Surpporting Information

Multi-layer Ag-embedded Silica Nanostructure as SERS-based Chemical Sensor with Dual-Function Internal Standards

Eunil Hahm, [†, §] *Myeong Geun Cha,* [‡, §] *Eun Ji Kang,* [†] *Xuan-Hung Pham,* [†] *Sang Hun Lee,* [∥]

Hyung-Mo Kim, [†] *Dong-Eun Kim,* [†] *Yoon-Sik Lee,* [⊥] *Dae-Hong Jeong* [‡] *and Bong-Hyun Jun* [†,*]

[†] Department of Bioscience and Biotechnology,Konkuk University,
Seoul 05029, Republic of Korea

[‡] Department of Chemistry Education, Seoul National University,
Seoul 08826, Republic of Korea

[∥] Department of Bioengineering, University of California Berkeley,
CA 94720, USA

[⊥] School of Chemical and Biological Engineering, Seoul National University, Seoul 08826, Republic of Korea

* Corresponding author: Bong-Hyun Jun˸ bjun@konkuk.ac.kr

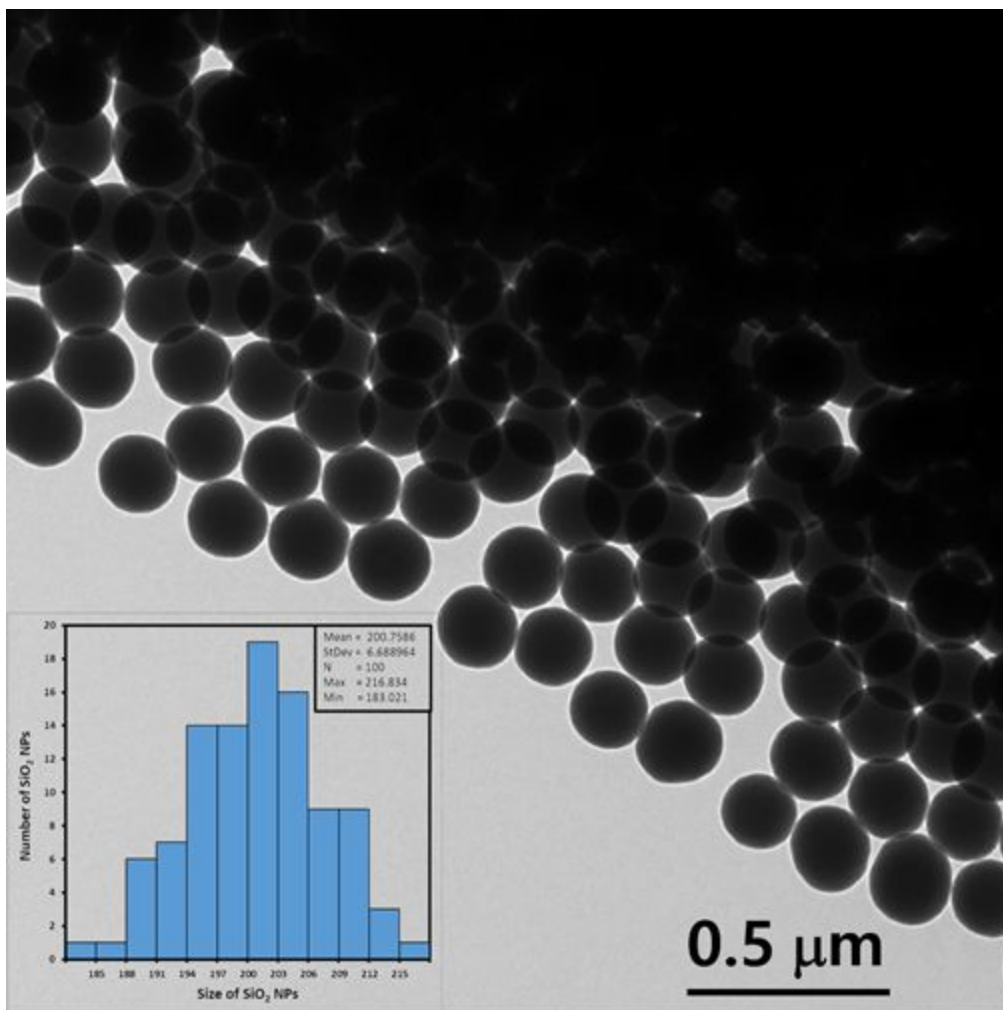§ *These authors contributed equally to this work*

