Supporting Information

A Benzoperylene Probe Self-assembled on Polyethyleneimine / Manganese Doped ZnS Quantum Dots: A New Nanocomposite for Bright and Tunable White Light Emission

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Table S1. Comparison of the phosphor materials used for the generation of white light emission

Materials	Methods for white light emission generation	Notes	ref
Commercial phosphors	Coating yellow (or combination of green and red) phosphor onto UV LED	Rare earth based, requires challenging and complex doping/mixing and delicate control of multiple materials and colors; high cost; unsuitable for solution process	S1, S2
Quantum dots	Combination of blue, green, and red emitting QDs; embedded in polymer encapsulant, silica or glass matrix; the use of full visible range covering QDs or hybrid materials	Low stability; complicated synthesis process; narrow emission; difficult size and color blending; self-quenching; re-absorption of light; undesired energy transfer	S2-S4
Organic compounds	Combination of different organic dye emitters; organic/polymeric materials; panchromatic emission	Concentration quenching; undesired intermolecular interactions; complex energy transfer processes	S1, S5, S6
QDs-organic molecules hybrids	Directly mixing; grafting organic molecules onto QDs; multilayer hybrids; layer-by-layer self-assembly; surface-bound	Fluorescent properties are limited in certain phases; undesired energy or charge transfer between the organic and inorganic components; poor processability	S7-S11
Metal-organic frameworks	Combinations of different metal centers and organic linkers	Complicated structures; strict control of ingredient ratio and crystal lattice; unsuitable for solution process; excitation light dependent emission	S12-S14
Organometallic complexes	Combination of different chromophores of different colors; emission property tuning via control of structure or aggregation state	Tedious synthesis and purification process; complex energy transfer process; excitation light dependent emission	S15-S17
This work	Self-assembly of benzoperylene probe onto PEI/Mn-ZnS QDs	Low cost; simple and mild fabrication process; available in solid, liquid and gel formats; large stokes shift; no self-absorption, energy transfer or concentration quenching	

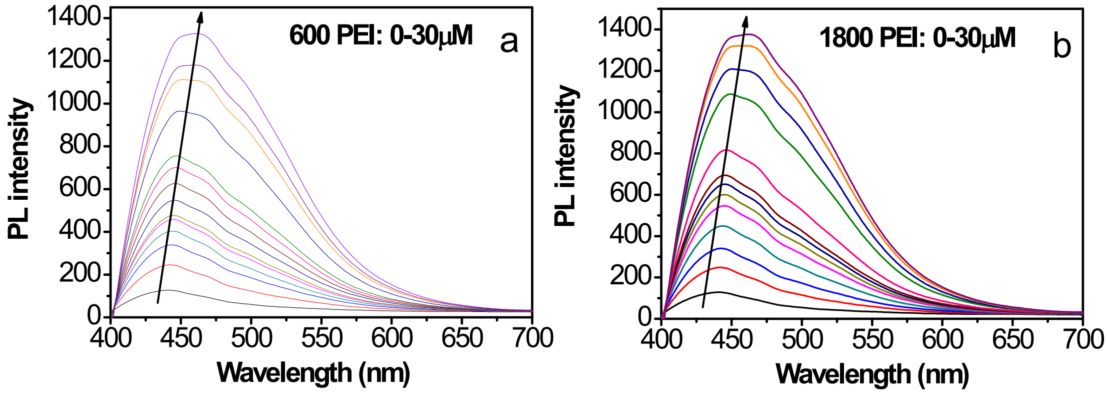

Figure S1. Changes in emission spectrum of probe 1 with probe concentration in the presence of 0.2 mg/ml PEI (a) MW=600, (b) MW=1800 g/mol.

