Electronic Supplementary Information

Influence of Shell Thickness on the Refractive Index Sensitivity of Localized Surface Plasmon Resonance Inflection Points in Silver-Coated Gold Nanorods

Kyeong Rim Ryu[a] and Ji Won Ha[a,b*]

[a]Advanced Nano-Bio-Imaging and Spectroscopy Laboratory, Department of Chemistry, University of Ulsan, 93 Daehak-ro, Nam-gu, Ulsan 44610, Republic of Korea

[b]Energy Harvest-Storage Research Center (EHSRC), University of Ulsan, 93 Daehak-ro, Nam-gu, Ulsan 44610, Republic of Korea

[*]To whom correspondence should be addressed.

J. W. Ha

Phone: +82-52-712-8012

Fax: +82-52-712-8003

E-mail: jwha77@ulsan.ac.kr

This document contains supplementary figures (Figure S1 to S6) and tables (Table S1 to S6).

Supplementary Figures

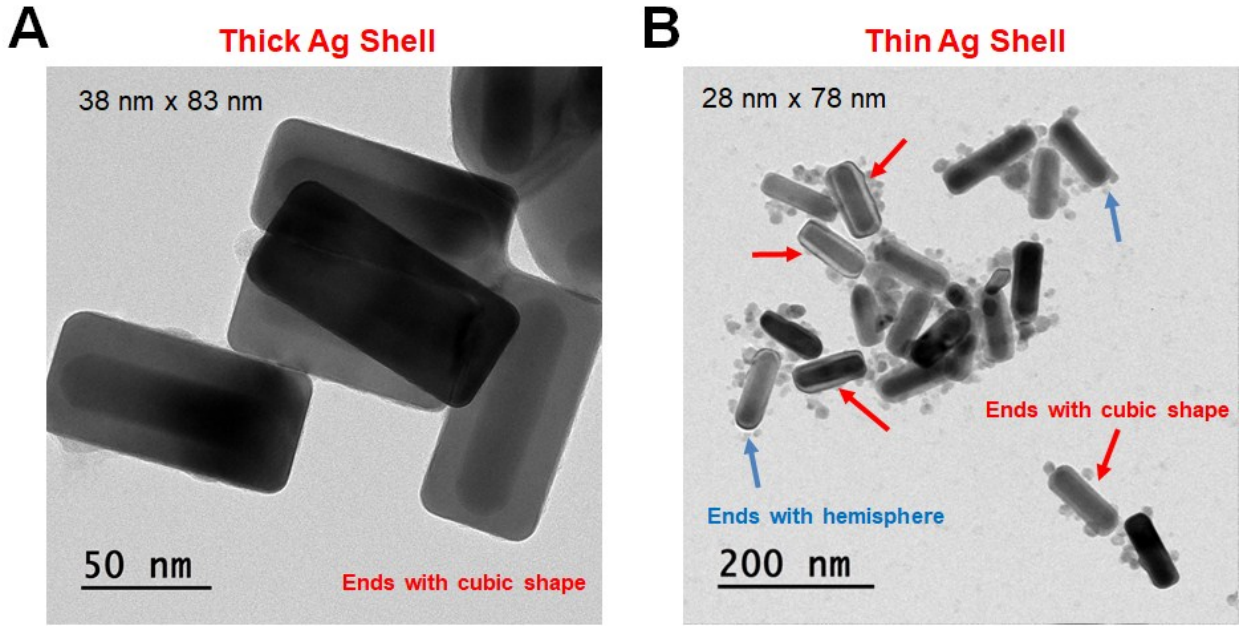

Fig. S1 (A) TEM image of single Ag@AuNRs with thick shell thickness, and they had a cubic shape at the ends. **(B)** TEM image of single Ag@AuNRs with thin shell thickness. Some of thin Ag@AuNRs have a cubic shape at the ends (indicated by red-arrow), whereas some of thin Ag@AuNRs have a shape of hemisphere at the ends (indicated by blue-arrow). But, from a TEM analysis using many particles, we found that a majority of thin Ag@AuNRs had the cubic shape at their ends.

