Supplementary Information

A new platform for rapid and indiscriminate detection of environmental pollutants based on surface-enhanced Raman spectroscopy

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S1. The enhancement factor (EF) of Ag@BOCNPs

I_R is the Raman intensity of the melamine solution and I_S is the SERS intensity of melamine under the condition of adding Ca^{2+} to the enhanced substrate. N_R is the number of molecules irradiated by melamine in the Raman detection, and N_S is the number of molecules irradiated by melamine in the SERS detection in the presence of Ca^{2+} added to the enhanced substrate. Because we performed the test in a capillary, the cross-sectional area and volume of the test were the same. The simplified formula is: $EF=I_S \cdot C_R / I_R \cdot C_S$

The concentration of melamine solution detected by Raman was 3mg/mL. The concentration of melamine solution used for SERS detection was 100ng/mL. For SERS detection, 10μL of the sample was mixed with 10μL of silver sol, followed by 1μL $CaCl_2$ solution.

C_R=3mg/mL

C_S= $(1\times10^{-4}$ mg/ml$\times10$μL$\times10^{-3})$ / $(10+10+1)$ μL$\times10^{-3}=4.76\times10^{-5}$ mg/ml

EF_{702}= $(10819\times3) / (19\times4.76\times10^{-5}) = 3.596\times10^{7}$

S2. TEM spectra of the Ag@BO and Ag@BOCNPs

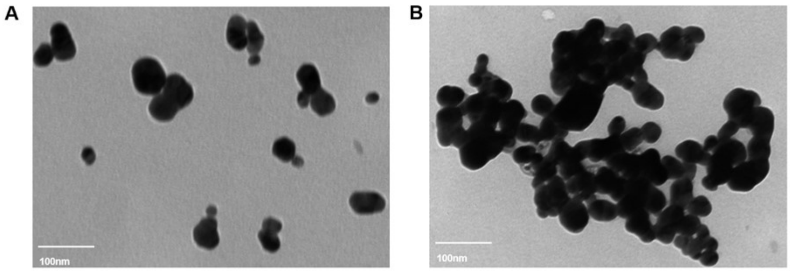

Figure S1. TEM images of the Ag@BO (A) and Ag@BOCNPs (B).

S3. SERS signals from different substrates

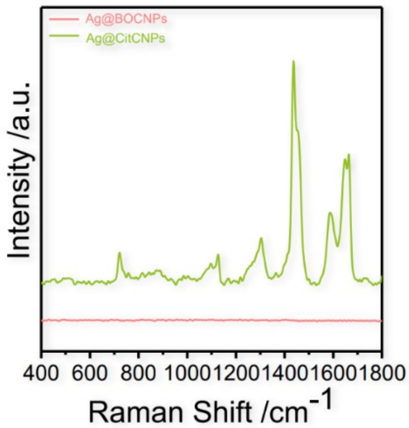

Figure S2. SERS spectra of silver nanoparticles reduced by sodium citrate (green line) and sodium borohydride (pink line) after adding Ca^{2+}.

S4. Synthesis of silver nanoparticles from different concentrations of sodium borohydride.

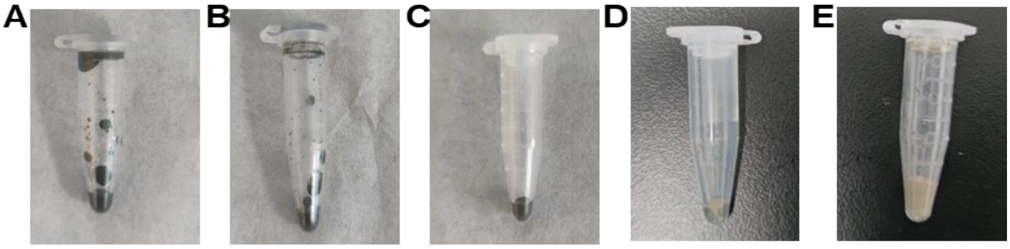

Figure S3. Silver nanoparticles synthesized by sodium borohydride and silver nitrate in different proportions, and their color states after centrifugation. (A)The ratio of silver nitrate to sodium borohydride is 1:5; (B)The ratio of silver nitrate to sodium borohydride is 1:6; (C)The ratio of silver nitrate to sodium borohydride is 1:7; (D)The ratio of silver nitrate to sodium borohydride is 1:8; (E)The ratio of silver nitrate to sodium borohydride is 1:9.

