Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Perylene Dye-Functionalized Silver Nanoparticles Serving as pH-Dependent Metal Sensor Systems

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UV-vis spectra sample preparation

$AgNO_3$ (0.5 mL, 10 mM) was added into the solution of **LPL** (20.0 mL, 7.5 μM) at given pH (12.6, 12.0, 11.0, and 10.0). Subsequently, a fresh $NaBH_4$ solution (0.5 mL, 0.1 M) was added into the solution with rapid stirring.

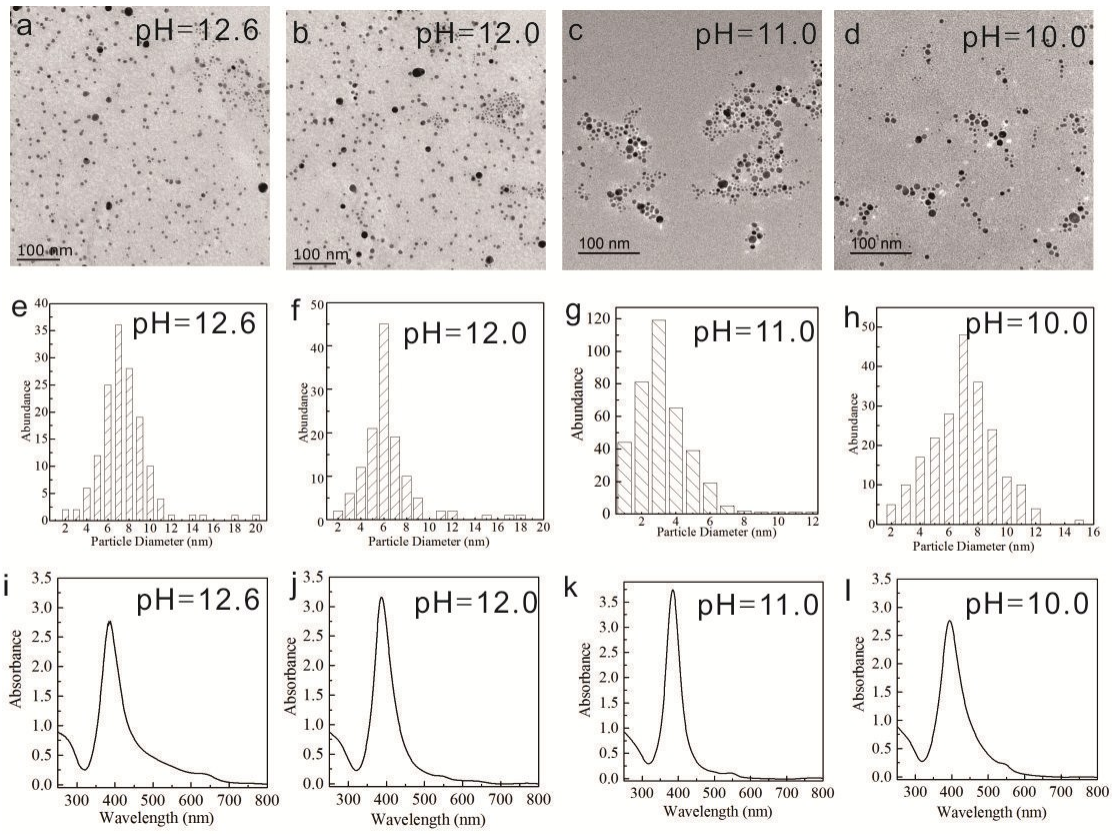

Figure S1. TEM images of the **LPL**-AgNPs at pH (a) 12.6, (b) 12.0, (c) 11.0, and (d) 10.0. (e)-(h) Histograms of the size distribution and (i)-(j) corresponding UV-vis spectra.

UV-vis spectra sample preparation

2.8 mL LPL (7.5 μM, pH=12.6) and 0.7 mL metal ions (10 μM, pH=7) were mixed for 20 min, then the UV-vis spectra were recorded.

2.8 mL LPL (7.5 μM, pH=12.0) and 0.7 mL metal ions (50 μM, pH=7) were mixed for 20 min, then the UV-vis spectra were recorded.

2.8 mL LPL (7.5 μM, pH=11.0) and 0.7 mL metal ions (10 μM, pH=7) were mixed for 20 min, then the UV-vis spectra were recorded.

2.8 mL LPL (7.5 μM, pH=12.0) and 0.7 mL metal ions (0.5 μM, pH=7) were mixed for 20 min, then the UV-vis spectra were recorded.