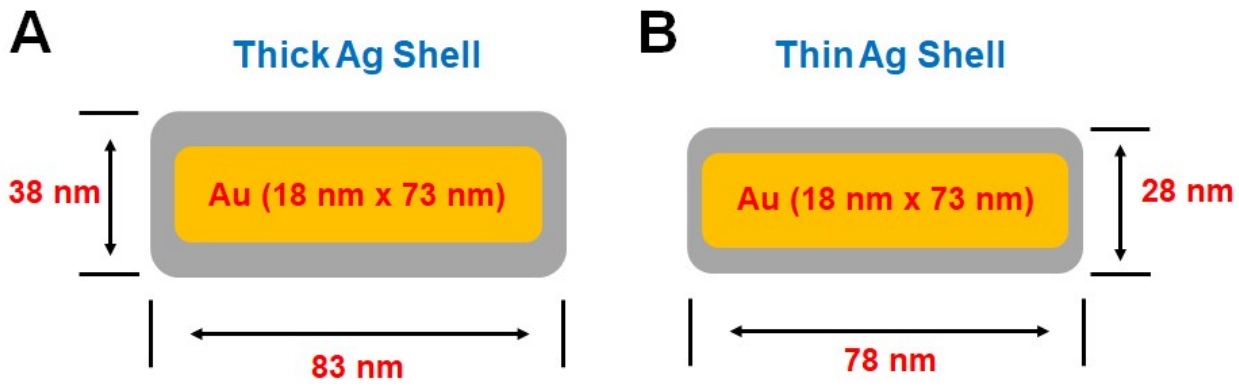

Fig. S2 Schematics to show the size and dimensions of Ag@AuNRs with two different Ag shell thickness. **(A)** Dimension of Ag@AuNR with thick Ag shell thickness at the same size of AuNR core. **(B)** Dimension of Ag@AuNR with thin shell thickness at the same size of AuNR core.

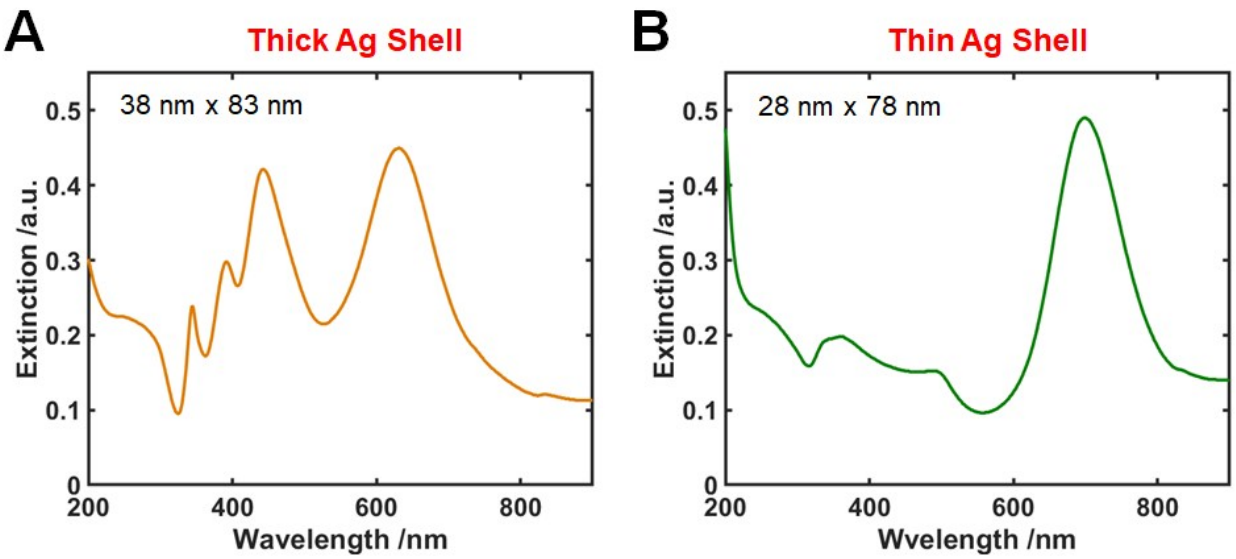

Fig. S3 UV-Vis extinction spectra of Ag@AuNRs with thick Ag shell in water **(A)** and Ag@AuNRs with thin Ag shell dispersed in water **(B)**.

