Supplementary information

Self-trapped Exciton Emission from Carbon Dots investigated by Polarization Anisotropy of Photoluminescence and Photoexcitaion

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C-dots synthesis

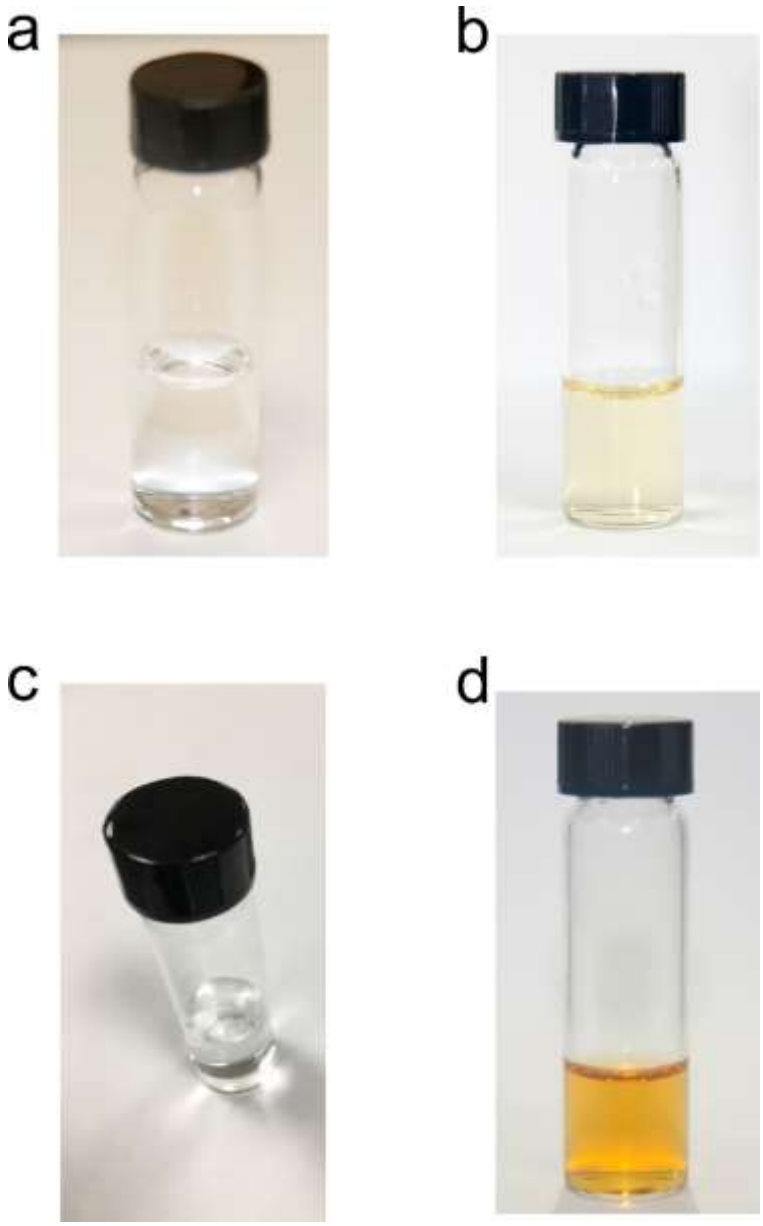

Figure 1 Synthesized C-dots samples. (a), (b) are the glucose and sample A aqueous solution. (c), (d) are the glucose, urea dissolved in 3ml DI water and the sample B aqueous solution

We employ the microwave assisted approach to synthesize C-dots as it can supply rapid, homogeneous heating but low cost. Typically, for C-dots sample A, 0.5g glucose (formula: $C_6H_{12}O_6$) (from sigma Aldrich) as the carbon source is dissolved into 3ml DI water forming the transparent solution (see Figure 1a). The solution become to faint yellow solid after 5 min continuously microwave heating, which imply the generation of the C-dots. 15ml DI water was utilized to dissolve the solid producing the C-dots suspension. We purify the C-dots sample by means of the 0.45μm filter, and 3 replicate purification process have been conducted to obtain to final faint yellow transparent solution,

the sample are presented as Figure 1b. For sample B, the precursors include glucose and urea (from sigma Aldrich), which the urea (formula: NH_2CONH_2) can introduce N element resulting the doping of C-dots sample. The synthesis procedure of sample B is similar to sample A. Briefly 0.5g glucose and 0.5g urea are dissolved into 3ml DI water(see Figure 1c), the transparent mixture solution become dark yellow, and turn to dark brown solid after undergoing 5 min heating. And the solid sample is dissolved into 150ml DI water, and also the suspension solution are purified by 0.45μm filter 3 times. The transparent sample B solution is shown in Figure (d). The carbon dots sample films are prepared by drop-cast the C-dots solution on transparent sapphire substrates.