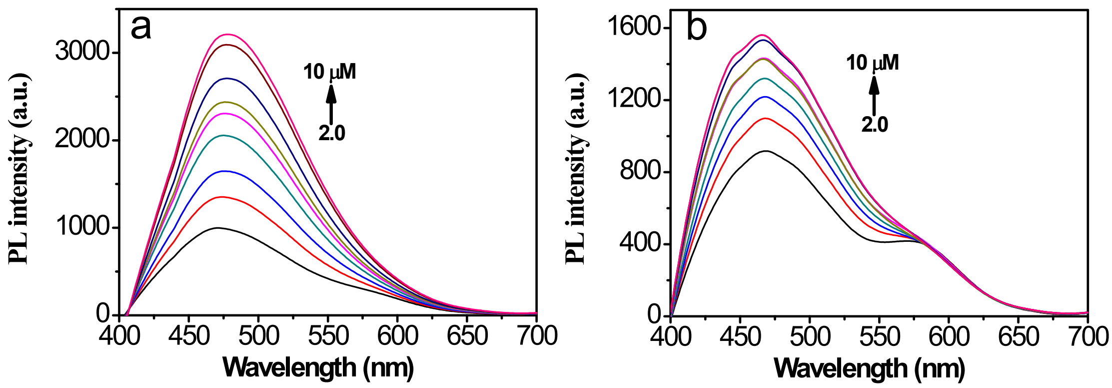

Figure S2. Changes in PL emission of the WLENs with high probe 1 concentrations (2-10 μM). Conditions: (a) with 10000PEI-QDs; (b) with 1800PEI-QDs. Sample solution contained 5 mM Tris-HCl buffer (pH 7.4) and 50 μg/ml PEI/Mn-ZnS QDs.

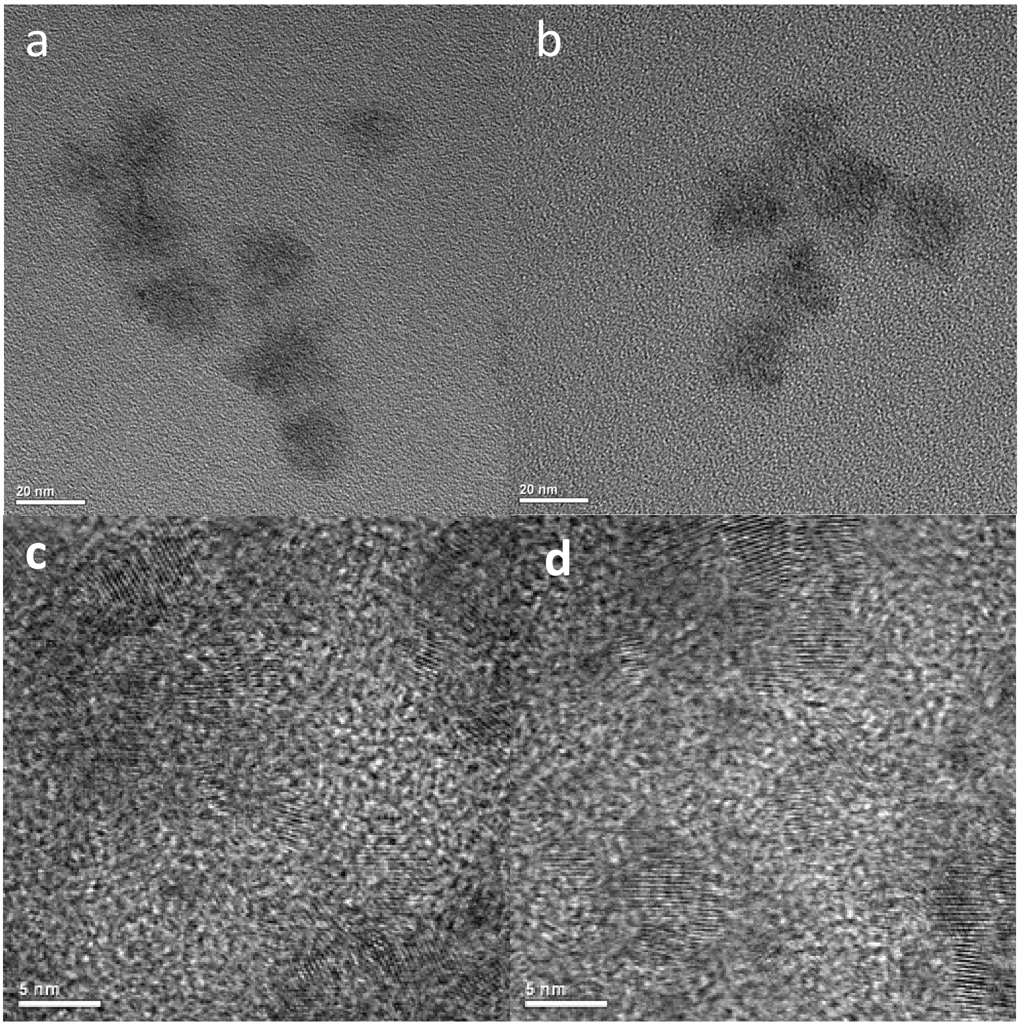

Figure S3. HR-TEM images of the (a) PEI/Mn-ZnS QDs and (b) WLENs, amplified HR-TEM images of the (c) PEI/Mn-ZnS QDs and (d) WLENs.

