# A novel single excitation dual-emission carbon dots for colorimetric and ratiometric fluorescent dual mode detection of $Cu^{2+}$ and $Al^{3+}$ ions

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**Table S1.** The emission peak position and quantum yield of D-CDs prepared from different raw materials under different reaction medium.

| Raw materials | Reaction medium | $\lambda_{em}$ (nm) | Φ |
|---|---|---|---|
| Green Tea | water | 403 | 2.53% (blue band) |
| | formamide | 409 | 10.86% (blue band) |
| | ethanol | *ca.* 470, 671, 715 | 3.57% (red band) |
| | acetone | *ca.* 470, 671, 715 | 4.72% (red band) |
| Red Tea | water | 420 | 3.78% (blue band) |
| | formamide | 408 | 4.41% (blue band) |
| | ethanol | *ca.* 470, 671, 715 | 4.48% (red band) |
| | **acetone** | ***ca.* 470, 671, 715** | **5.47%** (red band) |
| Dark Tea | water | 418 | 2.96% (blue band) |
| | formamide | 415 | 9.57% (blue band) |
| | ethanol | *ca.*472, 671, 715 | 3.84% (red band) |
| | acetone | *ca.*478, 671, 715 | 4.20% (red band) |

**Table S2.** The optimization of synthetic conditions.

| Raw materials | Temperature ($^{o}$C) | Reaction time | Φ (red band) |
|---|---|---|---|
| Red Tea | 140 | 2 h | 4.88% |
| | 160 | 2 h | 4.90% |
| | 180 | 2 h | 5.47% |
| | 200 | 2 h | 4.79% |
| | **180** | **1 h** | **6.06%** |
| | 180 | 2 h | 5.47% |
| | 180 | 3 h | 4.80% |
| | 180 | 4 h | 5.20% |
| | 180 | 5 h | 4.33% |
| | 180 | 6 h | 4.11% |
| | 180 | 7 h | 4.45% |
| | 180 | 8 h | 4.85% |

**Table S3.** Quantum yield of red emission band of D-CDs in different solvents.

| | DMSO | Ethanol | Acetone | Water | DMF | Acetonitrile | THF | $CH_2Cl_2$ |
|---|---|---|---|---|---|---|---|---|
| η | 1.48 | 1.36 | 1.36 | 1.33 | 1.333 | 1.343 | 1.405 | 1.424 |
| Φ | 7.72% | 5.53% | 6.06% | 0.35% | 8.93% | 5.83% | 6.26% | 5.86% |

**Table S4.** Rate constant of D-CDs in ethanol solution in the absence and presence of $Al^{3+}$ ions ($\lambda_{ex}$ = 410 nm, $\lambda_{em}$ = 478 nm)

| | D-CDs | D-CDs+$Al^{3+}$ |
|---|---|---|
| Φ/% (blue band) | 0.80 | 8.01 |
| τ / ns | 3.83 | 4.80 |
| $k_r$ / $10^6$ $s^{-1}$ | 2.09 | 16.69 |
| $k_{nr}$ / $10^8$ $s^{-1}$ | 2.59 | 1.92 |