Excitation anisotropy and linear polarization of C-dots films

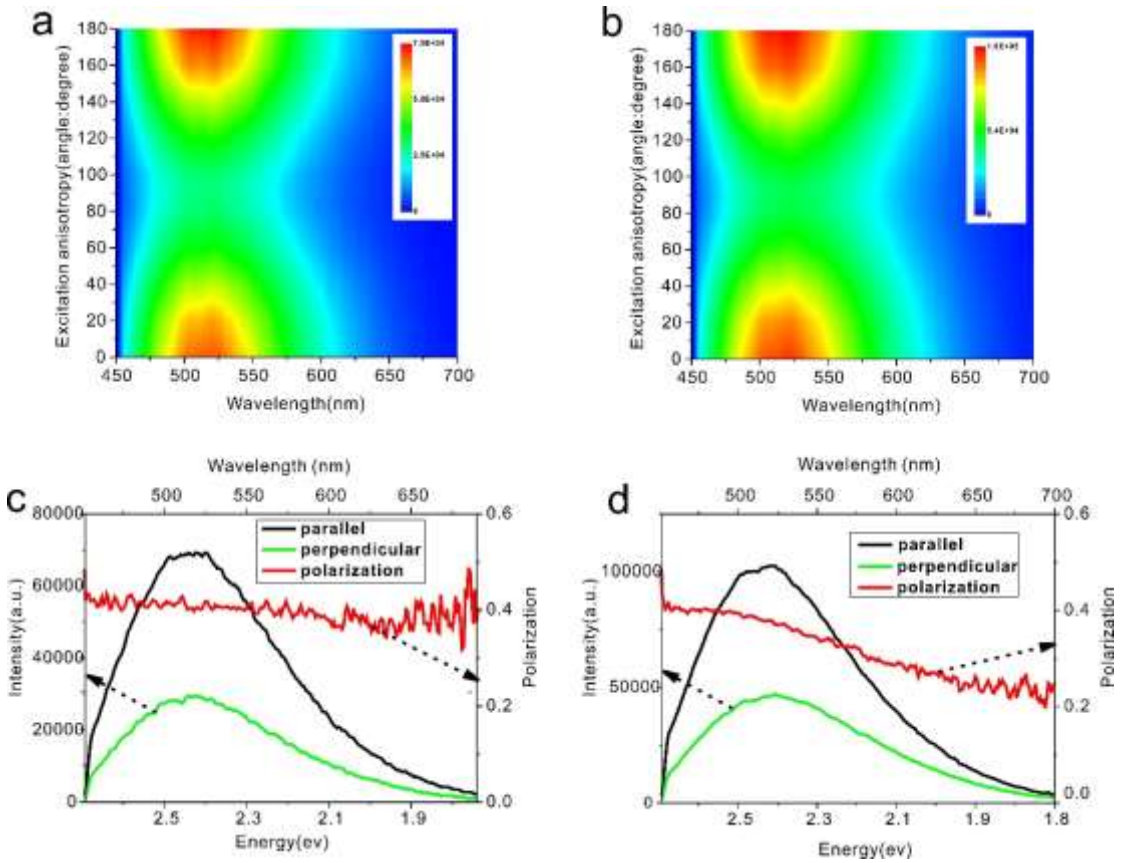

Figure 2 (a), (c) Excitation anisotropy and degree of linear polarization for sample A, (b), (d) are the results for sample B. Both the excitation anisotropy and polarization show similar behaviors of emission. Excitation wavelength: 442 nm

The results of the excitation anisotropy of C-dots sample A and B are depicted in Figure 2a, 2c for sample A and 2b, 2d for sample B, the measurement configuration is analogous to the emission measurement. The polarization of the emission light which we collect is fixed to the vertical direction by a linear polarizer. The excitation polarization are rotated by a half wave-plate. The degree of the excitation linear polarization is defined as $P_{ex} = \frac{I_{ex\parallel} - I_{ex\perp}}{I_{ex\parallel} + I_{ex\perp}}$, where the $I_{ex\parallel}$ is the emission intensity when the polarization of the excitation light is parallel to the collection emission polarization (0 degree), $I_{ex\perp}$ is the emission intensity where the polarization of the excitation light is perpendicular to the emission polarization(90 degrees). Both the excitation anisotropy and the polarization of C-dots are similar to the emission results, which reconfirm the anisotropy properties of C-dots.

