Supporting Information

Highly sensitive detection of exosomes by SERS using gold nanostar@Raman reporter@nanoshell structures modified with a bivalent cholesterol-labeled DNA anchor

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Supporting figures and table



Fig. S1. (A) Photographic images corresponding to (a) AuNP, (b) AuNS, (c) AuNS@4-MBA@Au. (B) DLS characterization of the nanoparticles at different stages.



Fig. S2. The colloidal stability of AuNS@4-MBA@Au in solution monitored by UV-vis absorbance, showing freshly made dispersion as well as those left for 4, 7, and 10 days, and after NaCl was added.



Fig. S3. TEM images of the magnetically separated precipitates with (A) and without (B) exosomes $(1 \times 10^4 \text{ particles}/\mu\text{L})$.



Fig. S4. (A) SERS spectra of AuNS with different concentrations of 4-MBA. (B) The integrated intensity of the 4-MBA peak at 1078 cm⁻¹. Spectra were acquired with a 10 s exposure time at 785 nm, (n = 3).



Fig. S5. (A) SERS spectra of 10×10^{-6} M 4-MBA molecules in AuNS@4-MBA@Au with di \Box erent concentrations of HAuCl₄. (B) Integrated intensity of the 4-MBA peak at 1078 cm⁻¹. Spectra were acquired with a 10 s exposure time at 785 nm, (n = 3).



Fig. S6. SERS spectra of AuNS@4-MBA@Au and AuNS@4-MBA@Au-anchor.



Fig. S7. (A) SERS spectra obtained at different incubation times. (B) Integrated intensity of the 4-MBA peak at 1078 cm⁻¹. Spectra were acquired with a 10 s exposure time at 785 nm, (n = 3).



Fig. S8. (A) SERS spectra of 4-MBA collected at 10 randomly selected spots on the immunocomplex. SERS detection parameters: $\lambda_{\text{excitation}} = 785$ nm, accumulation time = 10 s, laser power = 100 mW.



Fig. S9. (A) The SERS spectra of 4-MBA within 24 h (4×10^4 particles/ μ L exosomes). (B) Signal intensities of 4-MBA at 1078 cm⁻¹ of data (A). SERS detection parameters: $\lambda_{\text{excitation}} = 785$ nm, accumulation time = 10 s, laser power = 100 mW.



Fig. S10. (A) The SERS spectra of 4-MBA within 7 days (4×10^4 particles/ μ L exosomes). (B) Signal intensities of 4-MBA at 1078 cm⁻¹ of data (A). SERS detection parameters: $\lambda_{\text{excitation}} = 785$ nm, accumulation time = 10 s, laser power = 100 mW.

Table S1.	Comparison	of different	methods for	r the detect	ion of exosomes.
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Method	LOD (particles/µL)	Dynamic range (orders of magnitude)	Analysis time	Referenc e
Single particle interferometric reflectance imaging sensor	3.94×10 ⁶	2	12 h	1
Aptasensor based on DNA-capped s- SWCNTs	5.2×10 ⁵	2	40 min	2
Aptamer-based electrochemical biosensor	1×10 ³	2	15 min	3
Lateral flow immunoassay	8.54×10 ⁵	2	15 min	4
Integrated magneto- electrochemical sensor	3×10 ³	4	48 min	5
Nano-plasmonic sensor	3×10 ³	2	60 min	6
Electrochemical sandwich immunosensor	2×10 ²	4	60 min	7
Alternating current electrohydro-dynamic methodology	2.76×10 ³	3	2 h	8

Nanotetrahedron (NTH)- assisted electrochemical sensor	20.9	7	30 min	9
Surface-enhanced Raman scattering (SERS)	1.2×10 ³	4	2 h	10
Surface-enhanced Raman scattering (SERS)	32	5	2 h	11
Surface-enhanced Raman scattering (SERS)	27	6	50 min	This work

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