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Supporting Information

MoS_2-based composite nanozymes with superior peroxidase-like activity for ultrasensitive SERS detection of glucose

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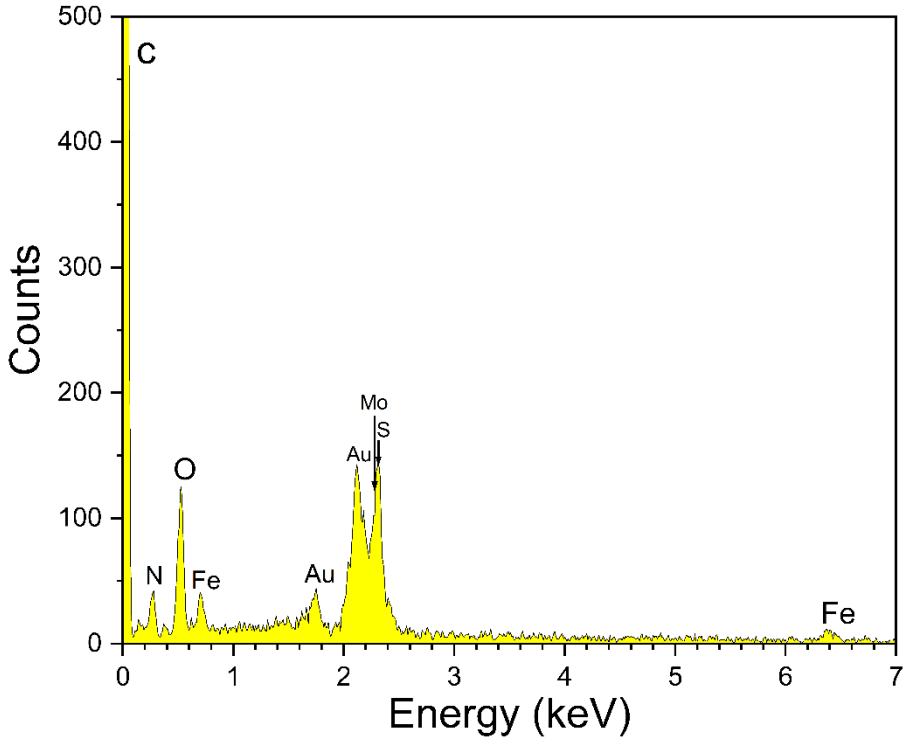


Figure S1. The EDS spectra of the PANI@MoS_2@Fe_3O_4@Au nanocomposites.

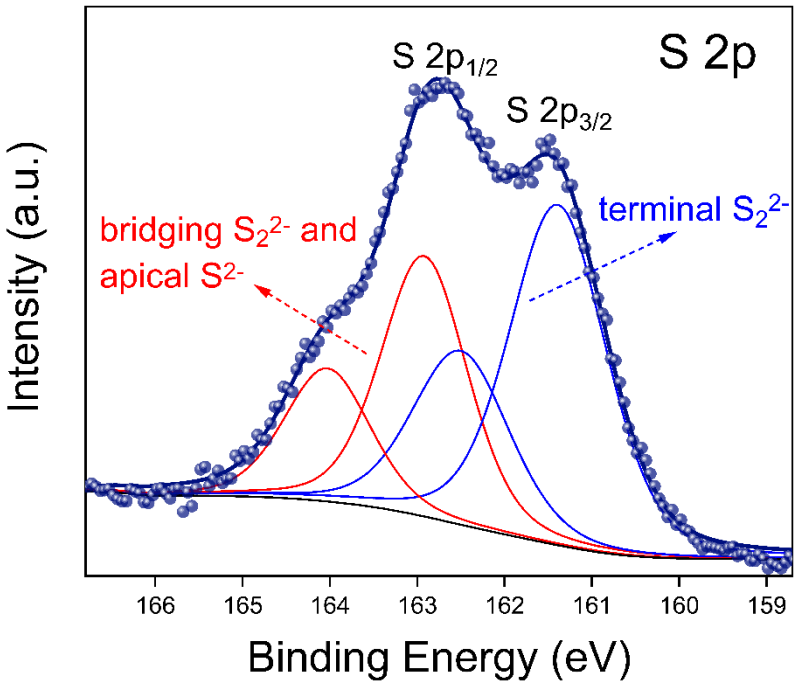


Figure S2. XPS spectra of S 2p of the PANI@MoS_2@Fe_3O_4@Au nanozymes.