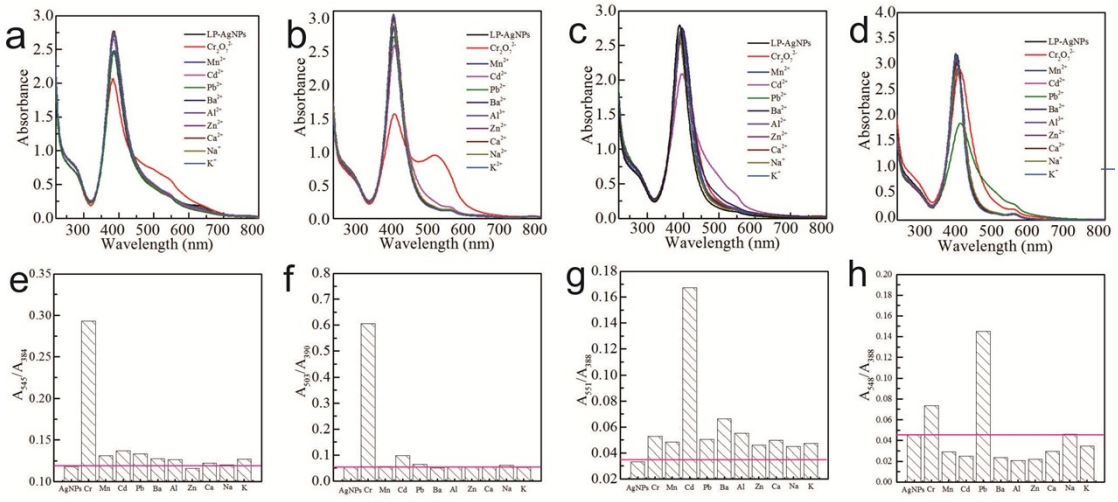

Figure S2. (a) UV-vis spectra of the **LPL**-AgNPs after the addition of different metal ions

(100 nM) at pH=12.6, (b) UV-vis spectra of the **LPL**-AgNPs after the addition of different metal ions (2 μM) at pH=12.0. (c) UV-vis spectra of **the LPL**-AgNPs after the addition of different metal ions (10 μM) at pH=11.0. (d) UV-vis spectra of **LPL**-AgNPs after the addition of different metal ions (2 μM) at pH=10.0. (e) Corresponding values of A_{545} /A_{384} (pH=12.6), (f) values of A_{503} /A_{390} (pH=12.0), (i) values of A_{551}/A_{388} (pH=11.0), (i) values of A_{551}/A_{388} (pH=10.0).

UV-vis spectra sample preparation

2.4 mL LPL (7.5 μM, pH=12.6) and 0.6 mL metal ions (100 μM, pH=7) were mixed, then the UV-vis spectra evolution were recorded.