S5. Raman signals intensity of melamine molecules under different enhanced substrate systems with different exposure times

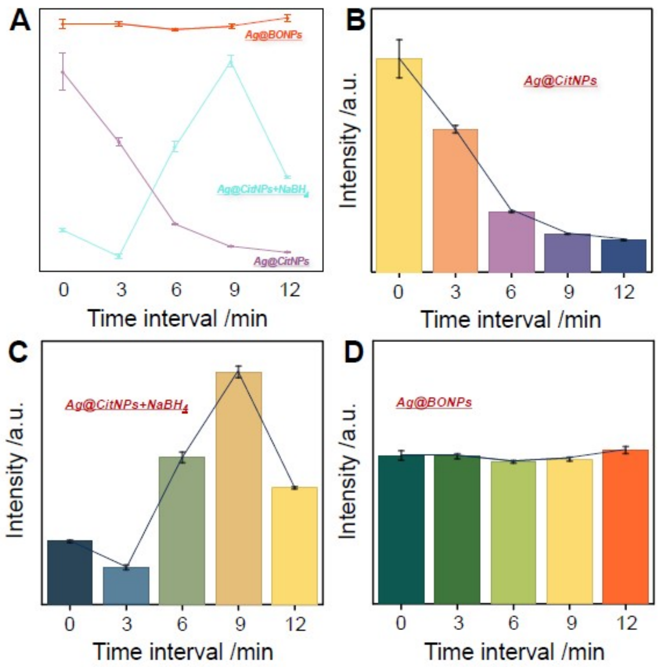

Figure S4. (A)The SERS signal intensity changes of melamine were obtained by exposure of Ag@CitNPs (purple line), Ag@CitNPs+$NaBH_4$ (blue line) and Ag@BONPs (orange line) silver nanoparticles to air for different time intervals (3 minute interval); (B)The peak intensity histogram of melamine was detected by exposing sodium citrate reduced silver nanoparticles at different time intervals in the air; (C)The peak intensity histogram of melamine was detected by exposure of sodium citrate reduced silver nanoparticles and sodium borohydride system at different time intervals in the air; (D) The peak intensity histogram of melamine was detected by exposing sodium borohydride reduced silver nanoparticles at different time intervals.

S6. Particle size diagram of silver nanoparticles

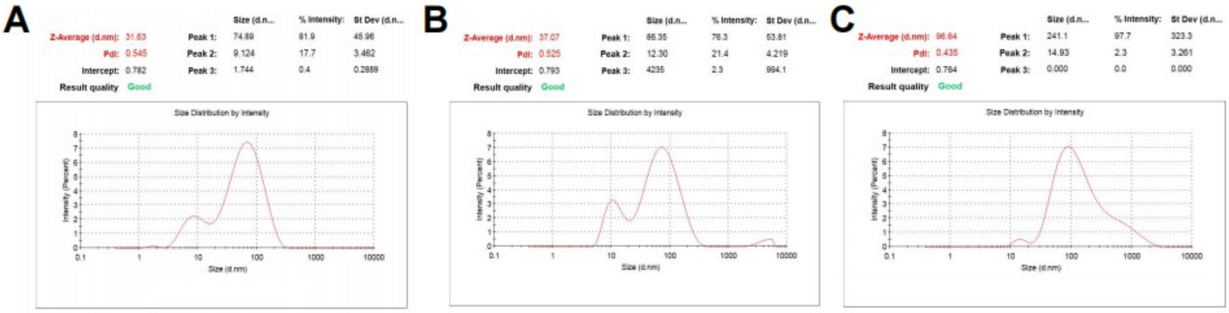

Figure S5: (A) The particle size diagram of Ag@BO; (B) Ag@BO Particle size plot of melamine added; (C) Particle size plots after Ca^{2+} was added to the systems of Ag@BO and melamine.

S7. SERS signals of melamine before and after Ca^{2+} addition

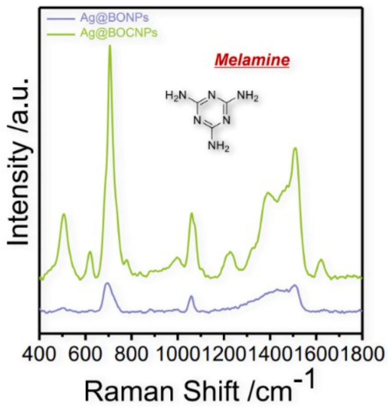

Figure S6: The SERS signal of melamine was obtained using Ag@BONPs (blue line) and Ag@BOCNPs (green line) silver nanoparticles.

