Supporting information

High Temperature Luminescence Quenching of Colloidal Quantum Dots

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Table S1. Characteristics of the colloidal nanocrystals used in the experiments. The core sizes have been determined from the position of the first absorption peak and known sizing curves [1]. Total particle sizes are based on analysis of TEM images of multiple NCs. The PL wavelength and quantum yield are measured by using the set-up described in the main text.

Sample name	Core diameter (nm)	Particle size[a] (nm)	PL wavelength (nm)	Quantum Yield (%)
CdSe QDs	3.4	3.4	573	28
CdSe/CdS/ZnS QDs	3.4	7.0	610	64
CdSe/CdS nanorods	3.2	5.5/21.1	604	72
CdTe/CdSe QDs	3.0	6.1	614	59

a. For spherical QDs, the particle sizes are given as average diameter. For nanorods, the average diameter and length are given.

Supporting Figures

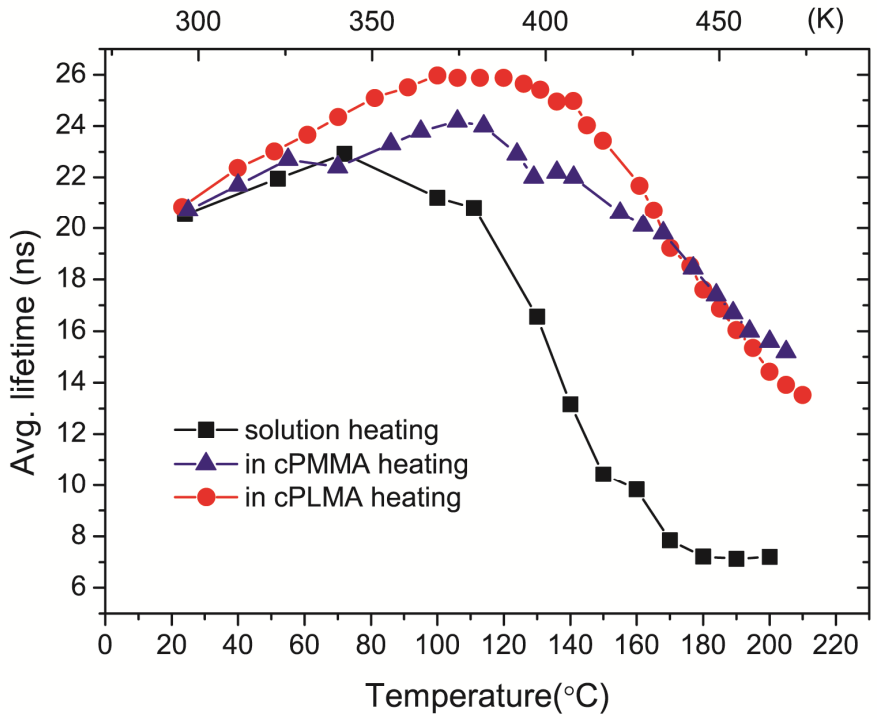

Figure S1. Temperature dependent average exciton lifetime for CdSe/CdS/ZnS core-shell-shell QDs in 1-Octadecene (ODE) solution (black squares), crosslinked PMMA (blue triangles) and crosslinked PLMA (red circles).

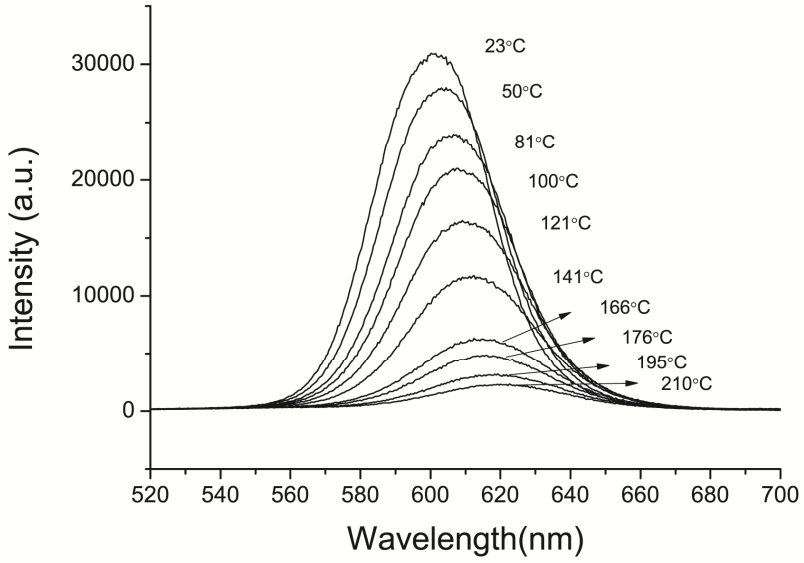

Figure S2. Temperature dependent PL spectra of CdSe/CdS/ZnS core-shell-shell QDs in PLMA at the temperatures indicated.