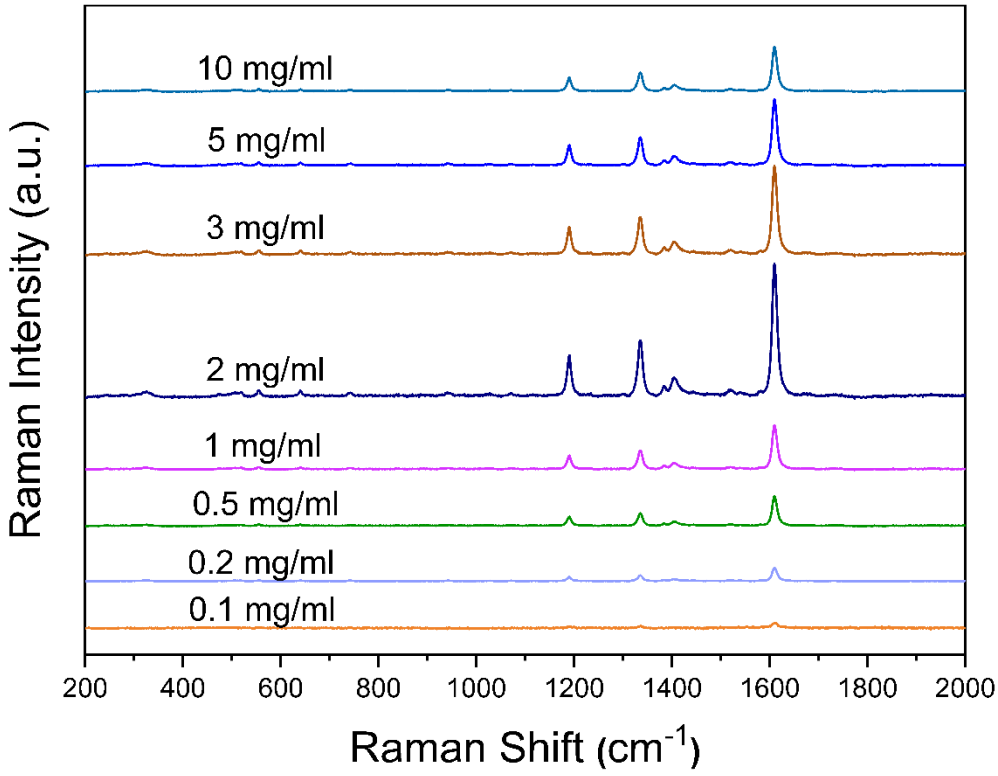


Figure S3. The SERS spectra of TMB molecules during the reaction on the surface of PANI@MoS_2@Fe_3O_4@Au nanozymes prepared at different concentrations of $HAuCl_4$. [PANI@MoS_2@Fe_3O_4@Au] = 10 μL (100 μg·mL^{-1}); [TMB] = 10 μL (1 mM); [H_2O_2] = 10 μL (10^{-5} M).