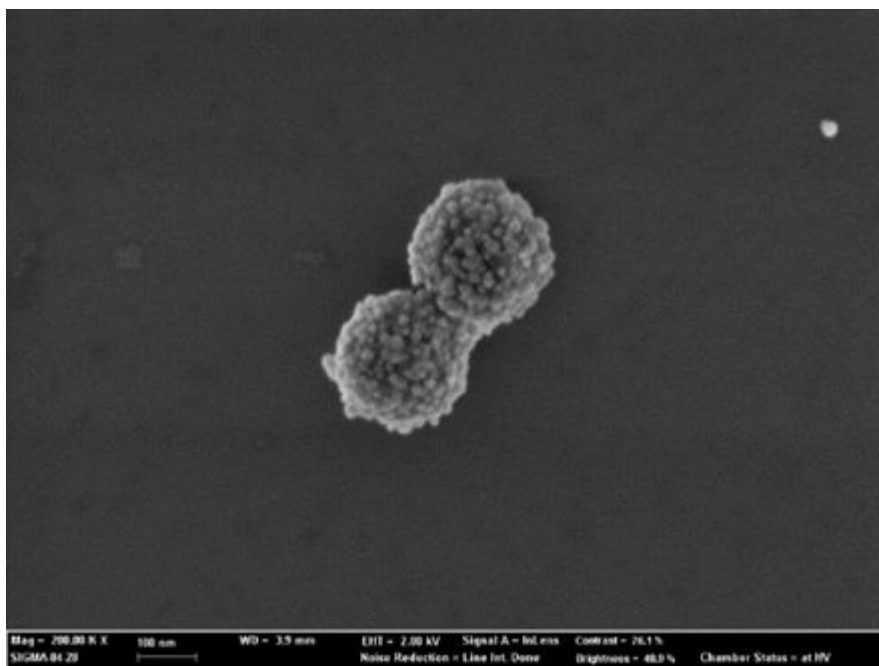**Figure S1.** TEM image of SiO_2 NPs and histogram of size distribution.
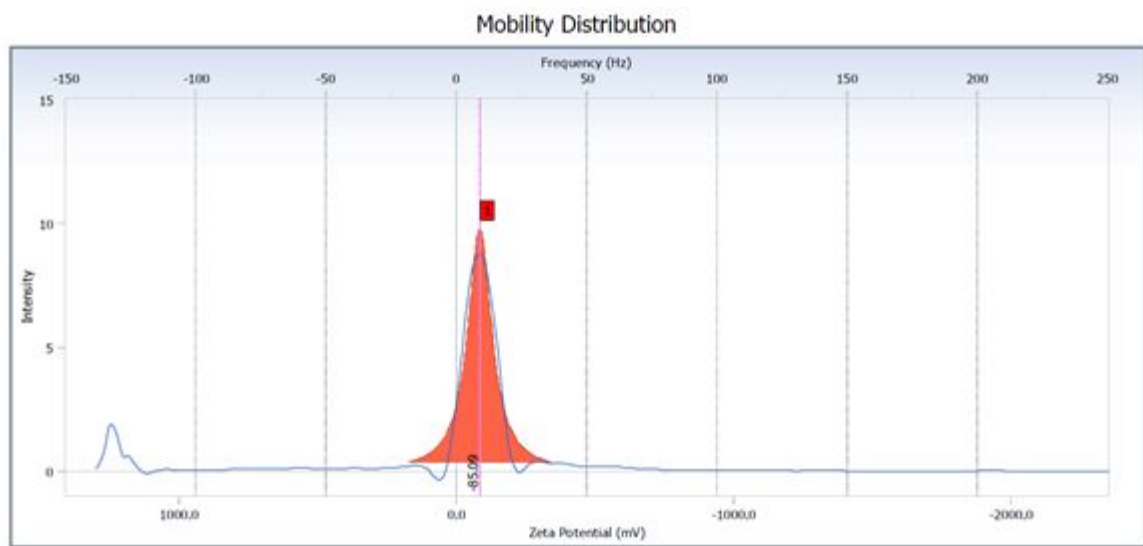
Figure S2. SEM image of ML$_{4\text{-BBT}}$ dot colloids.

Figure S3. Zeta potential of ML$_{4\text{-BBT}}$ dot colloids.

Element	Line Type	k factor	Absorption Correction	Wt%	Wt% Sigma	Atomic %
Si	K series	1.00000	1.00	16.29	0.25	42.73
Br	K series	1.74536	1.00	0.36	0.10	0.33
Ag	L series	1.83762	1.00	83.35	0.27	56.94
Total:				100.00		100.00