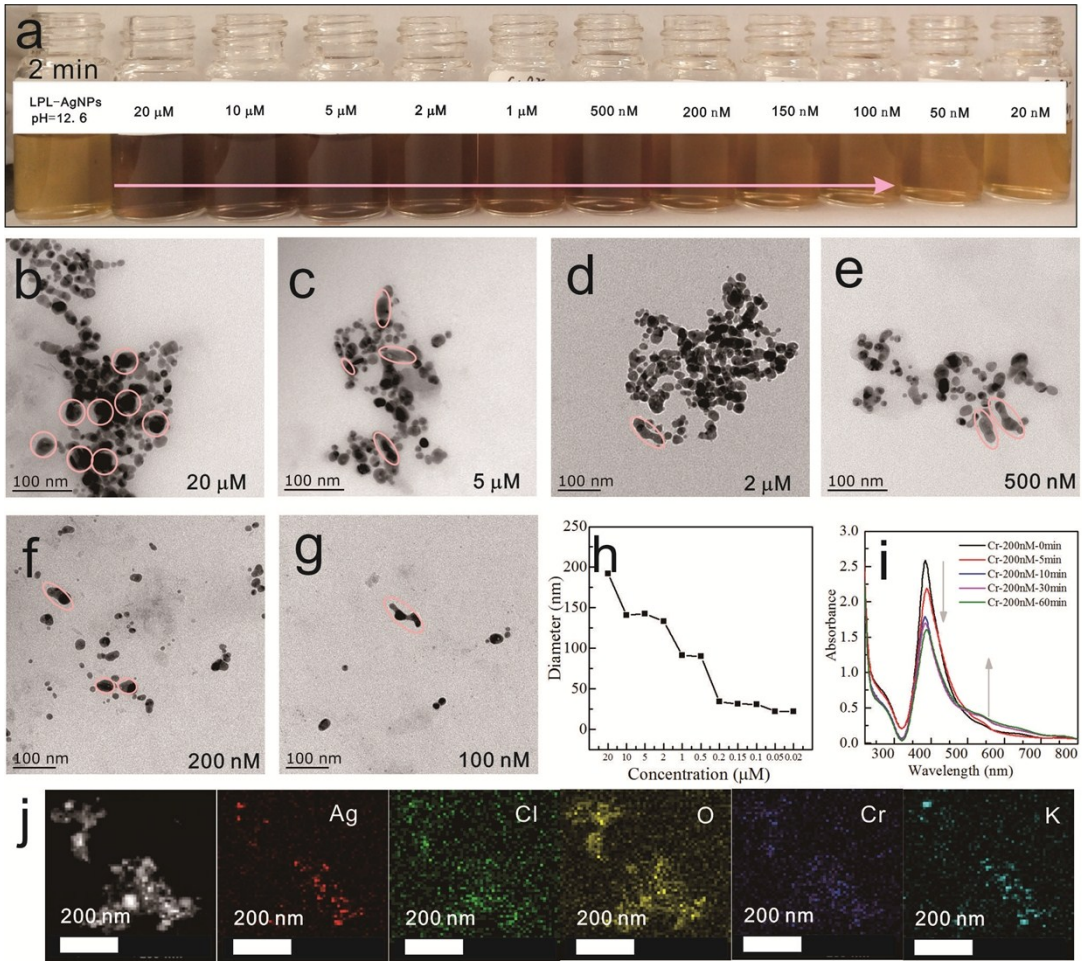

Figure S3. (a) Digital image of **LPL**-AgNPs interacting with different concentrations of Cr^{6+}. (b)-(g) TEM images of the **LPL**-AgNPs after interacting with Cr^{6+} at concentrations of 10 μM, 2 □M, 200 nM, and 100 nM. (h) Evolution of the diameter of the **LPL**-AgNPs. (i) UV-vis spectra of the **LPL**-AgNPs with time. (j) Left: STEM image of the **LPL**-AgNPs -Cr^{6+}. Right: The corresponding mapping images.

UV-vis spectra sample preparation

2.4 mL LPL (7.5 μM, pH=11.0) and 0.6 mL metal ions (100 μM, pH=7) were mixed, then the UV-vis spectra evolution were recorded.

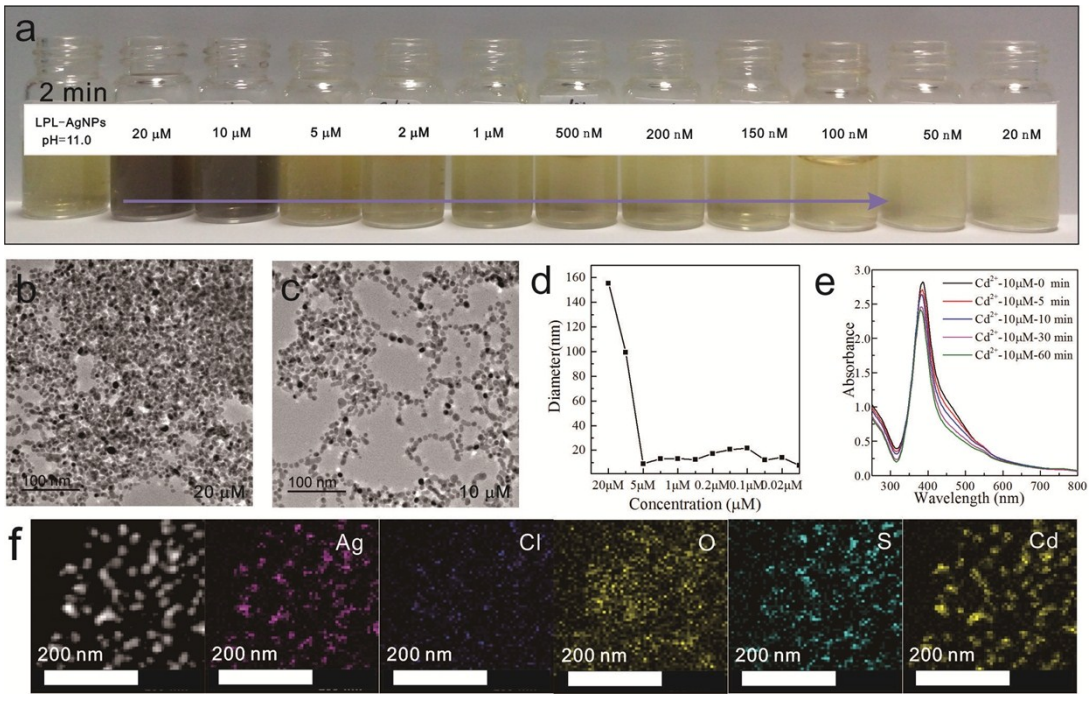

Figure S4. (a) Digital image of **LPL**-AgNPs interacting with Cd^{2+}. (b-c) TEM images of the **LPL**-AgNPs after interacting with Cd^{2+} at concentrations of 20 μM and 10 μM. (d) Evolution of the diameter of the **LPL**-AgNPs. (e) UV-vis spectra of the **LPL**-AgNPs with time. (f) Left: STEM image of the **LPL**-AgNPs-Cd^{2+}. Right: The corresponding mapping images.

UV-vis spectra sample preparation

2.4 mL LPL (7.5 μM, pH= 10.0) and 0.6 mL metal ions (100 μM, pH=7) were mixed, then the UV-vis spectra evolution were recorded.

