Supporting information

Effect of the Surface-Plasmon-Exciton coupling and charge transfer process on the photoluminescence of metal-semiconductor nanostructures

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S1. The extinction spectra of the samples

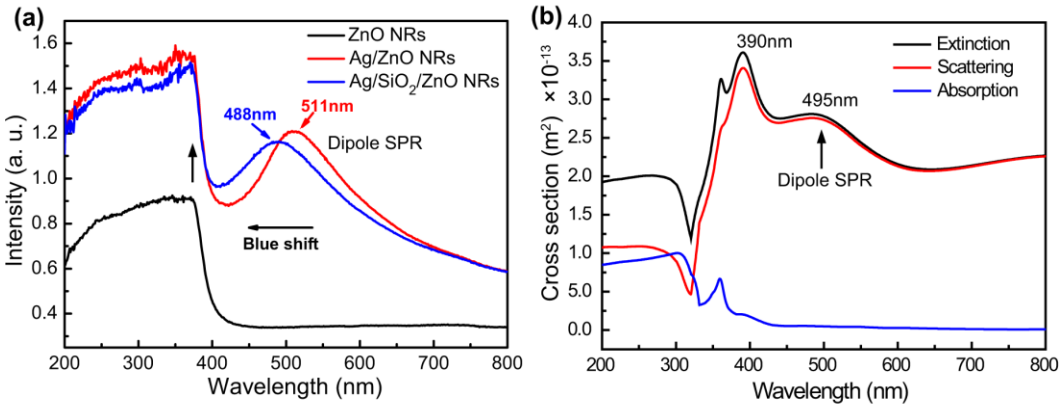

Fig. S1 (a) Extinction spectra of the ZnO NRs, Ag/ZnO NRs and Ag/SiO_2/ZnO NRs samples; (b) Calculated extinction, scattering and intrinsic absorption spectra for a typical Ag NPs (diameter of 150 nm) in air using Mie theory.

Fig. S1(a) shows the measured extinction spectra of the ZnO NRs, Ag/ZnO NRs and Ag/SiO_2/ZnO NRs samples. It can be seen in Fig. S1(a) that the absorption has been obviously enhanced after decorating the Ag NPs, which should be attributed to the SPR effect of the Ag NPs. With considering the Ag NB's size is larger than 100 nm in this work, the dipole mode SPR from the Ag NBs can be responsible for the broad peak in the visible region as seen in Fig. S1(a). The blue shift of the dipole mode SPR peak for the Ag/ZnO NRs and Ag/SiO_2/ZnO NRs should come from the Ag NPs with different morphology and average size due to inserted SiO_2 layer. The different wetting property for ZnO and SiO_2 makes the aggregated Ag NPs show a little different morphology as seen in Fig. 1 in the paper. The enhanced absorption near the band edge should come from the higher order SPR resonance. In order to verify this, the extinction spectra of a single Ag NP with a typical diameter of 150 nm are calculated to do a comparative analysis, as seen in Fig. S1(b). It can be seen that another resonance peak located near the band edge (390 nm) emerges besides the dipole mode SPR in the visible region. This resonance peak should come from the higher order of SPR resonance and should be the main contribution to the coupling process between SPs-excitons.

S2. TEM characterization of the samples.

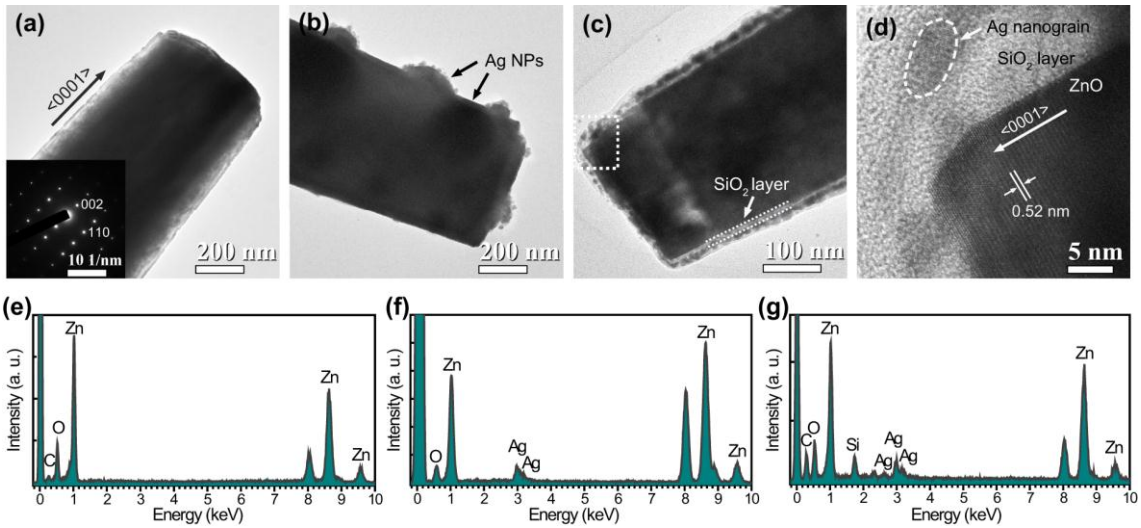

Fig. S2 (a)-(c) The TEM images of the ZnO NRs, Ag NPs/ZnO NRs and Ag NPs/SiO_2/ZnO NRs samples, respectively. The inset of (a) shows the selected area electron diffraction (SAED) pattern taken from the ZnO NRs shown in (a), which indicates that the growth direction is along *c*-direction consistent with the XRD results. (d) The high resolution TEM (HRTEM) images of the area marked in (c), showing distinguished boundaries of the Ag NPs (nanograins), SiO_2 layer and ZnO. (e)-(g) The EDS spectra collected from the typical area of the samples shown in (a)-(c), respectively.

TEM characterization was also carried as shown in Fig. S2 to further investigate the morphologies and crystal structures of the samples. It can be seen that the results agree well with the SEM and XRD characterization results as shown in the paper. The thin SiO_2 blocking layer can be clearly seen between the ZnO NRs and coated Ag NPs as shown in Fig. S2(c) and (d), which demonstrates the successful preparation of an ideal electron blocking layer. Fig.S2 (e)-(g) show the EDS spectra collected from the typical area of the samples shown in (a)-(c), respectively. The Ag elements can be seen in the spectra after the ZnO NRs was coated with Ag NPs. The Si element also can be seen in the spectra shown in (g) after inserting a thin SiO_2 film between the Ag NPs and ZnO NRs for the Ag NPs/SiO_2/ZnO NRs sample.