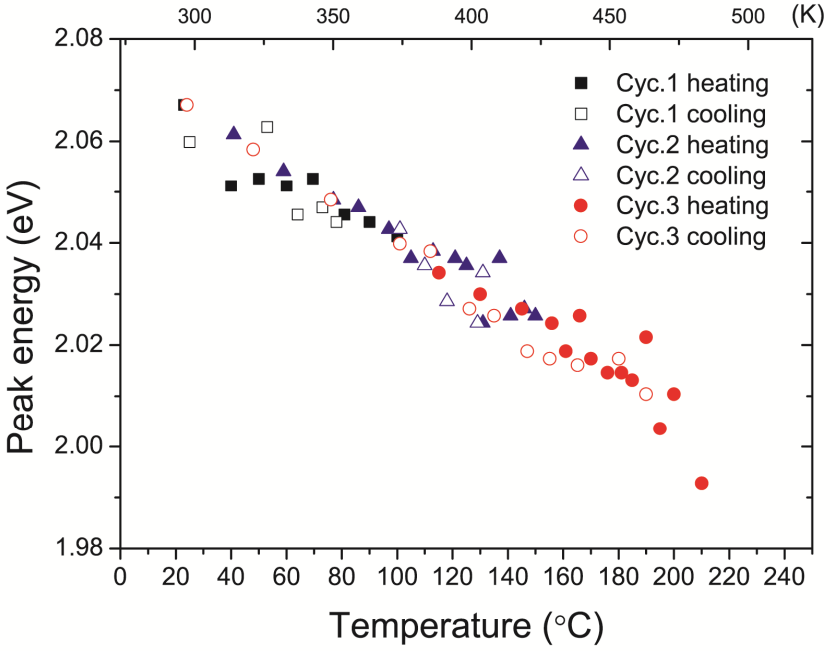

Figure S3. PL peak energy of CdSe/CdS/ZnS core-shell-shell QDs in PLMA during heating cycles.

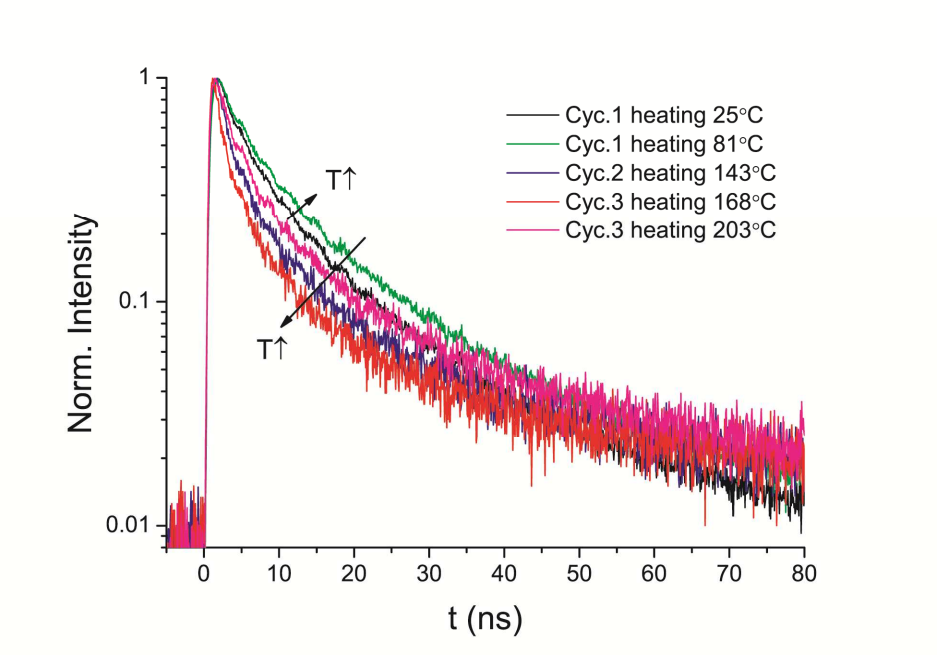

Figure S4. PL luminescence decay curves of CdSe/CdS dot core/rod shell nanorods at selected temperatures.

