Chiral $Cu_{2-x}S$ quantum dots and their near-infrared photothermal conversion properties

Jiayun Zheng[a], Guangmin Li[a*], Shuang Li[b], Hongfei Liu[a], Xinyu Jin[a], Anning Guo[a], Zhibo Chen[a], Xiongzhe Fan[a], Hongbin Zhao[a], Jiajia Kang[a], Guozhi Jia[a*], Jiafeng Li[c], Gaoling Yang[d*]

Experimental section

Synthesis of chiral $Cu_{2-x}S$ quantum dots (QDs)

All reagents used in this experiment are analytical reagents. Add 0.2 mmol of $CuCl_2 \cdot 2H_2O$ and 0.2 mmol of sodium citrate into two-neck flasks, dissolve them in 19 mL of water and stir for 10 minutes. Then, the oxygen in the solution is pumped out, nitrogen is introduced, and after reacting for 30 minutes under the protection of nitrogen, 200ul of thiourea of 0.2 mol/l and 1ml of L-cysteine or D- cysteine of 0.1 mol/l are added. After stirring for 5 minutes, the flask was placed in a water bath at 60℃ and stirred for 2 hours, thus obtaining L/D-Cys-$Cu_{2-x}S$ QDs，and then drying for later use.

Characterization

The XRD pattern of the sample was obtained by using Cu-K radiation on the X-ray diffractometer D8 Discover. XPS measurement was carried out by using ESCALAB 250Xi surface analysis spectrometer. TEM images of nanoparticles were taken by Talos F200s transmission electron microscope. Fluorescence spectrum was analyzed by F-7000 fluorescence spectrophotometer (HITACHI, Japan). The UV−vis absorption was measured on a Lambda 750 UV-VIS-NIR spectrometer (PerkinElmer), the reference standard used was BaSO4 (Spectrum pure). The FT-IR spectrum was recorded on Nicolet iS5 spectrometer (Thermo Electron Corporation). The Raman spectra were measured on a Finder 930 Raman spectrometer. In order to measure the photothermal temperature of quantum dots, an 808 nm laser is used to provide energy to quantum dots. The light source used is an externally adjustable power (0-2w) 808nm continue wave semiconductor laser with a 1 mm diameter laser module (Changchun, Changchun New Industries, CNI. China). Temperature detection is a hand-held temperature detector (Jiangsu, Nanjing Longshun instrument and Meter. China), and record the temperature.

Photothermal characterization: The photothermal performance of chiral Cu2-xS QDs was characterized under an 808 nm NIR laser (LSR808H, Q-BAIHE, Wuhan, China). The solution was irradiated for 600 s with a power densities of 0.1 W, 0.15 W, 0.2 W, 0.3 W, 0.4 W, and then cooled down to room temperature naturally. The temperature was measured every 20 s by an infrared imaging device

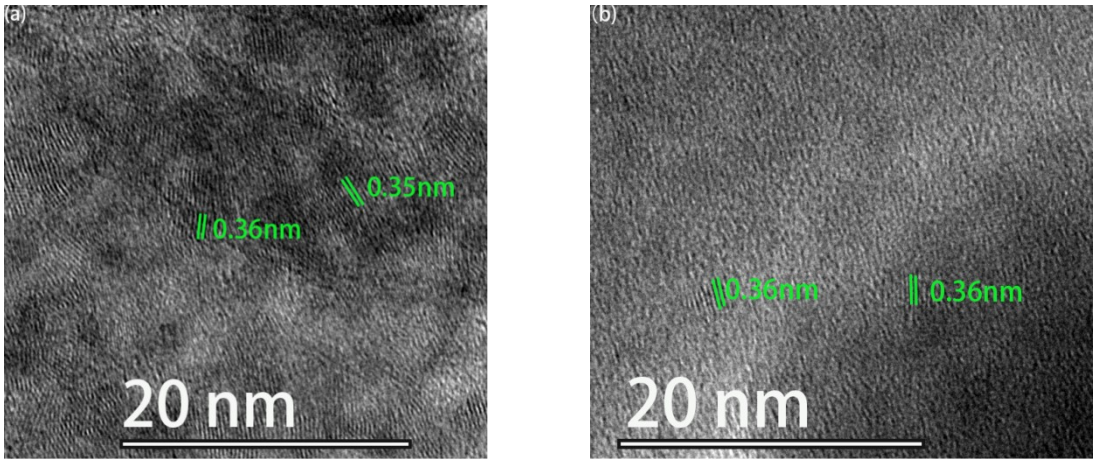

Figure S1. (a) TEM image of L-Cys-$Cu_{2-x}S$ QDs. (b) TEM image of D-Cys-$Cu_{2-x}S$ QDs.