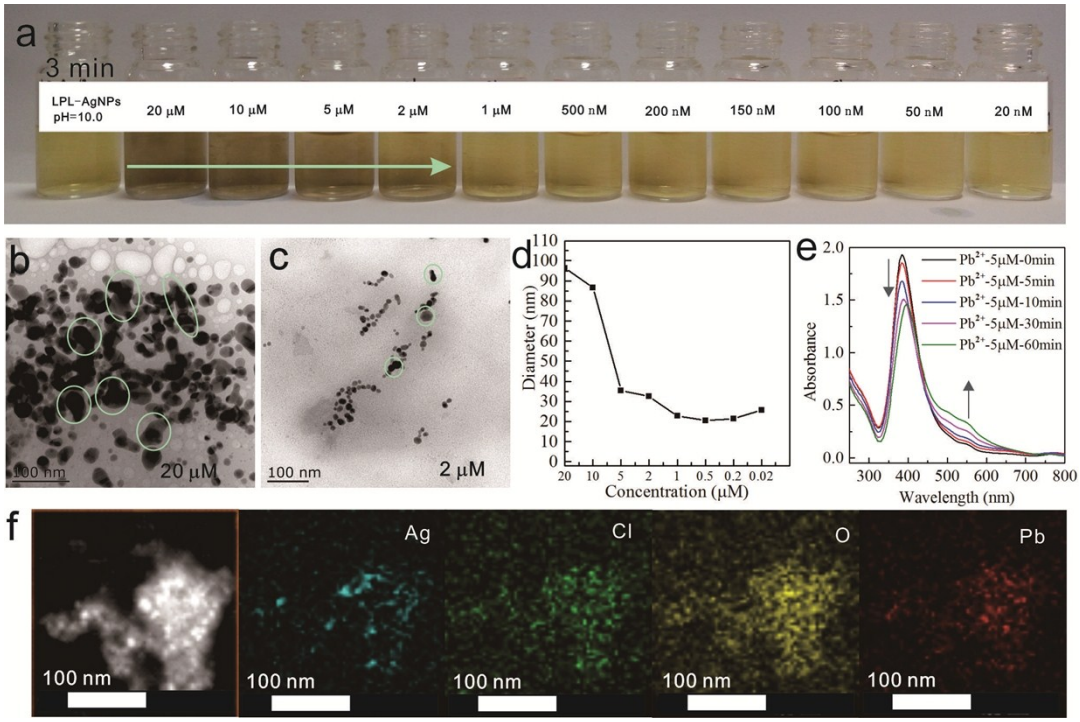

Figure S5. (a) Digital image of **LPL**-AgNPs interacting with different concentrations of Pb^{2+}. (b)-(c) TEM images of **LPL**-AgNPs after interacting with Pb^{2+} at the concentrations of 20 μM and 2 μM. (d) Evolution of the diameter of the **LPL**-AgNPs with the concentration. (e) UV-vis spectra of **LPL**-AgNPs with time. (f) Left: STEM image of the **LPL**-AgNPs-Pb^{2+}. Right: The corresponding mapping images.

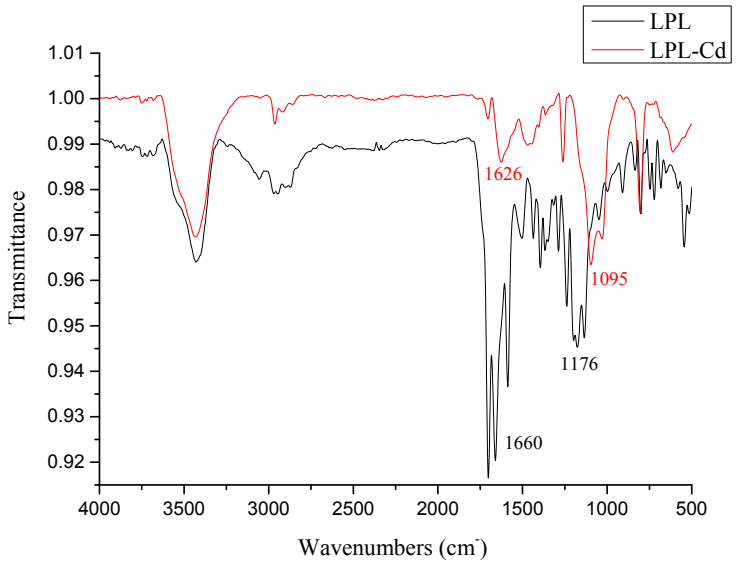

Figure S6. FT-IR spectra of LPL before and after the addition of $Cd2^{+}$.