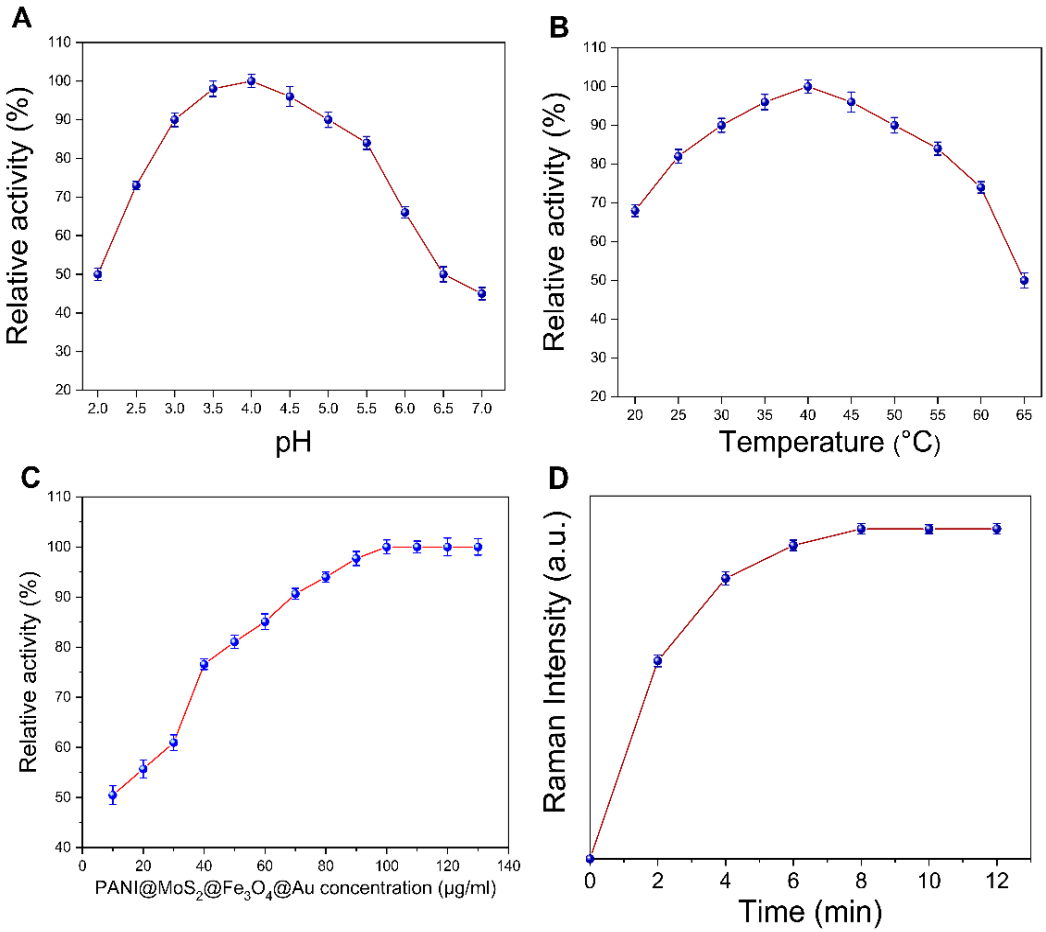


Figure S4. Peroxidase activities under varied reaction conditions. (A) A pH-dependent response curve is performed at pH 2.0-7.0. (B) Temperature (20℃, 25℃, 30℃, 35℃, 40℃, 45℃, 50℃, 55℃, 60℃, 65℃). (C) Effect of PANI@MoS_2@Fe_3O_4@Au concentration on catalytic efficiency (10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130 mg·mL^{-1})， and (C) Dependence of the peroxidase-like activity on time (0, 2, 4, 6, 8, 10, 12 min). (D) System reaction changes with time (0, 2, 4, 6, 8, 10, 12 min). Error bars represent the standard error derived from three repeated measurements.

