Supplementary Information

Label-Free Plasmonic-Based Biosensing Using a Gold Nanohole Array Chip Coated with a Wafer-Scale Deposited WS$_2$ Monolayer

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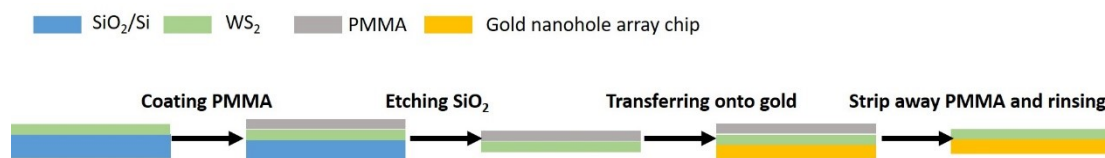E-mail: EPDPuiu@ntu.edu.sg;

E-mail: lxkang2013@sinano.ac.cn.

Fig. S1. Schematic description of the process used to transfer the WS$_2$ film onto the gold nanohole array chip.
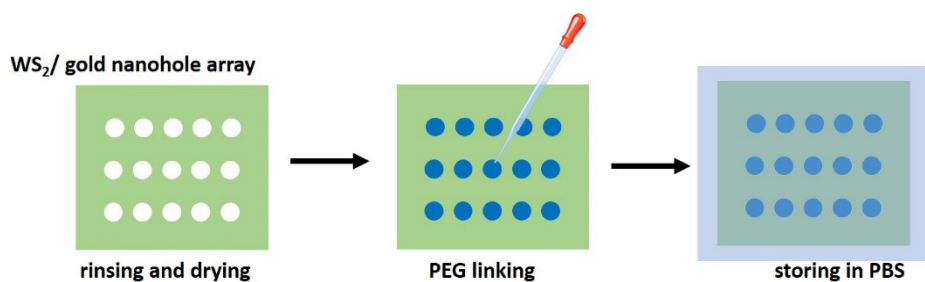

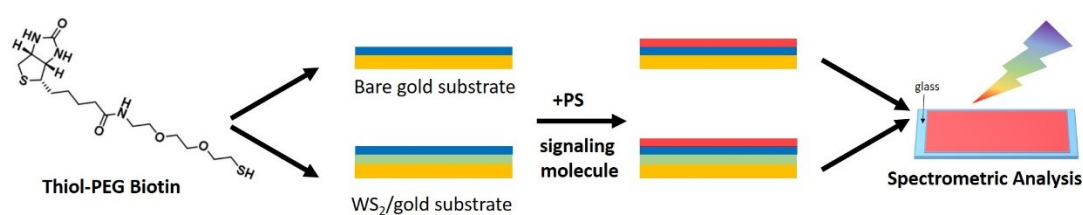**Fig. S2.** Schematic description of the WS$_2$ film functionalization process.

Fig. S3. Schematic description of the biotin-streptavidin coupling process.

Supplementary Table ST1: Measured thicknesses for 10 different WS$_2$ monolayer samples and their calculated mean and standard deviation values, respectively.

Sample nr.	WS$_2$ film thickness [nm]
#1	0.65
#2	0.82
#3	0.64
#4	0.75
#5	0.63
#6	0.86
#7	0.66
#8	0.72
#9	0.89
#10	0.61
Mean value [nm]	**0.723**
Standard deviation σ [nm]	**0.097**

Supplementary Table ST2: Measured data for the Raman shifts of 10 different WS_2 monolayer samples and their calculated mean and standard deviation values, respectively.

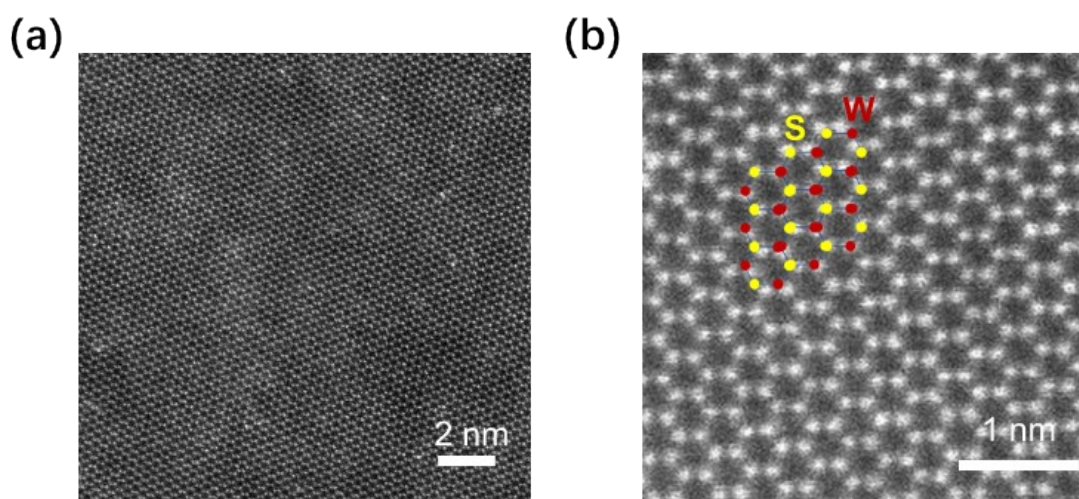| Sample nr.	Raman shift [cm^{-1}] for the E^1_{2g} peak	Raman shift [cm^{-1}] for the A_{1g} peak
#1	357.90	422.80
#2	355.88	420.78
#3	356.91	421.80
#4	357.30	422.21
#5	354.92	420.02
#6	355.89	420.29
#7	357.40	422.80
#8	354.93	420.62
#9	355.89	419.80
#10	356.90	421.80
Mean value [cm^{-1}]	**356.384**	**421.292**
Standard deviation σ [cm^{-1}]	**0.9899**	**1.071**

Fig. S6. The TEM morphology of the functionalized WS_2 film.

Supplementary Table ST3: Mean and standard deviation values of normalized performance parameters: SPR transmission intensity, full width at half maximum (FWHM) of the first transmission peak, and detection sensitivity resulted for 10 different sensors, respectively.

Parameter of performance	Mean value (normalized)	Standard deviation σ
Transmissivity	1	0.0186
FWHM	1	0.0133
Sensitivity	1	0.0672

Supplementary Table ST4: Values of all parameters for the linear fitting equation $y = mx + n$ quantifying the extracted variation of the central wavelengths of the main transmission peaks with the RI value of the analyte.

Fitting parameter values	Bare Au nanohole array	WS$_2$-Au nanohole array
	Second peak	Second peak
Slope (sensitivity) m [nm/RIU]	458.2	563.2
Y-axis intercept n [nm]	624.2	629.9
R^2	0.9934	0.9908

Supplementary Table ST5: Comparative analysis between the performances of previously reported plasmonic biosensors of interest.

Plasmonic Probe	Analyte	LOD	Reference
Light-diffusing fibers SPR sensor	C-reactive protein	1.3×10^{-10} M	1
SPR-sensor chip	Human serum transferrin	4.4×10^{-9} M	2
SPR-sensor chip	Dopamine	10^{-8} M	3
SPR-sensor chip	Tetramethylthiuram disulfide	10^{-6} M	4
SPR-sensor chip	Polystyrene	10^6 beads/mL	This work

References for Supplementary Table ST5:

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