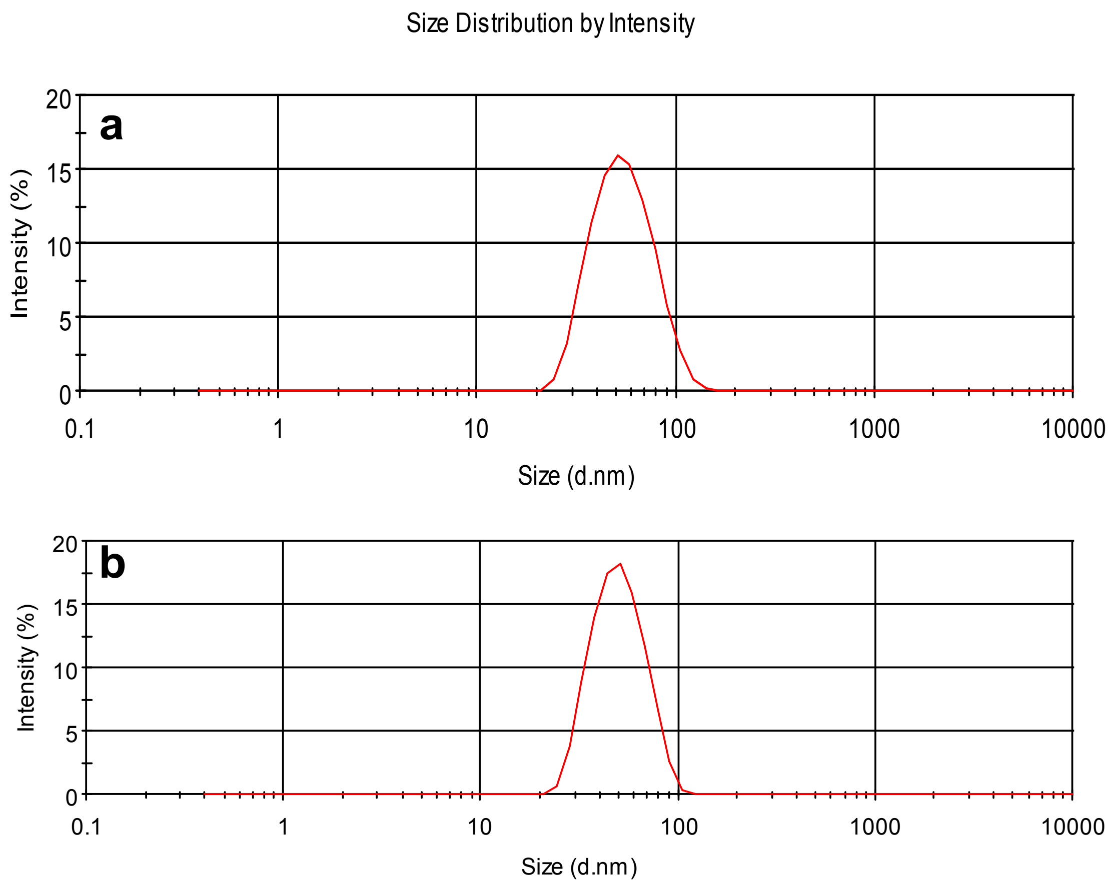

Figure S4. Average hydrodynamic diameter of the PEI/Mn-ZnS QDs (a, 50.7 ± 0.5 nm) and the WLEN (b, 46.7 ± 0.4 nm). Please note that the average hydrodynamic diameter determined by DLS (about 50 nm) is considerably larger than the particle size (about 20 nm) determined with TEM. The larger diameter in water is a result of the strong interactions between PEI and the water molecules (hydration interactions).