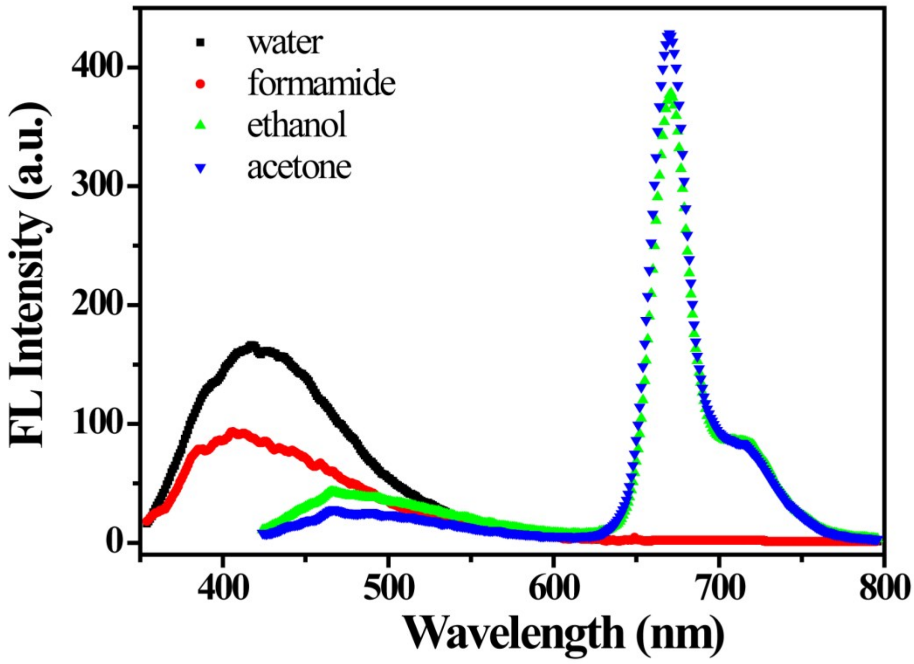


**Fig. S1** FL emission spectra of carbon dots obtained in different solvents.

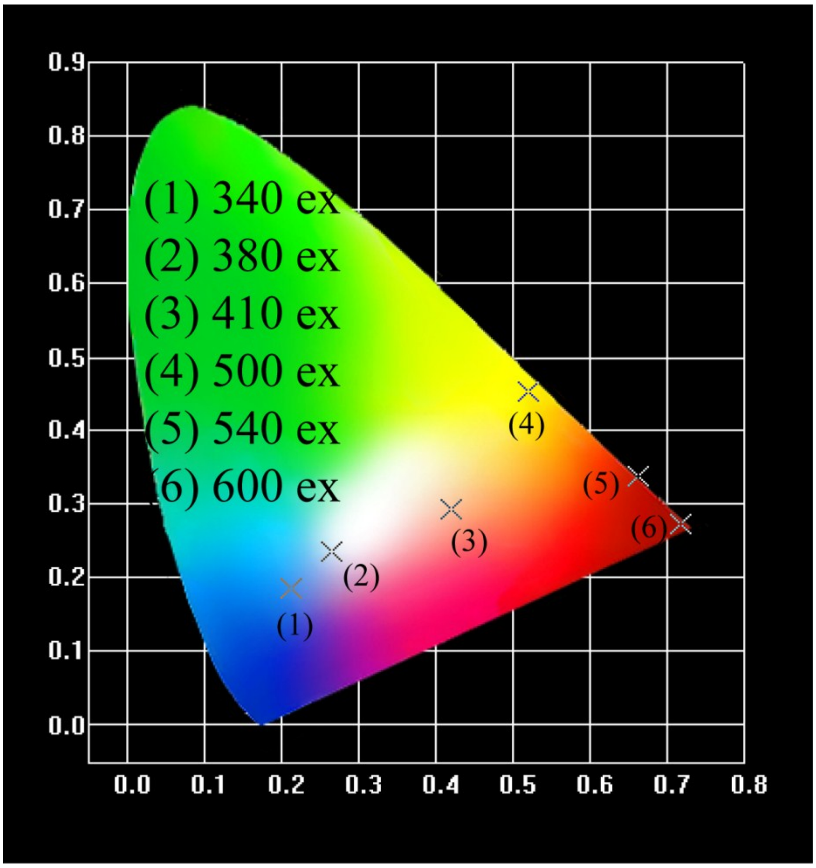


**Fig. S2** CIE chromaticity diagram of D-CDs at