Excitation anisotropy and polarization of C-dots solution

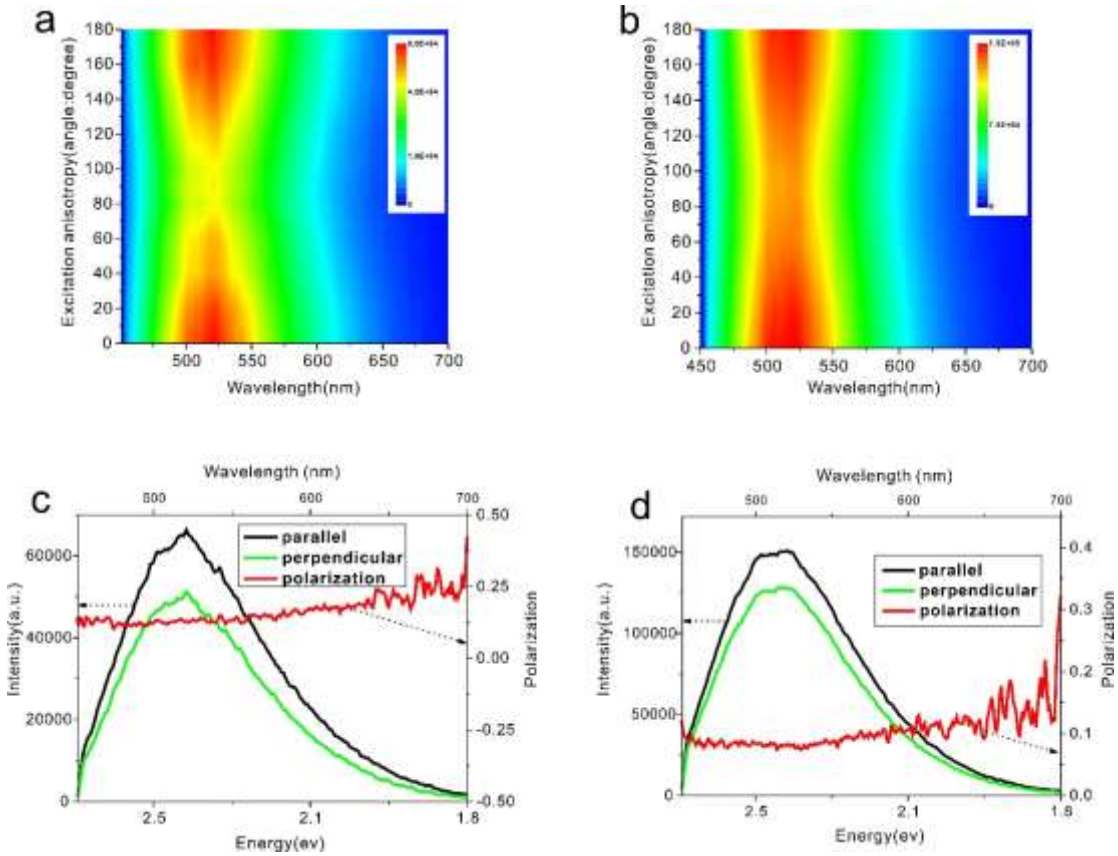

Figure 3 (a), (c) Excitation anisotropy and degree of linear polarization for sample A aqueous solution, (b),(d) are the results for sample B aqueous solution. Both the excitation anisotropy and polarization show similar behaviors of emission. Excitation wavelength: 442 nm

We also carry out the excitation anisotropy of C-dots solution, the results are depicted in Figure 3a, 3c for solution sample A and 3b, 3d for solution sample B, which is analogous to the emission results of the C-dots solution. It is clear that the anisotropy of the C-dots solution is different from the C-dots film as predicted by our model.

Electric-field modulation of C-dots film emission

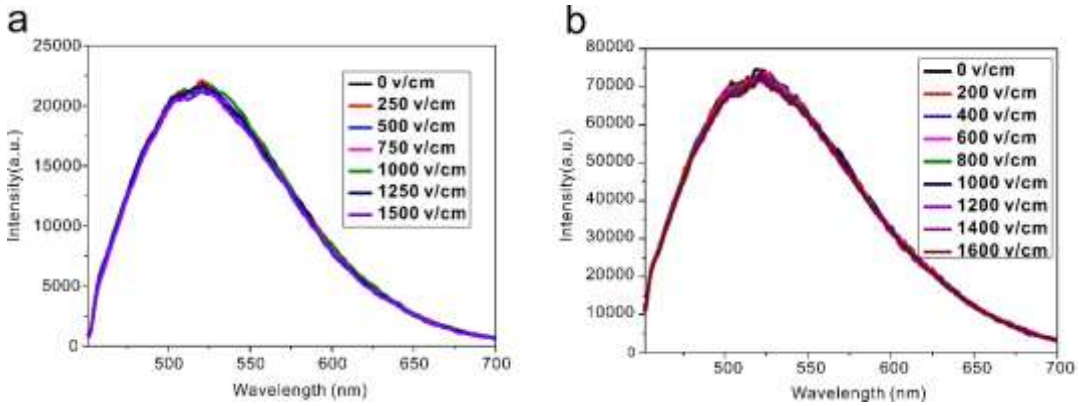

Figure 4 The emission spectra of the C-dots sample when applying electric filed. (a) for sample A, (b) for sample B. Excitation light: 442 nm

The applied electric field reach to 1500v/cm, the spectra are still no obvious change for both emission intensity and the line shape. The results are presented at Figure 4a for sample A and Figure 4b for sample B.

