Spin-exciton delocalization enhancement in multilayer chiral linker/quantum dot structures- Supporting Information

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The document include: Quantum dots (QDs) preparation, three exponent emission decay fit model, intensity average life time and energy red shift calculation.

Quantum dots preparation

The CdSe QDs with different sizes were prepared according to the procedure given below. The size of the QDs depended on the synthesis conditions which were summarized in the Table S1.

In general, a mixture of cadmium oxide (CdO) and oleic acid (OA) in a molar ratio of 1:4 and 7.5 mL of 1-octadecene (ODE) was put in a 25 mL three-neck flask. The reaction mixture was degassed for 1 h at 100 °C under vacuum. Under nitrogen, the temperature was then raised to 300 °C until the solution turned clear, indicating the formation of cadmium oleate. Then the solution was cooled, and amine was added in a molar ratio of 1:8 (Cd/amine). Dependence of the reaction either hexadecylamine (HDA) or octadecylamine (ODA) was used. Afterward, the solution was heated to the desired temperature and trioctylphosphine selenide (TOPSe) solution was injected under vigorous stirring. The growth was terminated after given reaction time by rapid injection of 10 ml of ODE and the reaction mixture was further cooled down by water bath. As prepared core CdSe CQDs were precipitated twice with a 2-propanol/ethanol mixture (1:1−1:2), separated by centrifugation, and dissolved in hexane.

CdSe QDs with diameter	CdO (mmol)	TOP:Se (mol/L)	Amine	Injection temperature (°C)	Reaction time
2.5 nm	1.6	2	HDA	245	20 sec
3.4 nm	0.8	1	HDA	280	2 min
4.5 nm	0.8	0.125	ODA	280	30 min

Table S1. Synthesis condition for preparation of CdSe QDs with various core diameters

Three exponent emission decay fit model

The fit to the emission decay counts measured by TCSPC was done exploiting the following equation:

$$\boldsymbol{I(t) = a_1 * e^{-\frac{t}{\tau_1}} + a_2 * e^{-\frac{t}{\tau_2}} + a_3 * e^{-\frac{t}{\tau_3}}}$$

QDs usually show multi-exponent decay where each component describes a process related to the exciton recombination.

The long decay is usually ascribes to surface traps mainly caused by dangling bonds as a results of incomplete ligand coverage[1]. The second one (shorter) time is related to energy transfer process and last for radiative recombination[2].

An example of such fit is showing in figure S1.

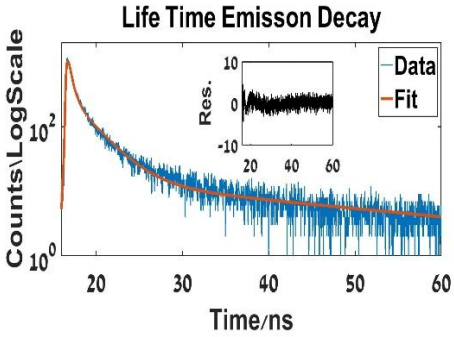

Figure 1s. Example of three exponent model fit. Time constants is 0.35 ns, 2.7ns and 33.27 ns.

Intensity Average lifetime

The lifetime presented is a statistical averaged value, and the QDs emit randomly throughout the decay. For a large number of QDs some will emit quickly following the excitation, and some will emit at times longer than the lifetime. This time distribution of emitted photons is the intensity decay. This value is obtained by averaging *t* over the intensity decay of the QD:

$$\langle \tau \rangle = \frac{\int tI(t)dt}{\int I(t)dt}$$

The average lifetime will be then express by the flowing equation[2]:

$$\langle \tau \rangle = \frac{\sum_{i-1}^{n} a_i * \tau_i^2}{\sum_{i=1}^{n} a_i * \tau_i}$$

Energy red shift calculation

The absorption spectra red shift, in different polarizations of the light excitation, was extracted from the measured results. The energy shifts between right circular polarization (RCP) and left circular polarization (LCP) was calculated by the following equation:

$$\Delta E = hc(\frac{1}{\lambda_{RCP}} - \frac{1}{\lambda_{LCP}})$$

References

(1) Fitzmorris, B. C.; Cooper, J. K.; Edberg, J.; Gul, S.; Guo, J.; Zhang, J. Z. Synthesis and Structural, Optical, and Dynamic Properties of Core/Shell/Shell CdSe/ZnSe/ZnS Quantum Dots. *J. Phys. Chem. C* **2012**, *116* (47), 25065–25073. https://doi.org/10.1021/jp3092013.

(2) Albrecht, C. Joseph R. Lakowicz: Principles of Fluorescence Spectroscopy, 3rd Edition. *Anal. Bioanal. Chem.* **2008**, *390* (5), 1223–1224. https://doi.org/10.1007/s00216-007-1822-x.