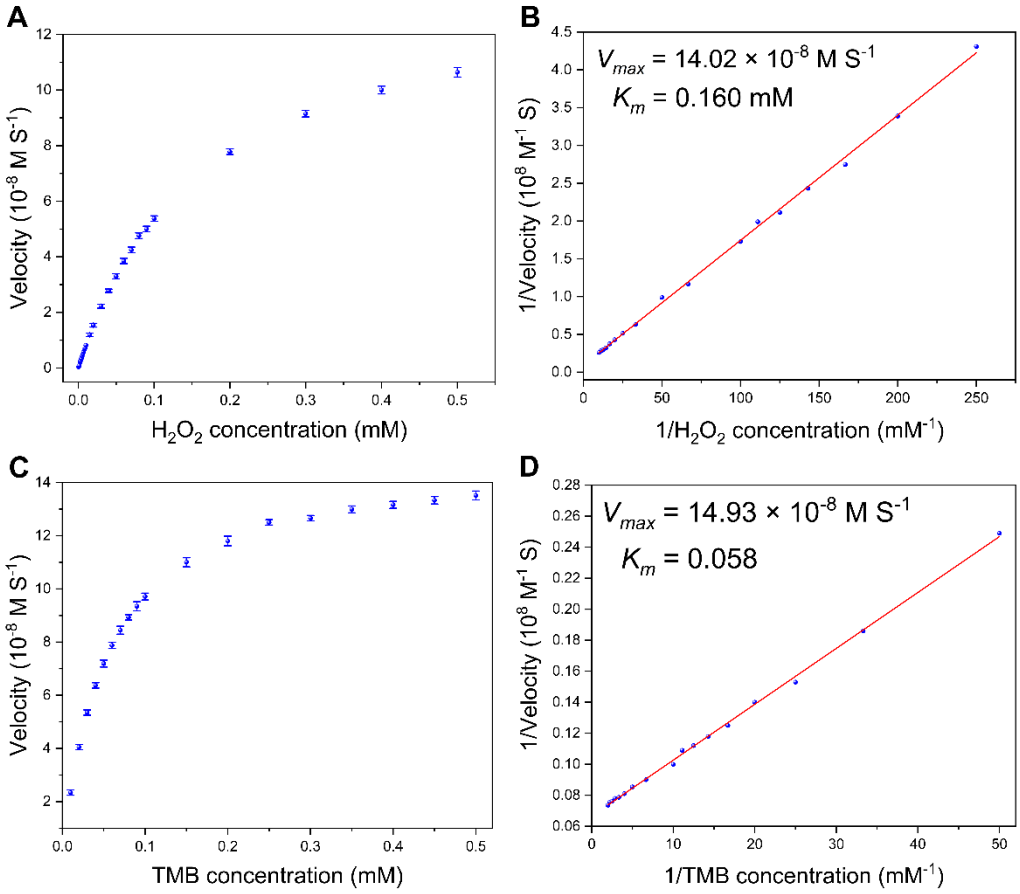


Figure S5. UV-vis-kinetic assays of the PANI@MoS_2@Fe_3O_4@Au nanozymes. (A) Plots of the velocity of the reaction versus different concentrations of H_2O_2 (0.5 mM TMB). (B) Lineweaver-Burk plots of the velocity versus varying concentration of H_2O_2. (C) Plots of the velocity of the reaction versus different concentrations of TMB (1 mM H_2O_2). (D) Lineweaver-Burk plots of the velocity versus varying concentration of TMB.

Table S1. Comparison of the kinetic parameters with natural enzyme and other nanocatalysts.

Nanocatalysts	**Substrates**	K_m **(mM)**	V_{max} **(10^{-8} M·s^{-1})**	**Ref.**
HRP	TMB	0.434	10.0	[1]
	H_2O_2	3.7	8.71	
Fe_3O_4	TMB	0.098	3.44	[1]
	H_2O_2	154	9.78	
MoS_2	TMB	2.668	1.501	[2]
	H_2O_2	1.809	1.642	
$NiFe_2O_4$	TMB	0.55	4.57	[3]
	H_2O_2	2.6	14.11	
Fe_2O_3 Mesoporous	TMB	0.298	7.36	[4]
	H_2O_2	146.7	6.37	
CuO	TMB	25	10.49	[5]
	H_2O_2	400	16.1	
Fe_3O_4@C	TMB	0.20	1.34	[6]
	H_2O_2	0.23	2.41	
MoS_2@$MgFe_2O_4$	TMB	0.806	141.3	[7]
	H_2O_2	0.238	37.8	
GO-Fe_3O_4	TMB	0.43	13.08	[8]
	H_2O_2	0.71	5.31	
MoS_2-PPy-Pd	TMB	0.93	-	[9]
	H_2O_2	6.4	-	
PANI@MoS_2@Fe_3O_4@Au	TMB	0.054	14.87	This work
	H_2O_2	0.159	13.83	

Table S2. Comparisons of various nanomaterial-based biosensors for glucose.

Target	Detection techniques	Nanomaterial	Linear range	LOD	Ref.
glucose	VL	AuNPs-MWCNT-IL/GCE	5-120 μM	2 μM	[10]
glucose	FL	CeO_2 NPs	10-200 μM	8.9 μM	[11]
glucose	CL&SERS	Au@Ag NPs	0.5-400 μM	0.02 μM	[12]
glucose	EC	Ag NP-graphene	2000-1×10^4 μM	100 μM	[13]
glucose	EC	Au NPs-CNTs/3DF	50-2000 μM	1.07 μM	[14]
glucose	SERS	PANI@MoS_2@Fe_3O_4@Au	10^{-5}-10^3 μM	10^{-6} μM	this work

VL: Voltammetry. FL: Fluorimetry. CL: Colorimetry. SERS: Surface-enhanced Raman scattering. EC: Electrochemistry.

