Silver nanocubes as superior building blocks for surface-enhanced Raman scattering (SERS) platforms

Our silver nanocubes are single-crystalline and highly monodisperse particles with sizes tunable from 70 to 120 nm (Figure 1A). Ag nanocubes support multiple localized surface plasmon resonance (LSPR) modes (Extinction spectrum, Figure 1B). The main dipole resonance is located at 535 nm, and this radiative resonance extends into the near-IR region. In addition, higher order LSPRs such as quadrupolar and octupolar modes are located at 345, 400 and 470 nm, respectively.[1] Importantly, the resonance modes are narrow, giving rise to high quality factors (Q-factor) which is highly desirable for optics and sensing applications.[2] The ability to support multiple LSPRs implies that **our Ag nanocubes are compatible with multiple common laser excitation wavelengths, i.e. 532 nm, 633 nm or 785 nm, for surface-enhanced Raman scattering (SERS) measurements**.[3]

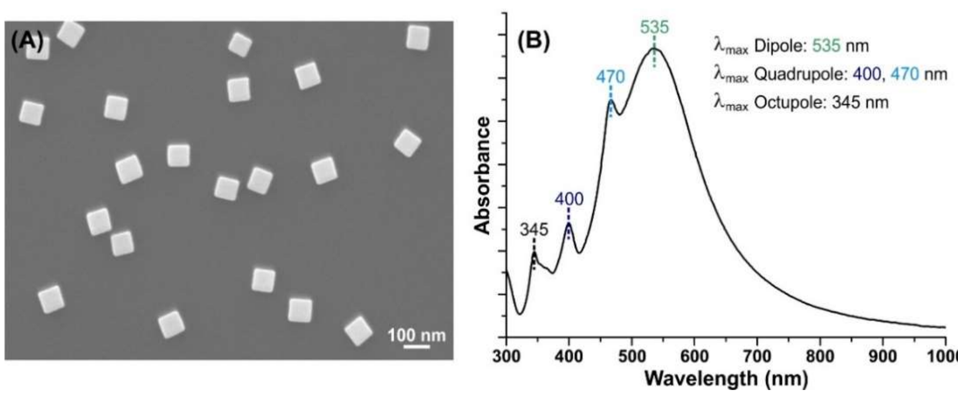

Figure 1. (A) Scanning electron microscope (SEM) image and (B) extinction spectrum of 70-nm silver nanocubes.

Unlike spherical nanoparticles, **our Ag nanocubes exhibit sharp edges and tips. These morphological features can efficiently generate intense electromagnetic field enhancement via the "lightning rod effect"**.[4] To further boost the electric field, these Ag nanocubes can be assembled into a close-packed array with interparticle separation of < 10 nm (Figure 2). Neighboring Ag nanocubes in proximity undergo plasmonic coupling to create a very intense electromagnetic field confined at the interparticle gaps between adjacent particles. Collectively, Ag nanocubes and their assembled platforms have demonstrated the capability to create electromagnetic fields capable of enhancing SERS signals by >10,000,000 times.[5]

contact@silverfactorytechnology.com
http://www.silverfactorytechnology.com
1092 Lower Delta Road, #04-04/05,
Singapore 169203

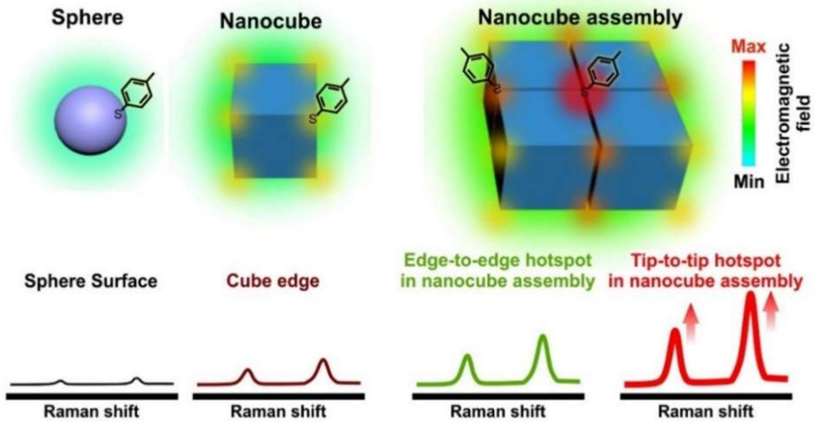

Figure 2. Graphical illustration of SERS responses of silver nanosphere, nanocube and nanocube assembly

Our *Power*SERS sensing substrates are precisely designed and engineered with high-density Ag nanocube metacrystals to maximize SERS hotspot density per unit area and give rise to ultrahigh SERS signal output (Figure 3A-B). The high-density SERS hotspots in our nanocube metacrystal boosts the SERS enhancement factor by at least four orders of magnitude.[6] This remarkable SERS enhancement highlights the importance of controlled assembly of plasmonic nanoparticles to create an ultrasensitive SERS sensor for ultratrace molecular detection. Moreover, PowerSERS chip exhibits excellent signal reproducibility with < 3% in signal variation across a large measuring area (Figure 3C-D).

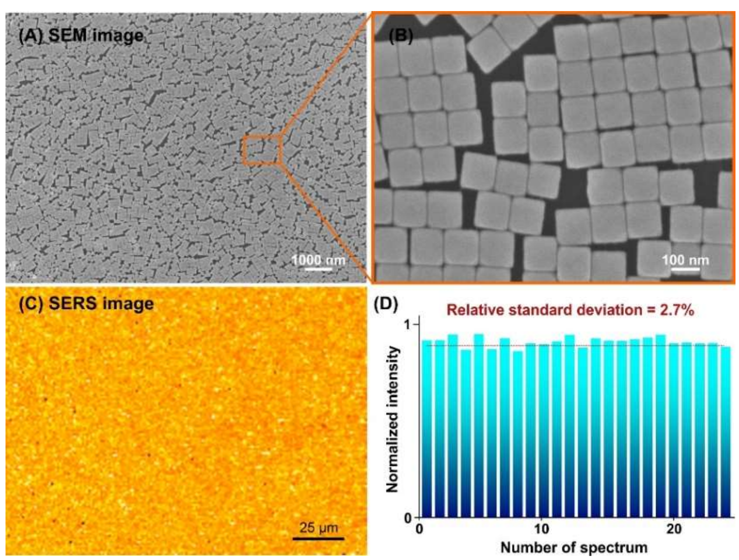

Figure 3. (A-B) SEM images of *Power*SERS sensing substrates by Silver Factory Technology. (C) Large area, strong and homogenous SERS signal and (D) with standard deviation less than < 3%.

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http://www.silverfactorytechnology.com
1092 Lower Delta Road, #04-04/05,
Singapore 169203

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contact@silverfactorytechnology.com
http://www.silverfactorytechnology.com
1092 Lower Delta Road, #04-04/05,
Singapore 169203

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