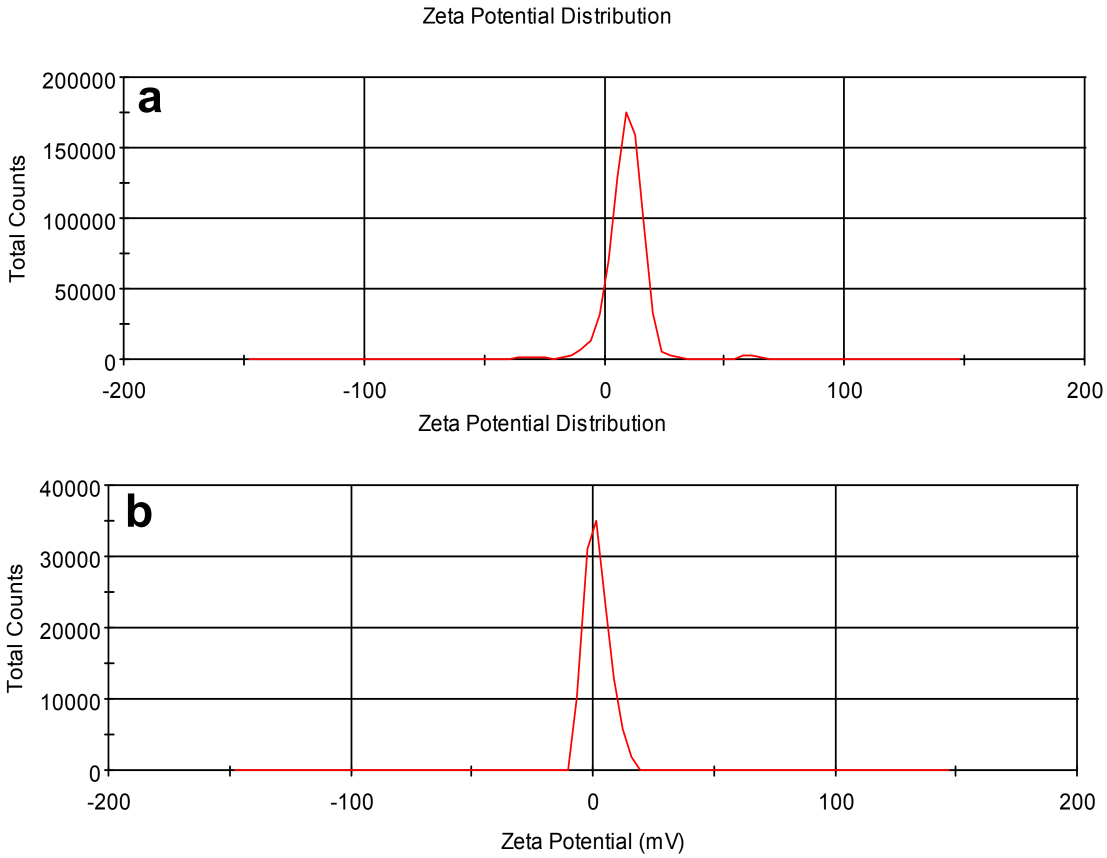

Figure S5. Zeta potential values of the PEI/Mn-ZnS QDs (a) and the WLEN (b).

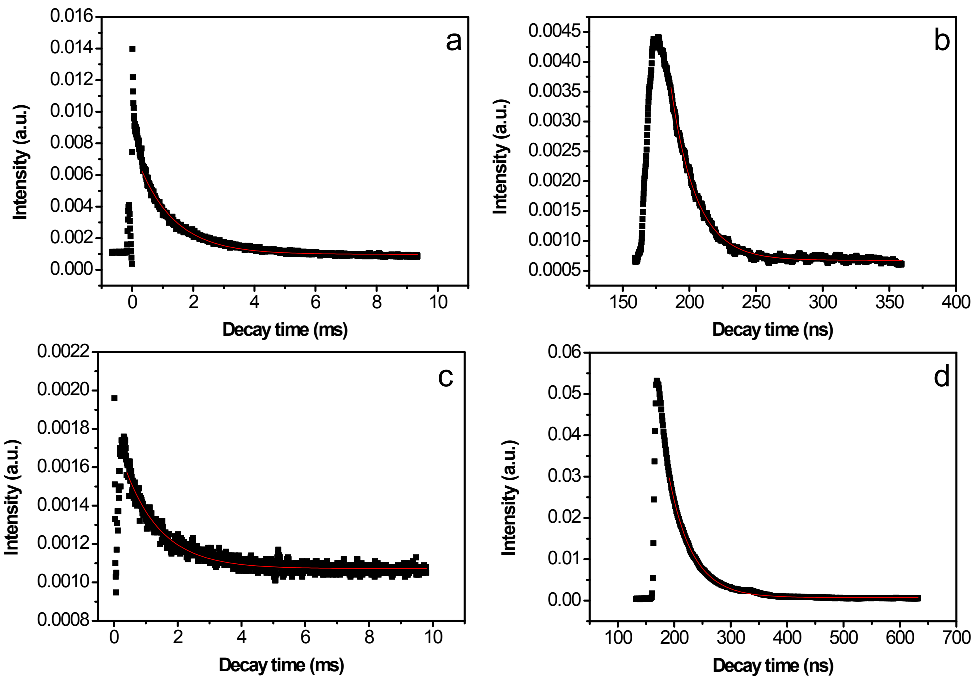

Figure S6. PL emission decay curves: (a) PEI/Mn-ZnS QDs (monitored at 580 nm), (b) probe 1 (monitored at 440 nm), (c) WLENs (monitored at 590 nm), (d) WLENs (monitored at 460 nm).

