

SERS-Boost solution

Rapid molecular identification with colloidal Ag nanocubes.

Silver Factory Technology's silver (Ag) nanocubes are single-crystalline and highly monodisperse particles with size tunable from 70 to 120 nm. Unlike spherical nanoparticles, our Ag nanocubes exhibit unique morphological features such as sharp edges and tips, which can generate intense electromagnetic field enhancement via the "lightning rod effect". This renders Ag nanocubes superior surface-enhanced Raman scattering (SERS) detection capability even in colloidal solution form.

We supply a new 100× concentrated Ag nanocube solution, i.e. SERS-Boost (5 mg/mL, Figure 1) for rapid SERS analysis. This application note demonstrates how colloidal Ag nanocubes can be feasibly applied for solution-phase SERS detection for preliminary molecular identification.



Figure 1. Silver Factory Technology's concentrated Ag nanocube solution (5 mg/mL), Ag nanocube's advantages as a more effective SERS enhancer, and scheme illustrating colloidal SERS detection.

Rapid and simple SERS detection can be done by (1) mixing analyte sample with concentrated Ag nanocube solution, and (2) measure SERS responses by aiming laser directly onto the solution, without any substrates. The mixing of samples can be done using one of the two following methods.

Method 1. Pre-mix sample and Ag nanocube solution (Figure 2)*

This method of mixing is recommended when the sample solution is viscous (due to high concentration of analyte, or being dissolved in viscous diol- or polymer-based solvents). In this method, a small volume of sample solution (1-10 μ L) is added into a clean container (glass vial, Eppendorf tube), followed by the addition of Ag nanocube solution (preferably in 1:1 v/v ratio with the sample volume). The mixture is thoroughly mixed via hand shake, vortex or sonication. The mixture solution (1-10 μ L) can be drop-casted



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onto a flat surface, preferably using surface with minimal Raman interference e.g. Si substrate or aluminium foil/plate. SERS measurement can then be performed by directly shining laser onto the solution and/or upon drying on the surface.

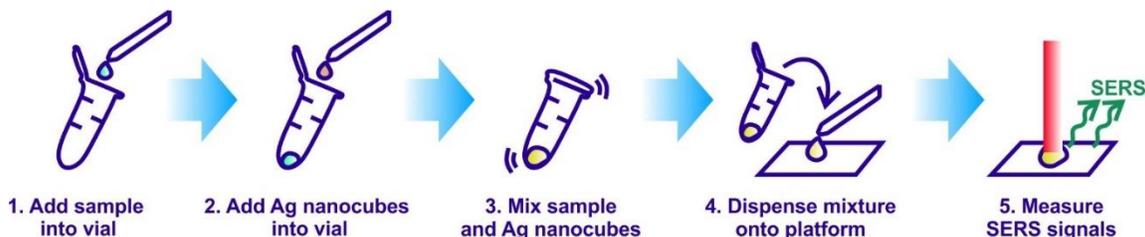


Figure 2. Pre-mix sample and Ag nanocube for colloidal SERS detection.

Method 2. *In situ* mixing of sample and Ag nanocube (Figure 3)*

This method is recommended when the sample solvent can be easily mix with Ag nanocube solution, such as those sample in water, ethanol, and toluene. In this method, a small volume of sample solution (1-10 μL) is added directly onto a flat surface (preferably surface with minimal Raman interference such as Si substrate or aluminum foil/plate). Ag nanocube solution (preferably in 1:1 v/v ratio with the sample volume) is then added into the sample solution. SERS measurement can be performed directly onto the solution or upon drying on the substrate.

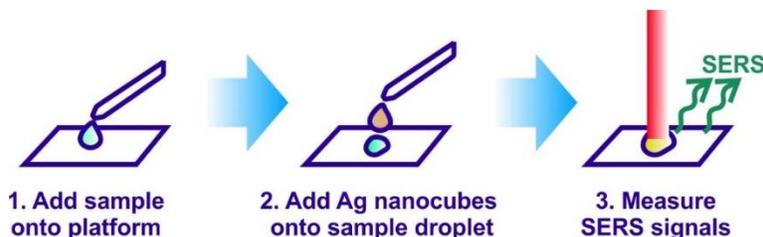


Figure 3. *In situ* mixing sample and Ag nanocube for colloidal SERS detection.