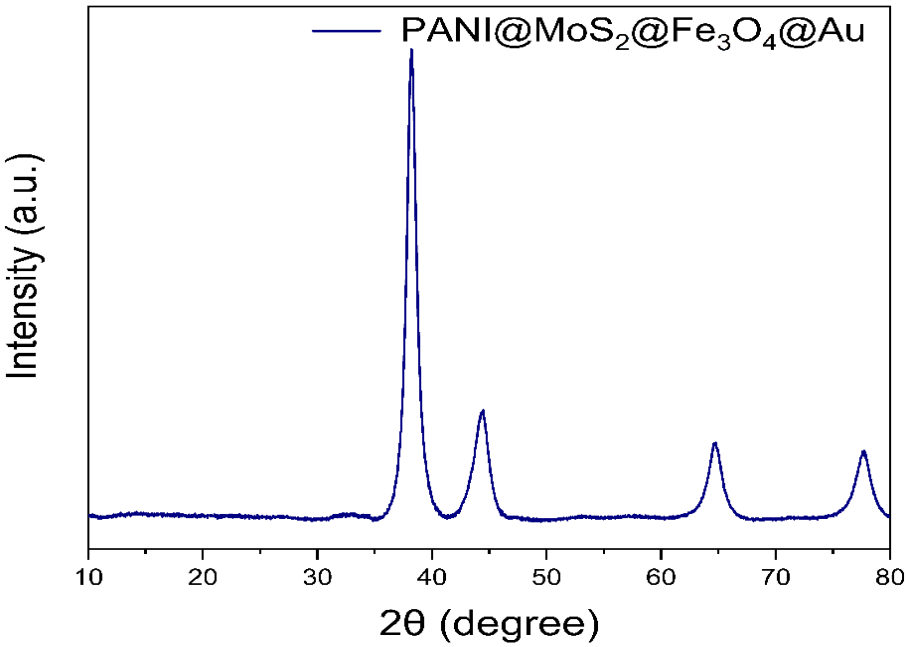
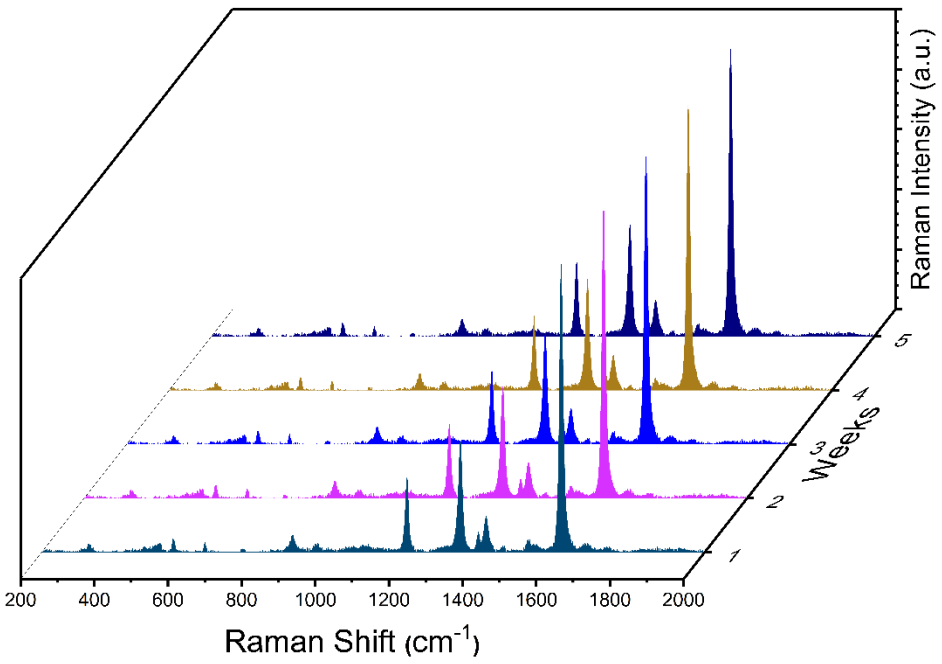