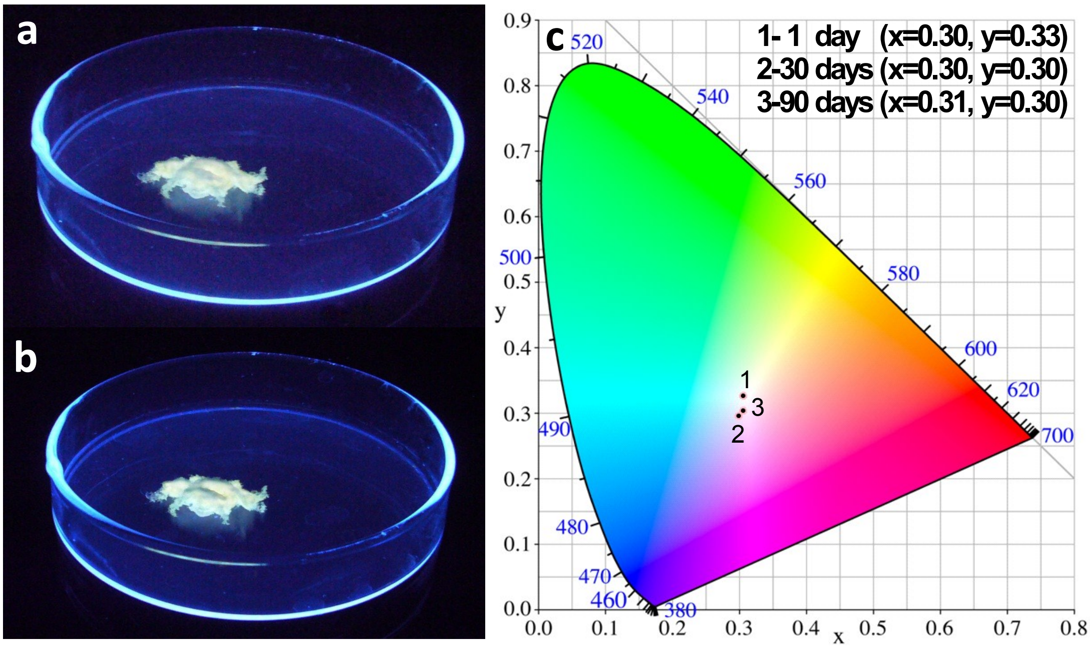

Figure S7. Photographs of the freeze-dried WLEN (a) under UV light, (b) after one hour UV light irradiation, (c) CIE coordinates of the WLEN solution after storage at an ambient temperature for a certain period of time (1, 30, and 90 days, respectively).

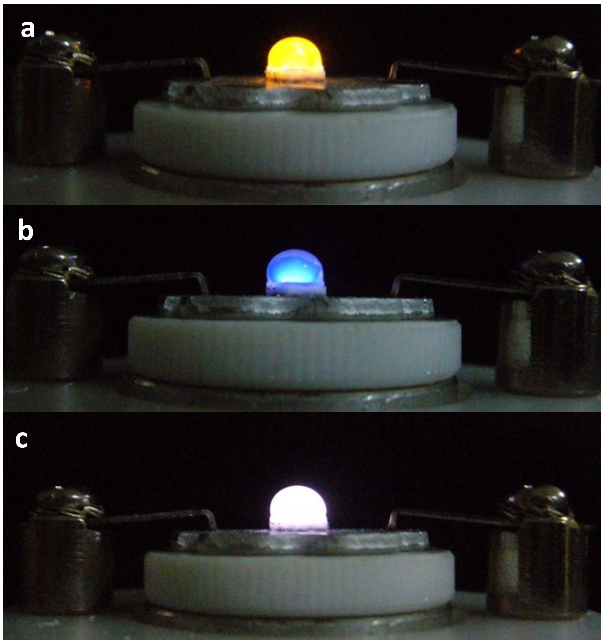

Figure S8. Photographs of LED coated with (a) PEI/Mn-ZnS QDs (b) probe 1 (c) WLEN solutions.

Figure S9. WLEN gel under UV light irradiation.

References

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