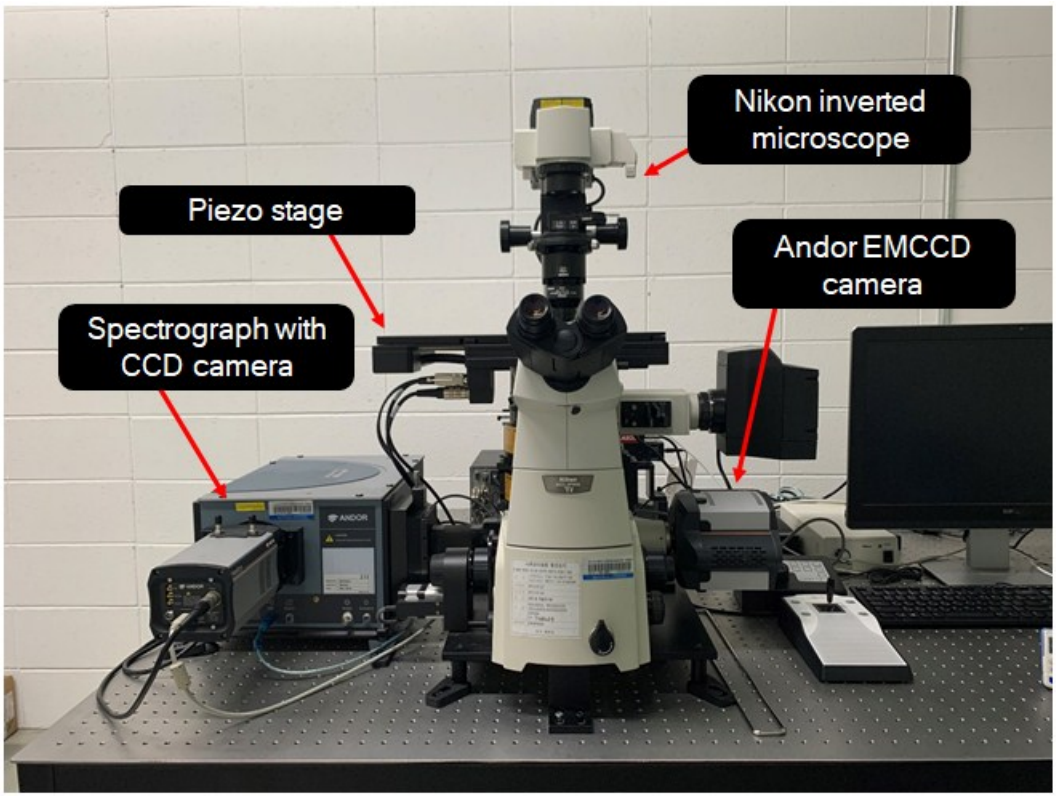

Fig. S4 A photograph to show the experimental setup for single particle DF microscopy and spectroscopy.