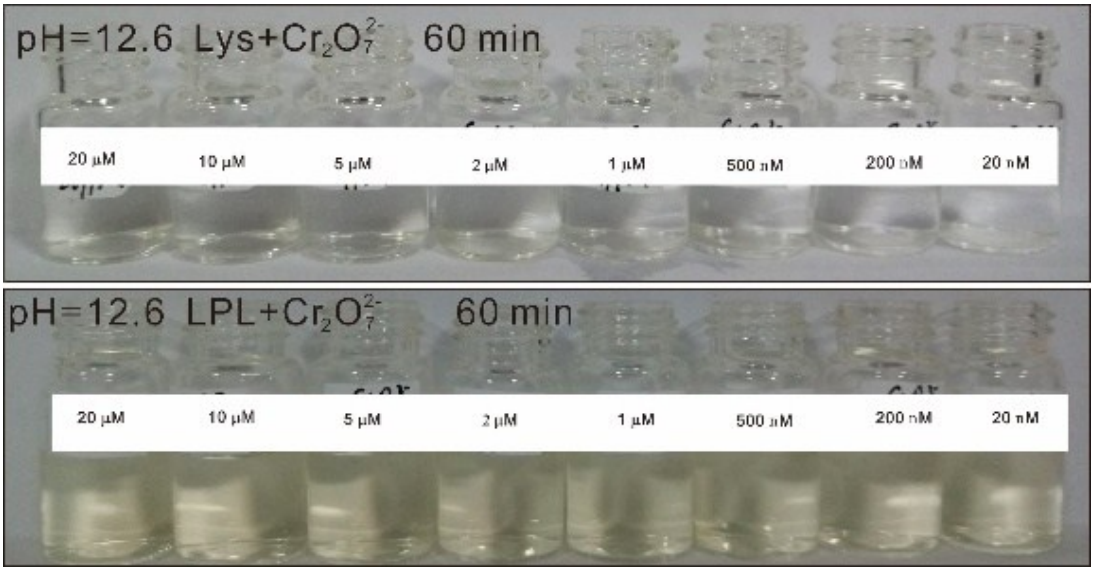

Figure S7. (Top) Digital image of the Lys interactions with different concentrations of $Cr_2O_7^{2-}$ (pH=12.6). (Bottom) Digital image of the **LPL** interactions with different concentrations of $Cr_2O_7^{2-}$ (pH=12.6).

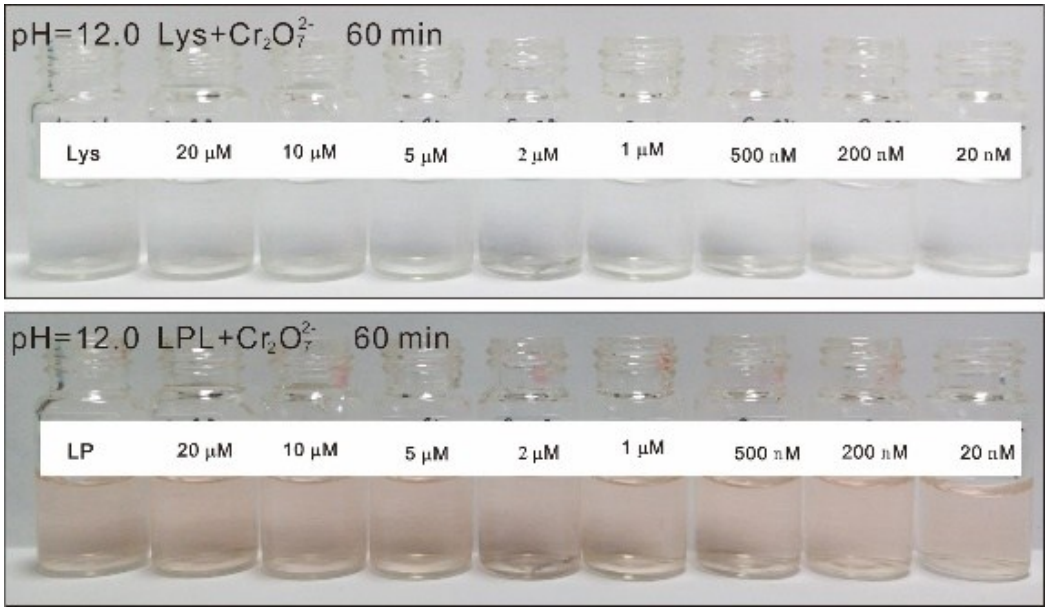

Figure S8. (Top) Digital image of the Lys interactions with different concentrations of $Cr_2O_7^{2-}$ (pH=12.0). (Bottom) Digital image of the **LPL** interactions with different concentrations of $Cr_2O_7^{2-}$ (pH=12.0).