different excitation wavelengths.

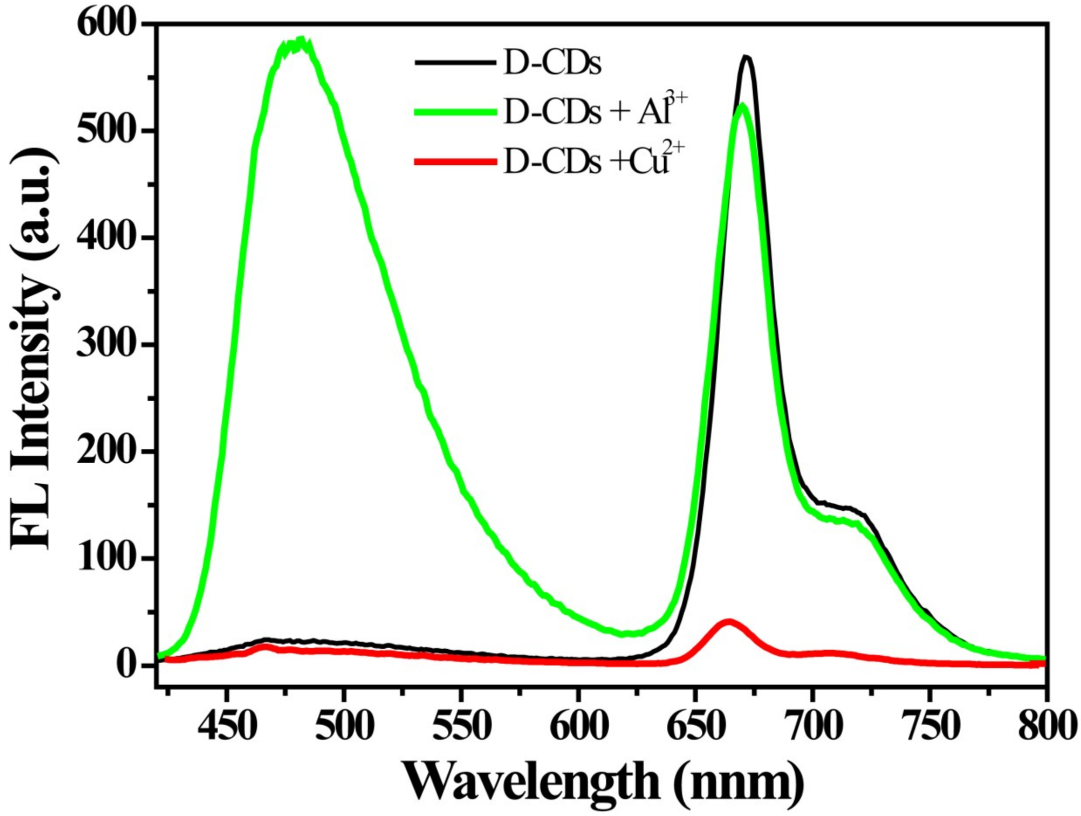


**Fig. S3** The FL spectra of D-CDs ($\lambda_{ex}$ = 410 nm) in ethanol in the absence and presence of $Al^{3+}$ and $Cu^{2+}$ ions.