The time-resolved photoluminescence for C-dots films

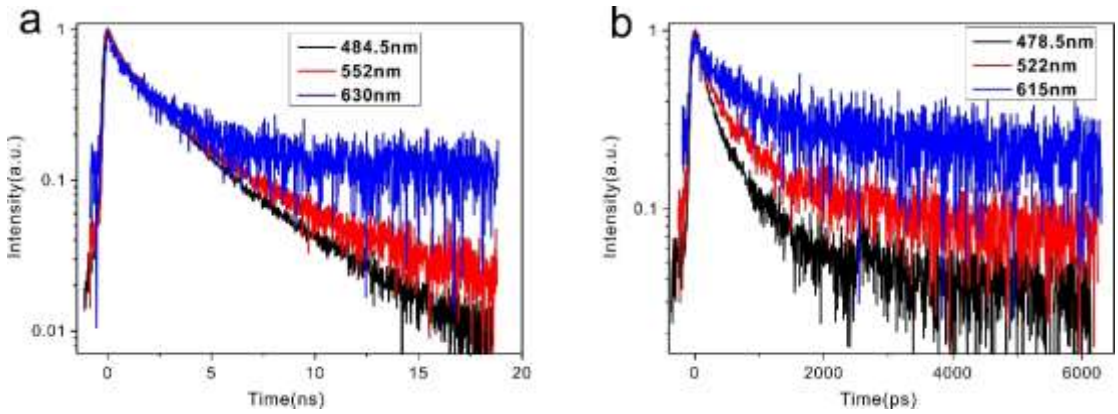

Figure 5 (a) Time-resolved spectroscopy measurements of film Sample A. (b) Time-resolved spectroscopy measurements of film sample B.

For both C-dots A and B films, the PL lifetime increase as the emission wavelength increase (film sample A from 484.5 nm to 630 nm, film sample B from 478 nm to 615 nm) which is consistent with our predictions.

The time-resolved photoluminescence for C-dots solution

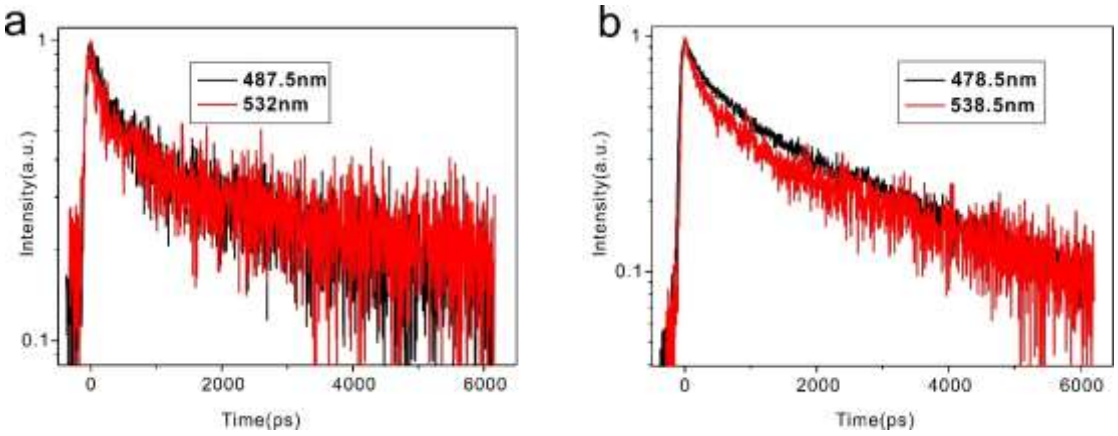

Figure 6 Time-resolved results for the C-dots aqueous solution. (a), (b)for sample A and B aqueous solution respectively.

Different from the C-dots films, the lifetime of C-dots solution manifest different behaviors. For C-dots solution sample A, the lifetime of different wavelength exhibit nearly the same value, and the for the C-dots solution sample B, the time-resolved measurement present totally opposite results to the film sample where the lifetime decrease with the emission wavelength increase, the results are depicted in Figure 6. We suggest that the different behaviors between the solid and aqueous solution C-dots are caused by the Brownian rotation in solution.