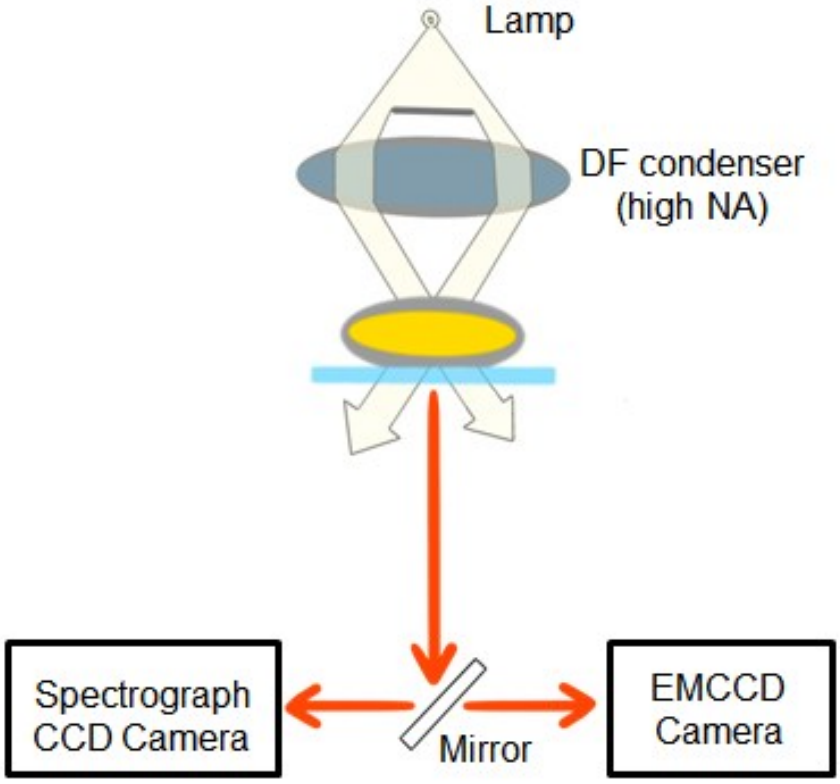

Fig. S5 Schematic depicting the working principle of scattering-based DF microscopy and spectroscopy.

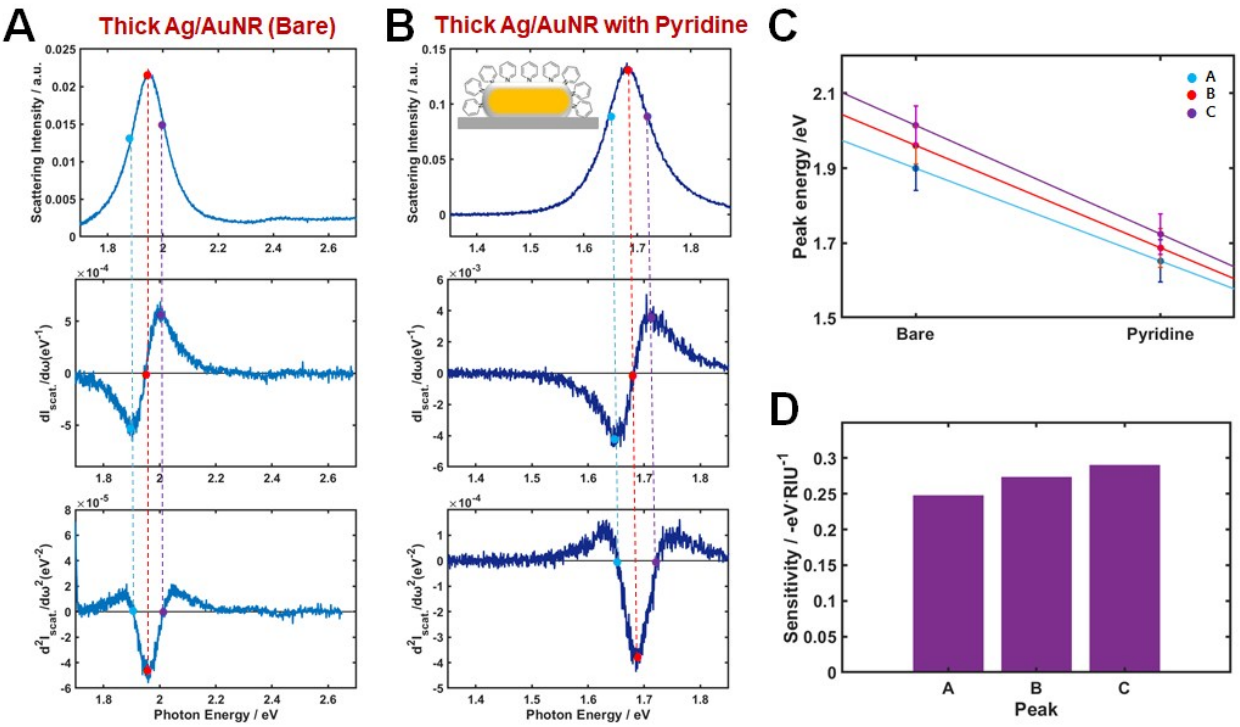

Fig. S6 Inflection point method for single particle LSPR scattering sensing with thick Ag@AuNRs in the presence of pyridine molecules as adsorbate. Pyridine molecules are effectively adsorbed on the Ag surfaces through Ag-nitrogen interaction. **(A, B)** LSPR scattering efficiencies (first row), LSPR scattering efficiencies first order derivatives (second row), and LSPR scattering efficiencies second order derivatives (third row). **(C)** Change in the peak energy upon the adsorption of pyridine molecules on the Ag surfaces. **(D)** Sensitivity of the pyridine adsorption on Peak shifts A, B and C.