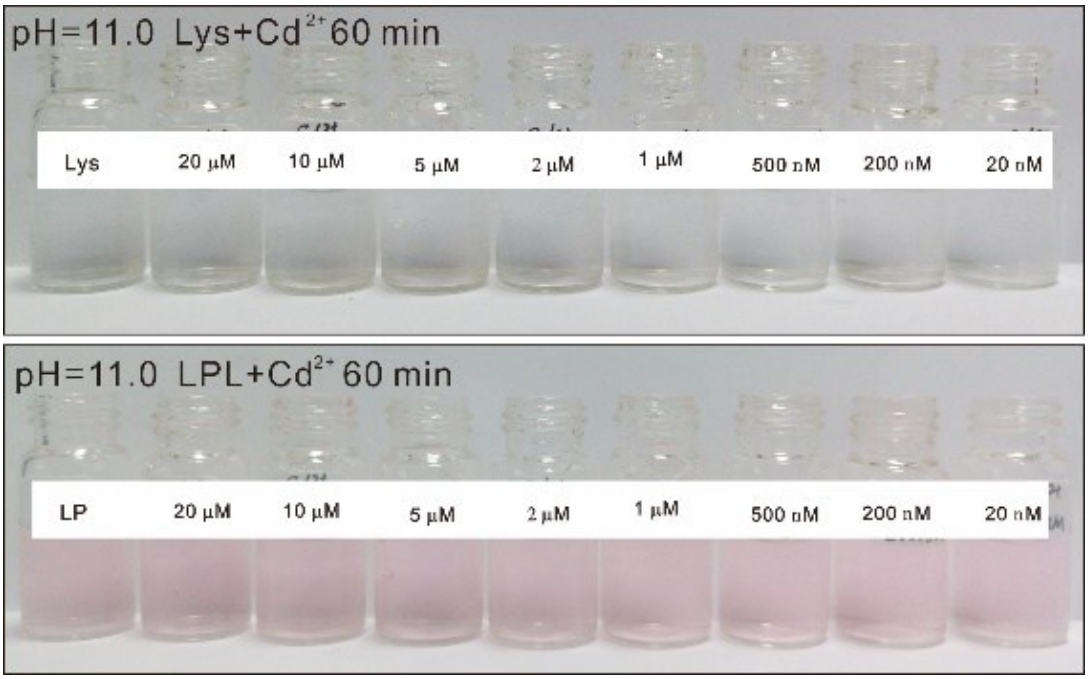

Figure S9. (Top) Digital image of Lys interactions with different concentrations of Cd^{2+} (pH=11.0). (Bottom) Digital image of the **LPL** interactions with different concentrations of Cd^{2+} (pH=11.0).

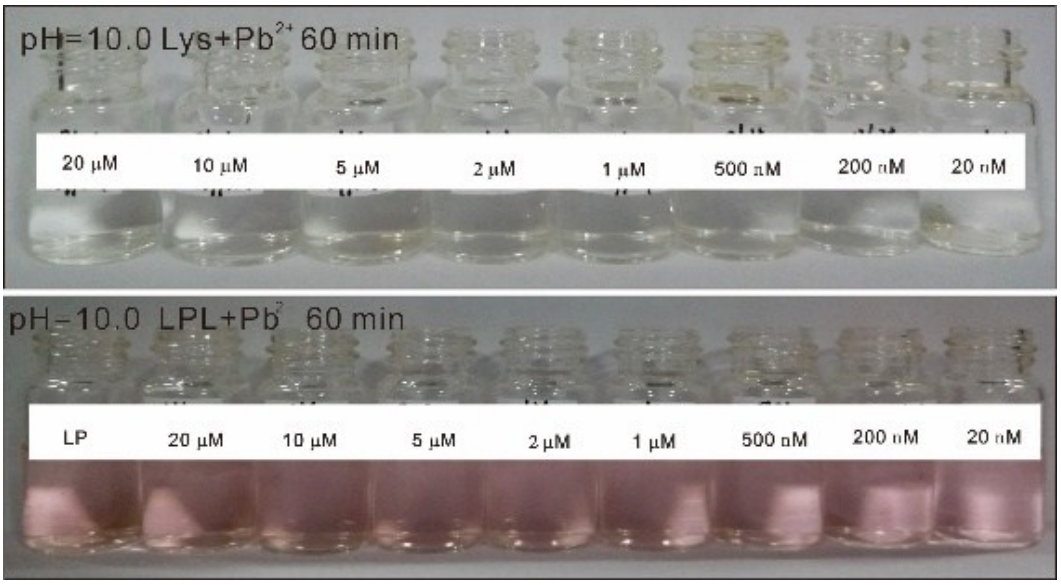

Figure S10. (Top) Digital image of the Lys with different concentrations of Pb^{2+} (pH=10.0). (Bottom) Digital image of the **LPL** interactions with different concentrations of Pb^{2+} (pH=10.0).