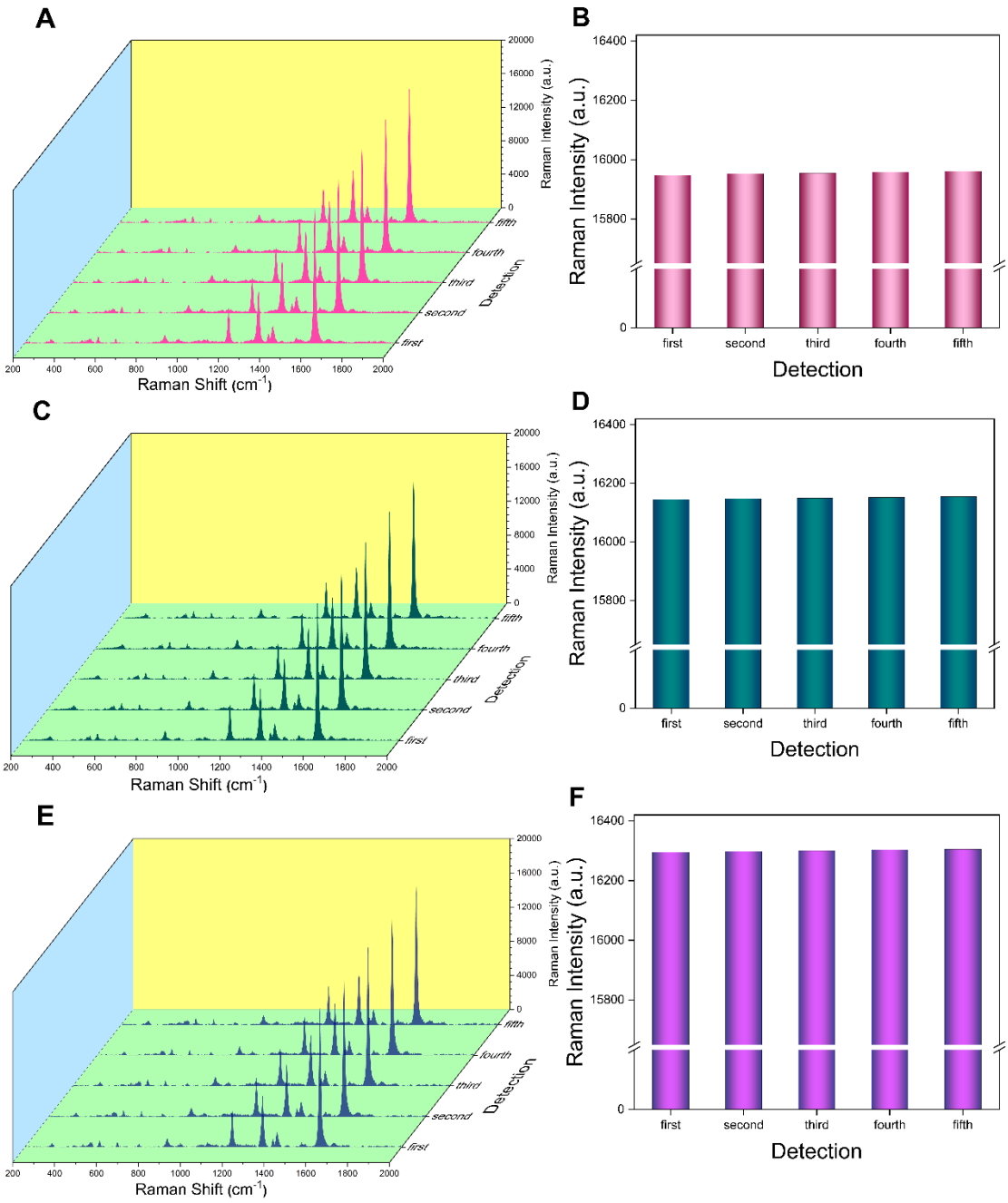