Supplementary Tables

Thick Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	2.1145	2.175	2.0987	2.0377	2.2192	2.087	2.2392	2.1761	2.1771	2.1531	**2.1477**	0.0625
LSPR B (eV)	2.1729	2.2392	2.1624	2.0997	2.2768	2.1635	2.3121	2.2448	2.2336	2.2148	**2.212**	0.0628
Inflection C (eV)	2.2392	2.3014	2.2358	2.1814	2.3411	2.2493	2.3899	2.3338	2.3014	2.2756	**2.285**	0.0612

Table S1. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thick Ag shell thickness in refractive index of air

Thick Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	1.9097	1.9376	1.9759	1.8493	1.9105	1.8373	1.9351	1.9326	1.9376	1.9418	**1.917**	0.0429
LSPR B (eV)	1.9681	1.9872	2.047	1.8817	1.9604	1.8739	2.0148	2.005	2.0121	1.9952	**1.975**	0.0566
Inflection C (eV)	2.023	2.0554	2.1175	1.9301	2.0112	1.9219	2.0802	2.062	2.085	2.062	**2.035**	0.0647

Table S2. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thick shell thickness in refractive index of water

Thick Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	1.7411	1.7622	1.7547	1.7213	1.7923	1.7391	1.8657	1.7795	1.8175	1.8565	**1.783**	0.0497
LSPR B (eV)	1.8117	1.8212	1.8161	1.7958	1.8649	1.8059	1.9247	1.8481	1.8955	1.9247	**1.851**	0.0492
Inflection C (eV)	1.8821	1.89	1.8734	1.8665	1.9397	1.8711	1.9816	1.9363	1.96	1.9859	**1.919**	0.0473

Table S3. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thick shell thickness in refractive index of oil

Thin Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	1.8576	1.9244	1.9452	1.9865	1.7862	1.8692	1.8584	1.7176	1.7855	1.856	**1.859**	0.0857
LSPR B (eV)	1.8944	1.97	1.9839	2.0314	1.8305	1.9056	1.9129	1.7529	1.8194	1.902	**1.9**	0.0883
Inflection C (eV)	1.9327	2.0114	2.0205	2.0804	1.8754	1.9385	1.9725	1.7883	1.8569	1.938	**1.942**	0.0911

Table S4. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thin Ag shell thickness in refractive index of air

Thin Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	1.7536	1.7347	1.7228	1.7314	1.7414	1.7189	1.7287	1.7597	1.738	1.7215	**1.735**	0.0135
LSPR B (eV)	1.7912	1.7652	1.7618	1.775	1.775	1.7502	1.7583	1.7933	1.7604	1.7583	**1.768**	0.0144
Inflection C (eV)	1.8128	1.8005	1.8005	1.8334	1.8297	1.7834	1.8019	1.8267	1.8019	1.7869	**1.807**	0.0174

Table S5. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thin shell thickness in refractive index of water

Thin Ag shell	1	2	3	4	5	6	7	8	9	10	Ave	Std
Inflection A (eV)	1.7577	1.6571	1.6912	1.7354	1.7228	1.7117	1.6718	1.7515	1.6887	1.6995	**1.709**	0.0333
LSPR B (eV)	1.799	1.6925	1.7195	1.7625	1.7495	1.7461	1.7001	1.7813	1.7143	1.7287	**1.739**	0.0348
Inflection C (eV)	1.8402	1.7314	1.7549	1.7983	1.789	1.7827	1.7354	1.8201	1.7481	1.7652	**1.776**	0.0361

Table S6. Inflection points and LSPR peak locations on the curvatures of single Ag@AuNRs with thin shell thickness in refractive index of oil