S8. SERS signals of S. aureus (10^6 CFU/mL) on conventional method compared to the current method (Ag@BOCNPs)

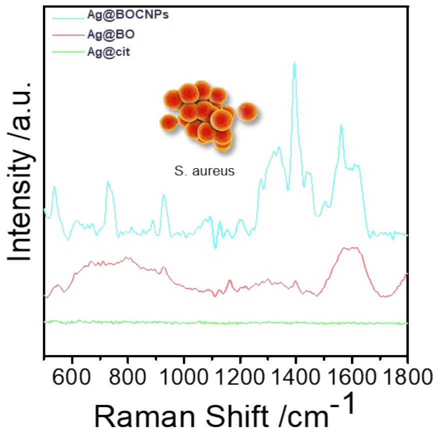

Figure S7: SERS signals of S. aureus were obtained by Ag@cit (green line) and Ag@BO (red line) silver nanoparticles; SERS spectrum of S. aureus was obtained using the present method (blue line).

S9. Detection limits for the crystal violet

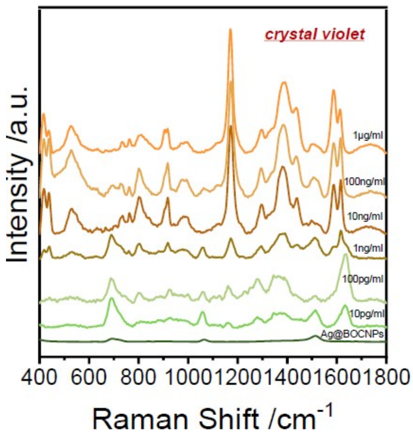

Figure S8. SERS spectra of crystal violet at various concentrations.