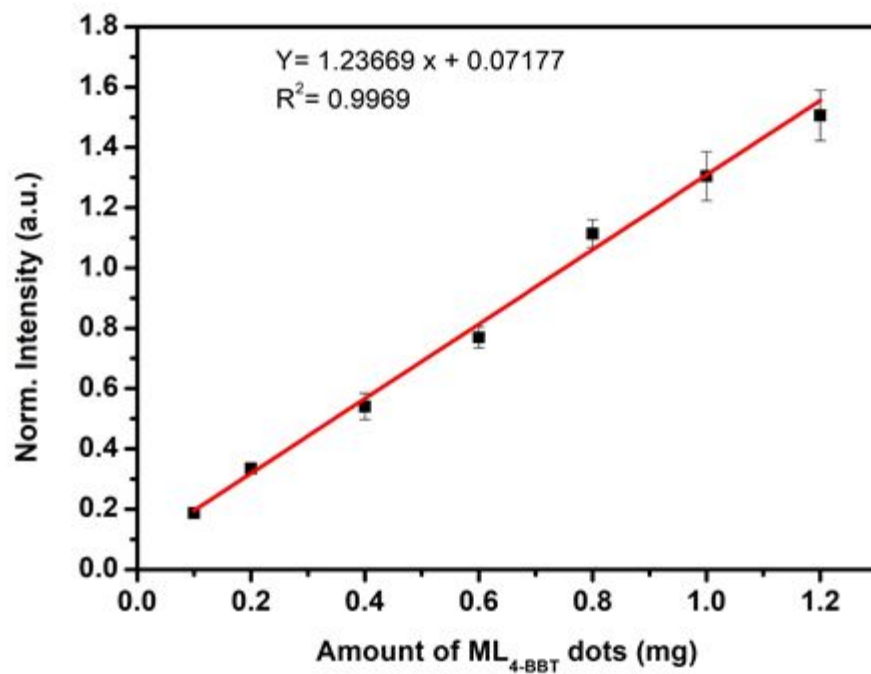**Figure S4.** EDX analysis results of ML$_{4\text{-BBT}}$ dots.

Figure S5. The internal standard SERS intensity according to amount of $ML_{4\text{-}BBT}$ dots

To prove that the ML dots solution can remain its well dispersion during the assay, we mixed the ML dots solution with analytes (4-FBT and thiram) and took pictures of the samples after 5 hours. As shown in Figure S6 (a), the ML dots mixed with analyte were still dispersed well. Also, the UV-Visible spectrum of ML dots solution mixed with analytes (4-FBT, several concentration) was very similar to UV-Visible spectrum of ML dots. Moreover, the z- potential of ML dots mixed with 4-FBT showed also high negative value (-73.75 mV), indicating that the ML dots remain its well dispersion during the assay. The UV-Vis spectrum and z-potential graph were shown below (Figure S6 (b) and (c)).
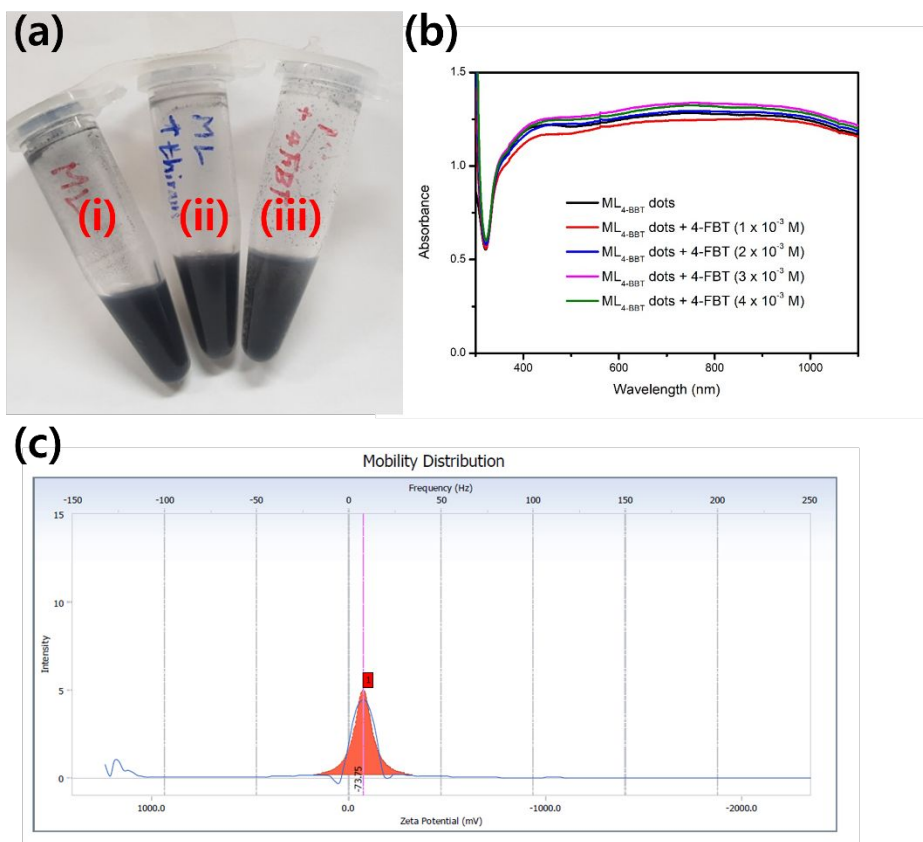

Figure S6. (a) The picture of $ML_{4\text{-BBT}}$ dots after 5 hours of mixing with analytes. (i) $ML_{4\text{-BBT}}$ dots, (ii) $ML_{4\text{-BBT}}$ dots mixed with thiram and (iii) $ML_{4\text{-BBT}}$ dots mixed with 4-FBT. (b) The UV-Vis spectrum of $ML_{4\text{-BBT}}$ dots mixed with several concentration of analytes. (c) The z-potential of $ML_{4\text{-BBT}}$ dots mixed with 4-FBT.