We demonstrate the rapid detection of molecules presented in several aqueous samples using SERS-Boost solution, achieving parts-per-million (ppm) detection sensitivity. Figure 4 showcases the detection of 1,2-bi-(4-pyridyl) ethylene (BPE), rhodamine 6G (R6G), methylene blue (MB) and R6G-BPE mixture (1:1) spectra, (Figure 4A, B, C) respectively. These spectra can be easily collected using micro-Raman system, portable and/or handheld Raman instruments.



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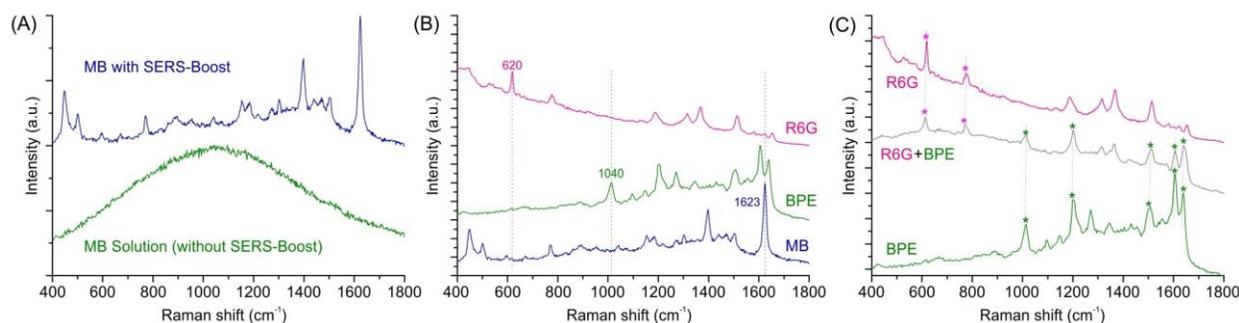


Figure 4. (A) Comparison of Raman spectra of 1 ppm methylene blue (MB) in the presence and absence of SERS-Boost solution. (B) The respective SERS spectra of 1 ppm of rhodamine 6G (R6G), 1,2-bi-(4-pyridyl) ethylene (BPE), methylene blue (MB) upon addition of 1:1 volume ratio of SERS-Boost solution. (C) Multiplex SERS spectra of R6G and BPE in the presence of 1:1 volume ratio of SERS-Boost solution.

A 1 ppm MB solution exhibits no observable fingerprints in normal Raman measurement in the absence of any SERS enhancer (Figure 4A). The addition of SERS-Boost solution into the MB solution results in a remarkable enhancement, which reveals a high-resolution fingerprint profile of MB under the same measurement condition. The detection is also applicable to other target analytes, including BPE and R6G (Figure 4B). Notably, SERS-Boost solution is also able to elucidate multiple analyte fingerprints in a multiplex detection of a mixture of more than one target analyte (Figure 4C). Thus, this is evident that our SERS-Boost method provides an excellent solution for rapid multiplex molecular identification, which can incorporate into various analytical protocols. We would like to emphasize that while SERS-Boost solution is ideal for preliminary qualitative detection, this approach only able to provide qualitative information, and does not provide absolute concentration-intensity accuracy for quantitative analysis. For quantitative analysis, we recommend using our *PowerSERS* sensing substrates with highly homogeneous signal readout (<3% standard deviation).

*Note:

- It is advisable to mix a small volume (microliter-range) of SERS-Boost solution with a comparable volume (preferably 5:1 to 1:1 SERS-Boost/Sample v/v ratio). The higher the volume of analyte sample is used to mix with the same volume of SERS-Boost solution, the more diluted the SERS-Boost becomes and the SERS enhancement effect in the resulting mixture decreases. Raman measurement does not require large volume. In our experiment, 10 μ L of SERS-Boost is mixed with 10 μ L of analyte sample.

- The SERS detection also depends on the Raman cross-section of analytes.



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