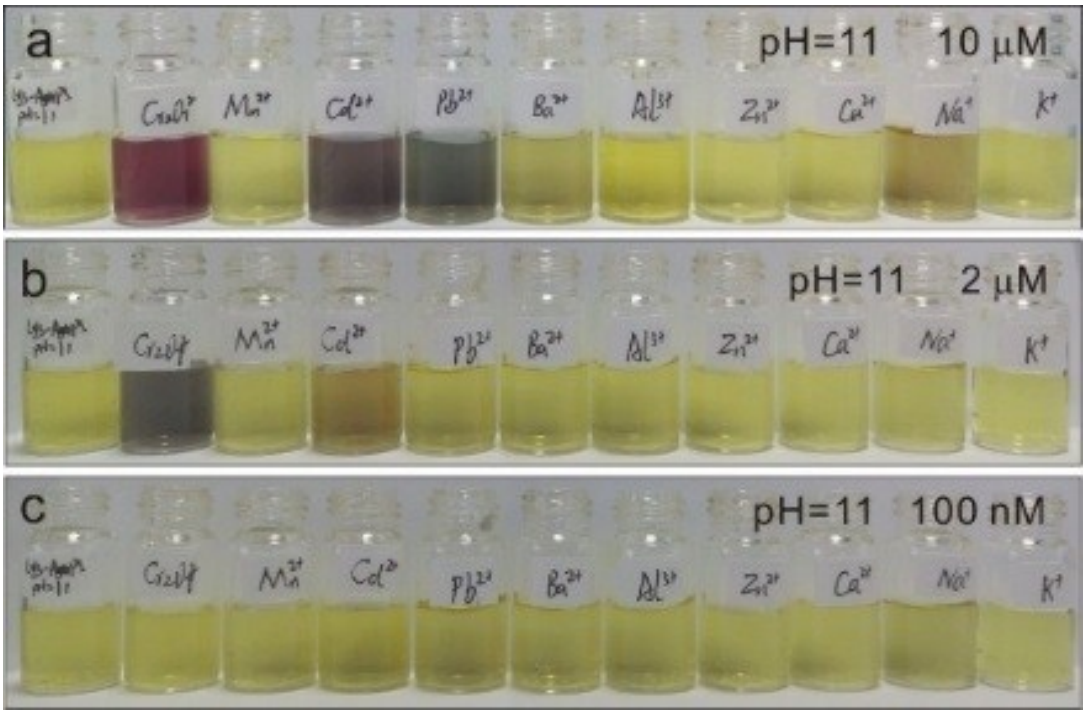

Figure S11. Digital images of the lysine-AgNPs with different metal ions at pH=11.0 with concentrations of (a) 10 μM, (b) 2 μM, and (c) 100 nM.

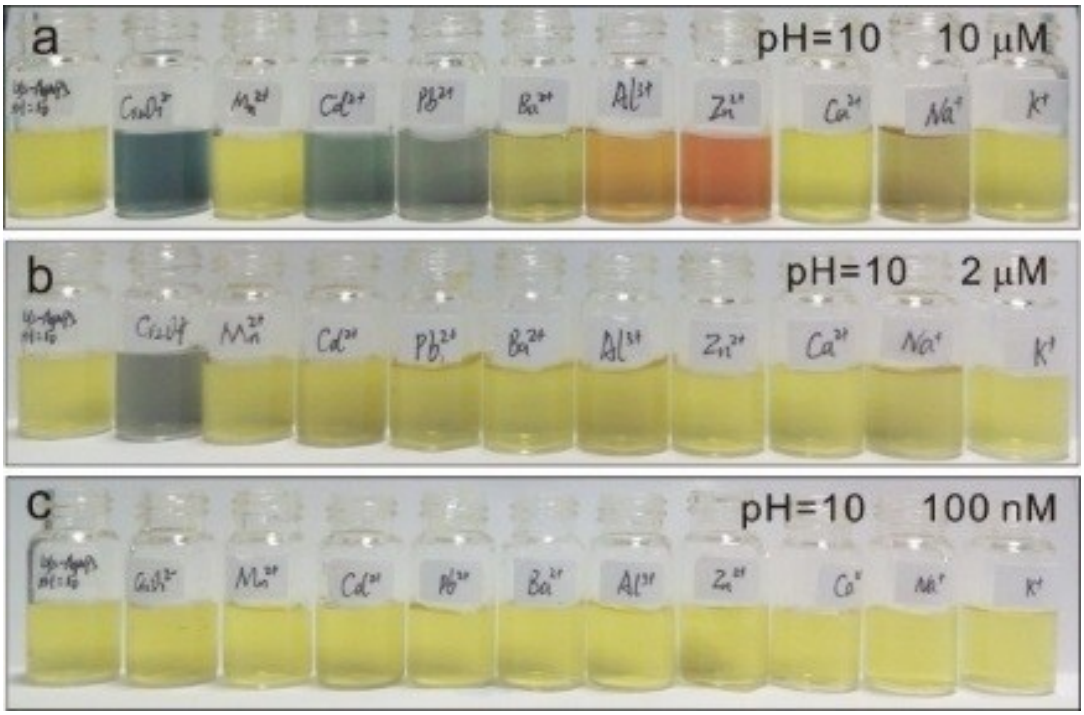

Figure S12. Digital images of the lysine-AgNPs with different metal ions at pH=10.0 with concentrations of (a) 10 μM, (b) 2 μM, and (c) 100 nM.

Fluorescence spectra sample preparation

pH=12.6. LPL-AgNPs-Cr^{6+}. 1.6mL LPL (7.5 μM，pH=12.6) and 0.4 mL metal ions（0.5μM，pH=7）were mixed, then the fluorescence spectra were recorded. **LPL-AgNPs.** 1.6mL LPL-AgNPs (pH=12.6) and 0.4 mL water（0.5μM，pH=7）were mixed, then the fluorescence spectra were recorded. **LPL.** 1.6mL LPL (7.5 μM，pH=12.6) and 0.4 mL water（0.5μM，pH=7）were mixed, then the fluorescence spectra were recorded.

pH=12.0. LPL-AgNPs-Cr^{6+}. 1.6mL LPL (7.5 μM，pH=12.0) and 0.4 mL metal ions（10μM，pH=7）were mixed, then the fluorescence spectra were recorded. **LPL-AgNPs.** 1.6mL LPL-AgNPs (pH=12) and 0.4 mLwater were mixed, then the fluorescence spectra were recorded. **LPL.** 1.6mL LPL (7.5 μM，pH=12) and 0.4 mL water were mixed, then the fluorescence spectra were recorded.

