
1	Sys <sub>1</sub>	Prism/Silver/Medium	P/Ag/M <sub>PBS</sub>
2	Sys <sub>2</sub>	Prism/Silver/S <sub>3</sub> N <sub>4</sub> /Medium	P/Ag/SN/M <sub>PBS</sub>
3	Sys <sub>3</sub>	Prism/Silver/S <sub>3</sub> N <sub>4</sub> /ssDNA/Medium	P/Ag/SN/T/M <sub>PBS</sub>
4	Sys <sub>4</sub>	Prism/Silver/Molybdenum Disulfide/Medium	P/Ag/MoS <sub>2</sub> /M <sub>PBS</sub>
5	Sys <sub>5</sub>	Prism/Silver/Molybdenum Disulfide/ssDNA/Medium	P/Ag/ MoS <sub>2</sub> /T/M <sub>PBS</sub>
6	Sys <sub>6</sub>	Prism/Silver/S <sub>3</sub> N <sub>4</sub> /Molybdenum Disulfide/Medium	P/Ag/SN/MoS <sub>2</sub> /M <sub>PBS</sub>
7	Sys <sub>7</sub>	Prism/Silver/Molybdenum Disulfide/S <sub>3</sub> N <sub>4</sub> /Medium	P/Ag/MoS <sub>2</sub> /SN/M <sub>PBS</sub>
8	Sys <sub>8</sub>	Prism/Silver/S <sub>3</sub> N <sub>4</sub> / Molybdenum Disulfide/ssDNA/Medium	P/Ag/SN/MoS <sub>2</sub> /T/M <sub>PBS</sub>
9	Sys <sub>9</sub>	Prism/Silver/Molybdenum Disulfide/S <sub>3</sub> N <sub>4</sub> /ssDNA/Medium	P/Ag/ MoS <sub>2</sub> /SN/T/M <sub>PBS</sub>

**Table S2.** Initial parameters of the proposed SPR Biosensor for sensing SARS-CoV-2.

Material	Refractive Index	Thickness (nm)	Ref.
BK-7 (P)	1.5151	---	[22]
Silver (Ag)	0.056253 + 4.2760 i	55.0	[23]
S <sub>3</sub> N <sub>4</sub> (SN)	2.0394	5.00	[24]
Molybdenum Disulfide (MoS <sub>2</sub> )	5.0805 + 1.1723 i	0.34	[25]
ssDNA (Thiol-Tethered, T)	1.462	3.20	[19]
Water (H <sub>2</sub> O)	1.33	---	[19]
PBS (M)	1.334	---	[19]

**Table S3.** Metric values of proposed SPR Biosensors.

Sys No.	Code	Attenuation (%)	FWHM	Sensitivity Enhancement (%)
0	Sys <sub>0</sub>	0.023	0.88	0
1	Sys <sub>1</sub>	0.023	0.90	0.68
2	Sys <sub>2</sub>	0.024	1.24	4.45
3	Sys <sub>3</sub>	0.022	1.31	5.19
4	Sys <sub>4</sub>	15.84	1.87	2.10
5	Sys <sub>5</sub>	15.92	1.97	2.73
6	Sys <sub>6</sub>	20.30	2.83	6.64
7	Sys <sub>7</sub>	16.62	2.59	6.43
8	Sys <sub>8</sub>	20.55	2.97	7.50
9	Sys <sub>9</sub>	16.88	2.72	7.29

**Table S4.** Metric values of Sys<sub>8</sub> configuration by changing the silver thickness.

Thickness (nm)	Attenuation (%)	FWHM	Enhancement (%)
40	3.40	4.56	0.58
45	0.17	3.79	0.67
50	6.75	3.28	0.75
55	20.55	2.97	0.81
60	37.24	2.82	0.83
65	53.13	2.81	0.86

**Table S5.** Metric values of Sys<sub>8</sub> by changing the silicon nitride thickness.

Thickness (nm)	Attenuation (%)	FWHM	Enhancement (%)
5	0.17	3.89	0.80
7	0.51	4.47	3.03
10	1.82	5.50	7.13
13	6.99	6.76	12.80
15	24.08	7.78	17.64
20	89.80	14.32	16.42

**Table S6.** Metric values of Sys<sub>s</sub> by increasing the number of Molybdenum Disulfide layers .

Layers	Attenuation (%)	FWHM	Enhancement (%)
L1	6.99	6.76	1.19
L2	45.50	9.61	4.71
L3	72.89	11.98	3.93
L4	82.80	13.93	2.59
L5	87.23	15.46	1.44
L6	89.66	16.64	0.44

**Table S7.** Metric values of Sys<sub>s</sub> by changing the ssDNA thickness.

Thickness (nm)	Attenuation %	FWHM	Enhancement (%)
3.2	45.50	9.61	0.63
5.0	50.88	9.79	0.93
10.0	64.97	10.42	1.14
20.0	82.01	12.17	0.54
30.0	89.13	14.29	0.30
50.0	94.22	18.93	0.00

**Table S8.** Metric values of optimized Sys<sub>s</sub> configuration after SARS-CoV-2 adsorption at very-low virus concentrations.

Concentration (mM)	PBS + SARS-CoV-2	Enhancement (%)	Attenuation %	FWHM
0.01	1.33400040000000012	0.0	45.50	9.78
0.10	1.3340040000000001	0.0	45.52	9.78
1.00	1.33404000000000012	0.02	45.57	9.78
10.0	1.33440000000000011	0.05	46.23	9.79