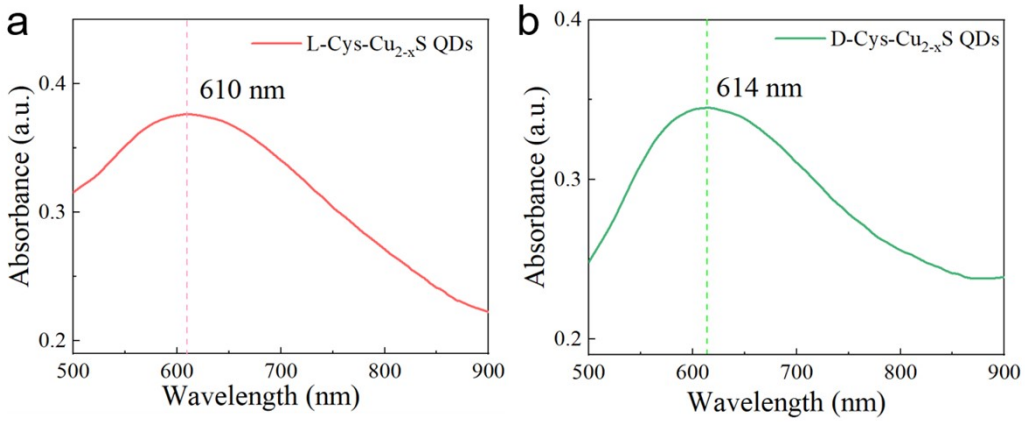

Figure S2. UV−vis absorption spectrum of (a) L-Cys-$Cu_{2-x}S$ QDs and (b) D-Cys-$Cu_{2-x}S$ QDs.

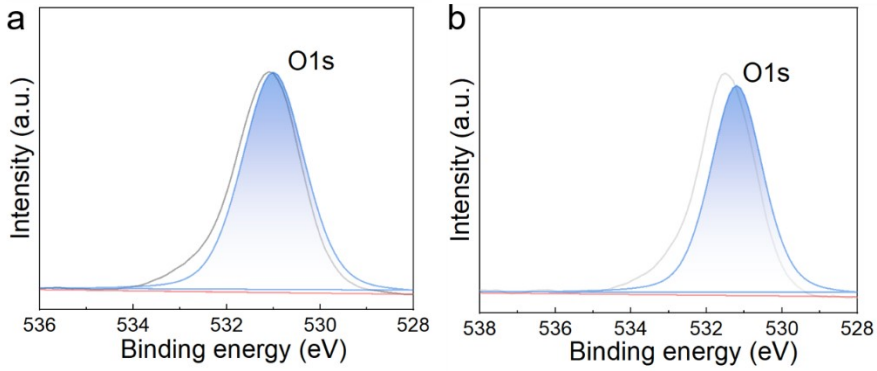

Figure S3. X-ray photoelectron spectra of O element of (a) L-Cys-$Cu_{2-x}S$ QDs and (b) D-Cys-$Cu_{2-x}S$ QDs.