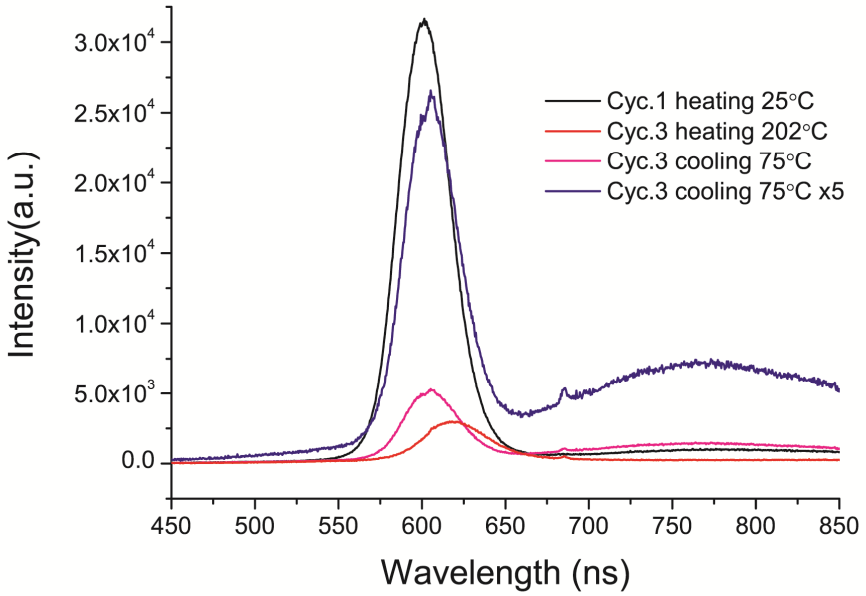

Figure S5. PL spectra of CdSe/CdS dot core/rod shell nanorods at the temperatures indicated. The black curve was measured prior to heating. The red curve was obtained at 202 ^{0}C in the third heating cycle. The magenta curve was measured at 75 ^{0}C upon cooling down from 202^{0}C, after the third heating cycle. The blue curve corresponds to the magenta curve multiplied by 5. The broad defect related emission at around 770 nm can be clearly observed.

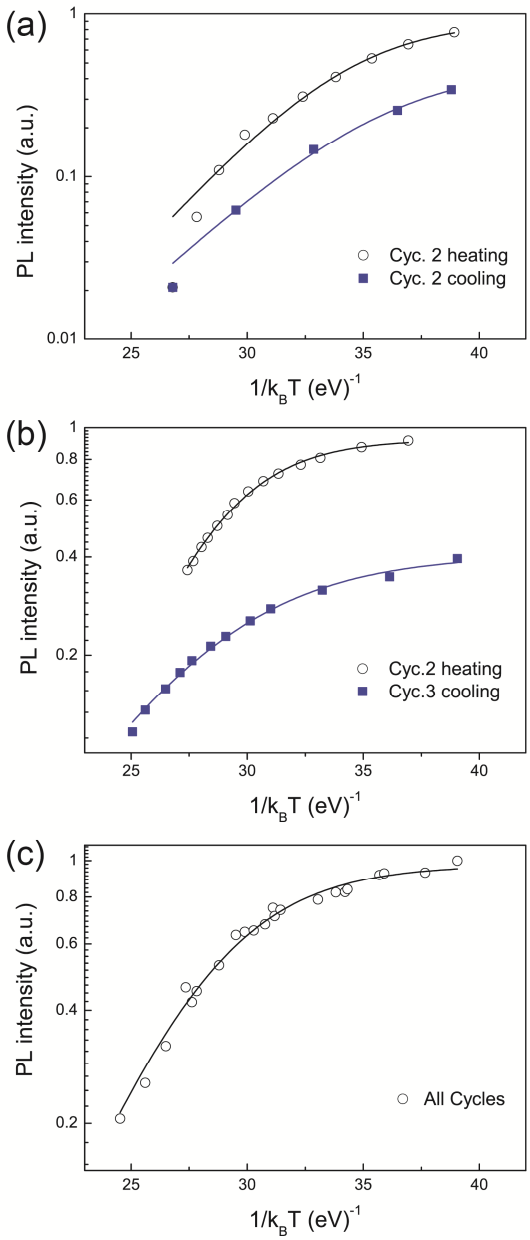

Figure S6. Integrated PL intensities of QDs with different structures are plotted as a function of $1/k_BT$. The solid lines are fitted curves for an Arrhenius dependence. (a) organically capped CdSe, (b)CdSe/CdS/ZnS QDs and (c) CdTe/CdSe QD.

Table S2. Activation energies extracted by fitting the temperature dependence of the integrated emission intensity to an Arrhenius dependence.

Sample name	E_a (eV)	Standard errors
CdSe QDs Cyc.2 heating	0.36	0.03
CdSe QDs Cyc.2 cooling	0.30	0.04
CdSe/CdS/ZnS QDs Cyc.2 heating	0.44	0.01
CdSe/CdS/ZnS QDs Cyc.3 cooling	0.26	0.02
CdTe/CdSe QDs	0.34	0.02

The thermal quenching of intensity is fitted to an Arrhenius behavior with a single activation energy, E_a which can be extracted by fitting the experimental data to the expression:

$$I \propto 1 / [1 + B\exp(-E_a / k_B T)] \quad (1)$$

where B is a constant, and k_B is the Boltzmann constant [Ref. 9, 10,12].

The fitted curves for organically capped CdSe, CdSe/CdS/ZnS QDs and CdTe/CdSe QDs are given in Figure S6. The activation energy E_a extracted from different heating cycles are presented in Table S2. For the same dots, E_a changes after heating cycles due to the irreversible quenching. For CdSe/CdS nanorods determination of E_a is hampered by the strong irreversible quenching.

References

1. Donega, C. D.; Koole, R. *J Phys Chem C* **2009,** 113, (16), 6511-6520.