S10. SERS spectra of food adulterants

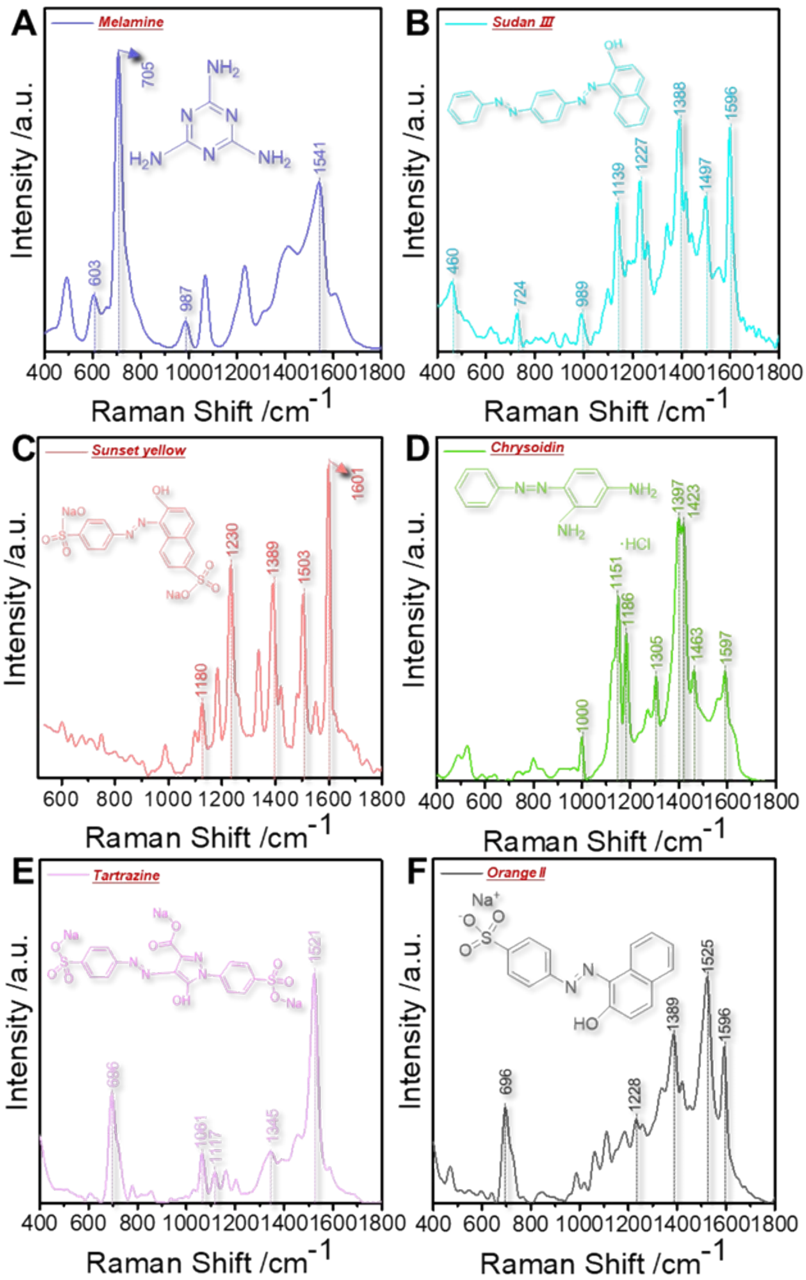

Figure S9. SERS spectra of melamine and five banned colorants. (A) SERS spectrum of melamine; (B) SERS spectrum of Sudan III; (C) SERS spectrum of Sunset yellow; (D) SERS spectrum of chrysoidin; (E)SERS spectrum of tartrazine; (F) SERS spectrum of orange II.

S11. Raman signals of pure sulfite and nitrite

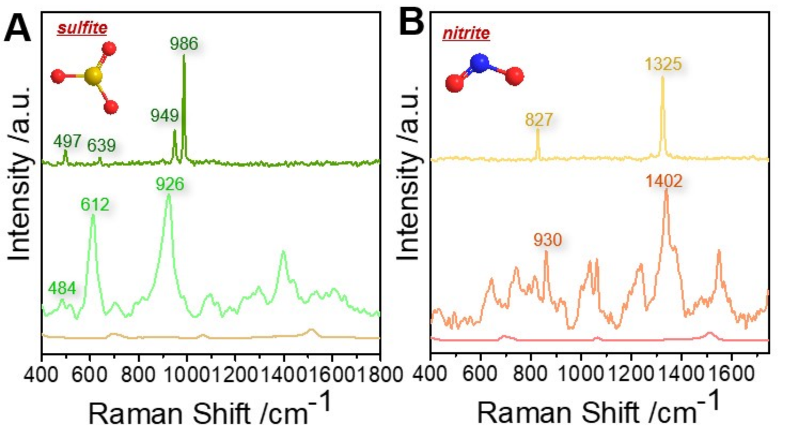

Figure S10. (A)Raman signal of pure sulfite (dark green line), SERS signal of sulfite (light green line, 1 μg/mL), and signal of Ag@BOCNPs (yellow line); (B) Raman signal of pure nitrite (light yellow line), SERS signal of nitrite (orange line ,1 μg/mL), and signal of Ag@BOCNPs (pink line).

S12. SERS signal of $NaNO_3$

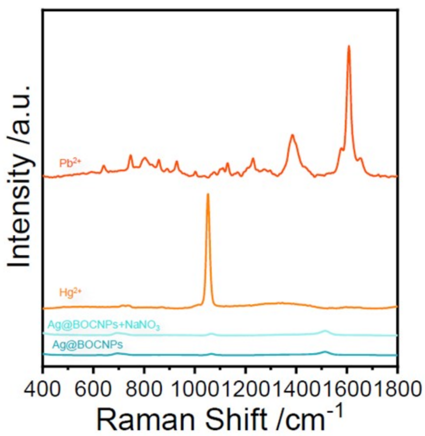

Figure S11. SERS signal of Pb^{2+} (red line), SERS signal of Hg^{2+} (orange line), SERS signal of Ag@BOCNPs+HNO_3 (wathet blue), and signal of Ag@BOCNPs (deep blue green line).

S13. The Raman peak assign to virus

Table S1: The bands and their assignment appeared in the SERS spectra of virus

Raman Shift (cm^{-1})	Assignment	**Ref.**
~723	adenine	[1]
744	adenine	[1]
761	Tryptophan	[2]
799	Cytosine + Uracil	[2]
816	The phosphate backbone stretch of the RNA	[3]
828	The phosphate backbone stretch of the RNA	[3]
~857	Tyrosine	[1]
874	Tryptophan	[4]
~884	Tryptophan	[4]
~960	Ribose	[4]
~1002	Phenylalanine	[5]
~1030	Phenylalanine	[5]
~1099	Phenylalanine	[4]
~1123	$\nu_{14}B_{1g}$	[2]
~1162	Tyr/$\nu_{30}B_{2g}$	[2]
1206	Amide III	[3]
1219	Phenylalanine	[2]

Note: ν = stretch, br = breathing, bk = backbone.

S14. References

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