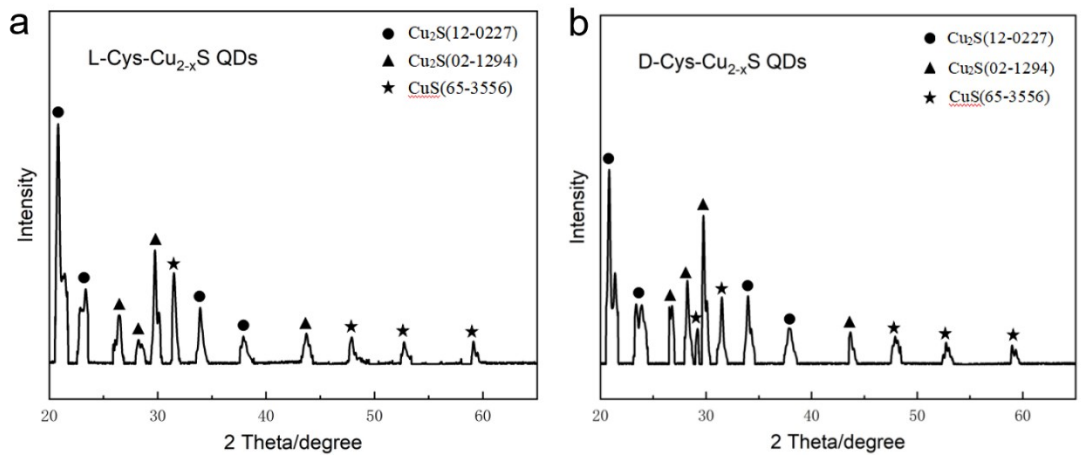

Figure S4. X-Ray Diffraction pattern of (a) L-Cys-$Cu_{2-x}S$ QDs and (b) D-Cys-$Cu_{2-x}S$ QDs.

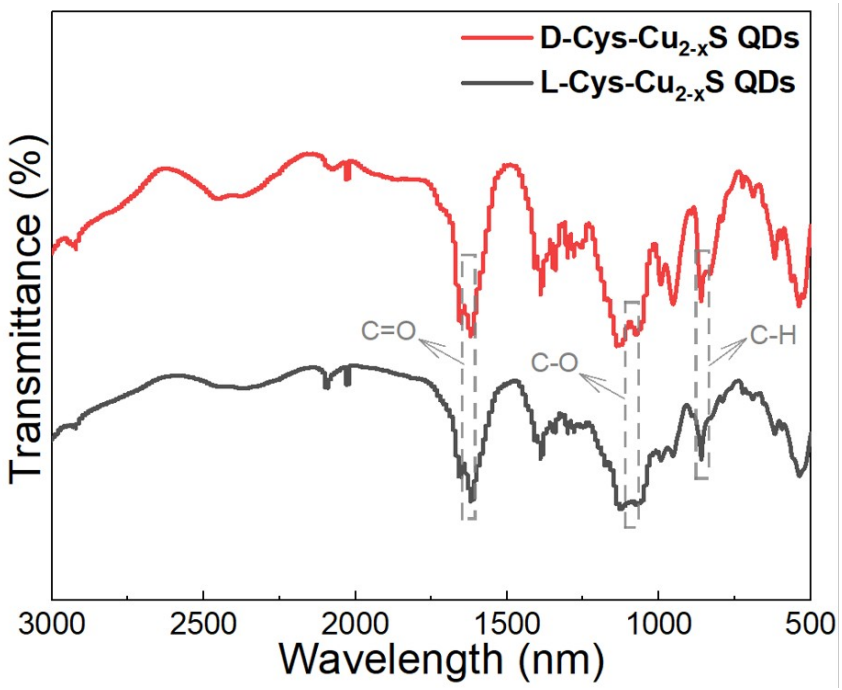

Figure S5. FT-IR spectra of L-Cys-$Cu_{2-x}S$ QDs and D-Cys-$Cu_{2-x}S$ QDs.

Table 1. Temperature variation of the photothermal data for L-Cys-$Cu_{2-x}S$ QDs and D-Cys-$Cu_{2-x}S$ QDs

	L-Cys-$Cu_{2-x}S$ QDs				
	0.1W	0.15W	0.2W	0.3W	0.4W
Initial temperature	23	22.5	23	23	22.9
Maximum temperature	27.4	30.9	33.5	39.5	43.9
Temperature variation	4.4	8.4	10.5	16.5	21
Percentage change(%)	19.1	37.3	45.7	71.7	91.7
	D-Cys-$Cu_{2-x}S$ QDs				
	0.1W	0.15W	0.2W	0.3W	0.4W
Initial temperature	22.5	22.5	23	23	22.5
Maximum temperature	28.7	32.6	38.2	45.7	50.9
Temperature variation	6.2	10.1	15.2	22.7	28.4
Percentage change(%)	27.6	44.9	66.1	98.7	126.2