Figure S6. XRD patterns of PANI@MoS_2@Fe_3O_4@Au nanozyme after 7 days in PBS.



Firure S7. SERS spectra of glucose(10^{-5} M) determination of PANI@MoS_2@Fe_3O_4@Au nanozymes in 5 weeks.


A
B
C
D
E
F
Raman Intensity (a.u.)
Raman Shift (cm-1)
Detection
first
second
third
fourth
fifth
16400
16200
16000
15800
0
20000
16000
12000
8000
4000
200
400
600
800
1000
1200
1400
1600
1800
2000

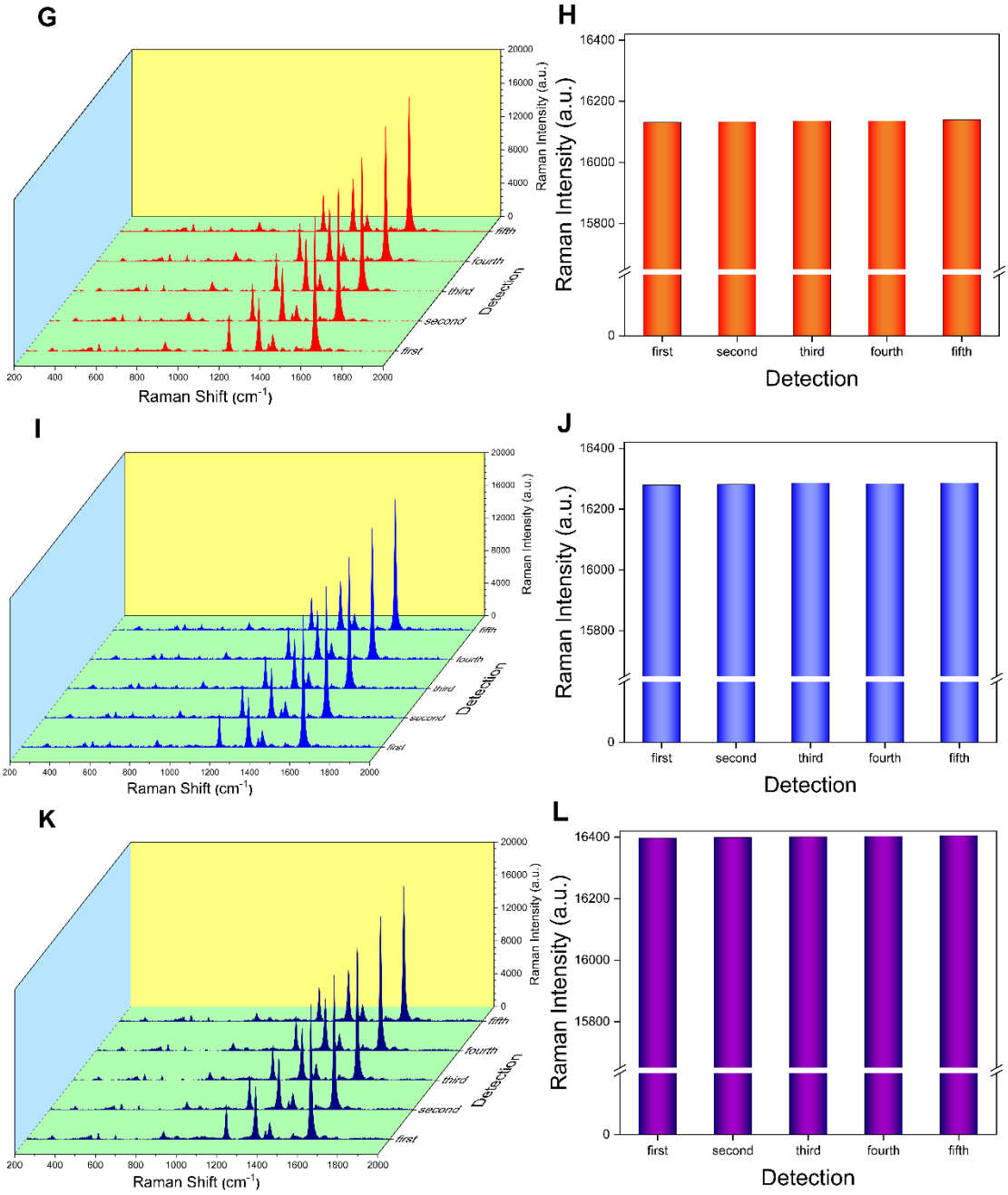


Figure S8. The Raman spectrum of the glucose content of human serum sample 1 after the addition of the value [(A) 2 mM, (C) 4 mM, (E) 6 mM)] determined by the SERS method and the corresponding intensity histogram at 1609 cm^{-1} [(B) 2 mM, (D) 4 mM, (F) 6 mM)]. Sample 1 is a human serum with a glucose concentration of 3.28 mM. The Raman spectrum of the glucose content of human serum sample 2 after the addition of the value [(G) 2 mM, (I) 4 mM, (K) 6 mM)] determined by the SERS method and the corresponding intensity histogram at 1609 cm^{-1} [(H) 2 mM, (J) 4 mM, (L) 6 mM)]. Sample 2 is a human serum with a glucose concentration of 5.12 mM.

Supporting References

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