pH=11.0. LPL-AgNPs-Cd^{2+}. 1.6mL LPL (7.5 μM，pH=11.0) and 0.4 mL metal ions（50μM，pH=7）were mixed, then the fluorescence spectra were recorded. **LPL-AgNPs.** 1.6mL LPL-AgNPs (pH=11.0) and 0.4 mL water were mixed, then the fluorescence spectra were recorded. **LPL.** 1.6mL LPL (7.5 μM，pH=11.0) and 0.4 mL water were mixed, then the fluorescence spectra were recorded.

pH=10.0. LPL-AgNPs-Pb^{2+}. 1.6mL LPL (7.5 μM，pH=10.0) and 0.4 mL metal ions（10μM，pH=7）were mixed, then the fluorescence spectra were recorded. **LPL-AgNPs.** 1.6mL LPL-AgNPs (pH=10.0) and 0.4 mL water were mixed, then the fluorescence spectra were recorded. **LPL.** 1.6mL LPL (7.5 μM，pH=10.0) and 0.4 mL water were mixed, then the fluorescence spectra were recorded.

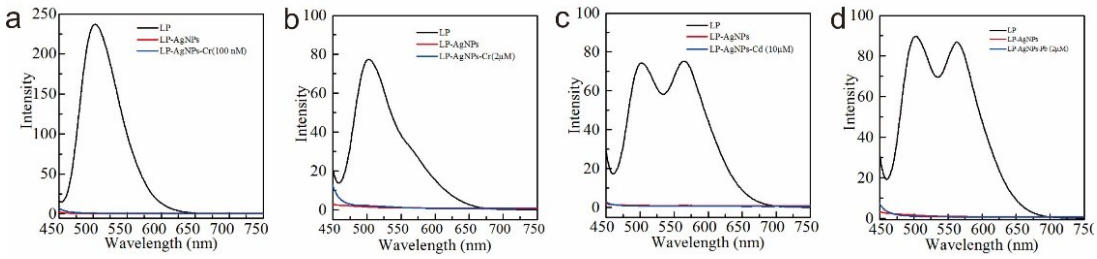

Figure S13. Fluorescence spectra of the **LPL**, **LPL**-AgNPs, and **LPL**-AgNPs-M at (a) pH=12.6, (b) pH=12.0, (c) pH=11.0, and (d) pH=10.0.

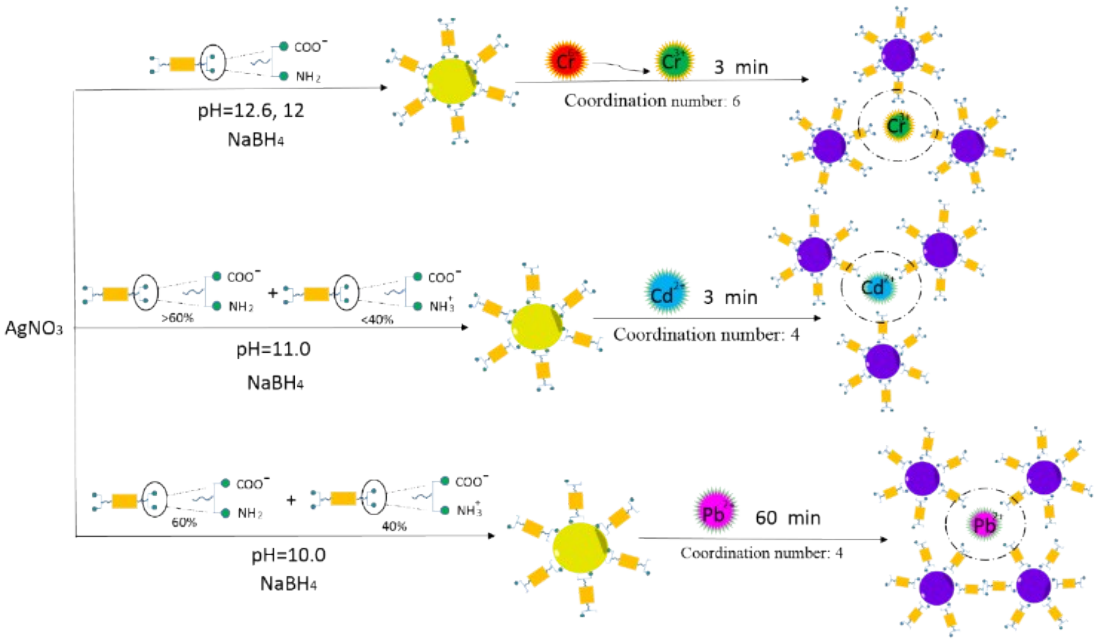

Figure S14. Possible mechanisms of the interactions between the metal ions and **LPL**-AgNPs. The ratio (>60%, and <40% at pH=11.0) was calculated based on the literature.