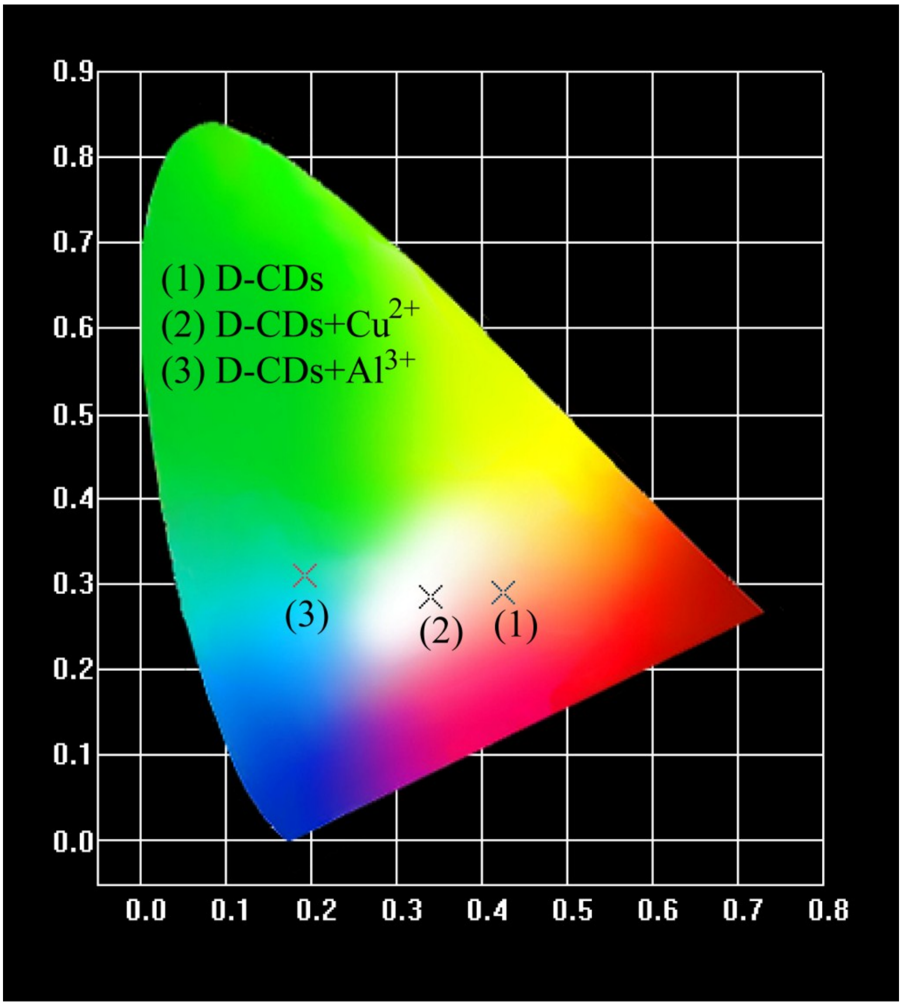


**Fig. S4** CIE chromaticity diagram of D-CDs in the absence and presence of $Cu^{2+}$ and $Al^{3+}$ ions.

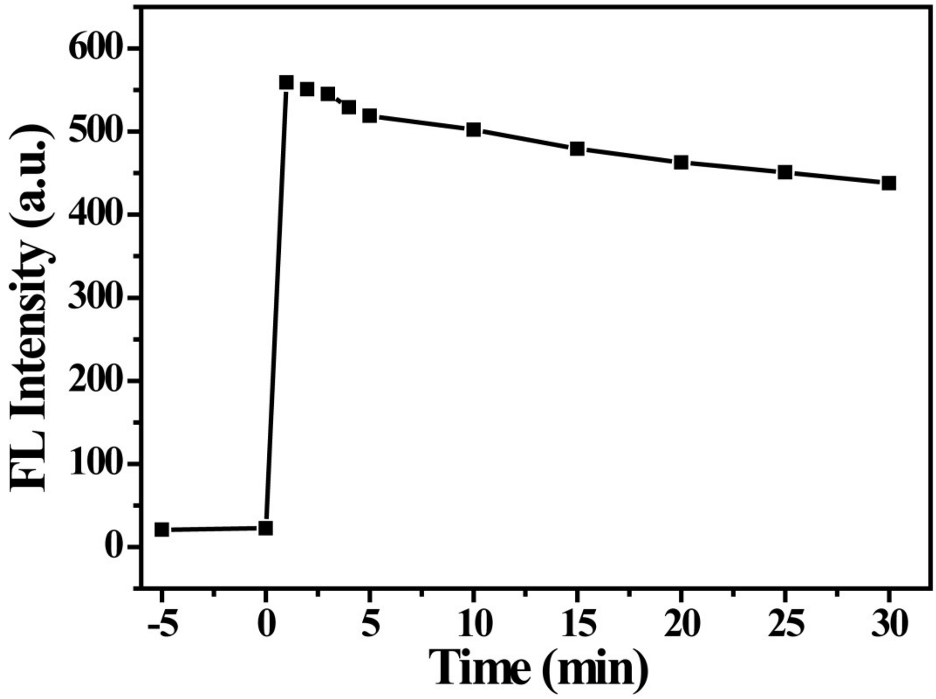


**Fig. S5** Effect of reaction time on fluorescence intensity of the blue-band of D-CDs in the presence of $Al^{3+}$.

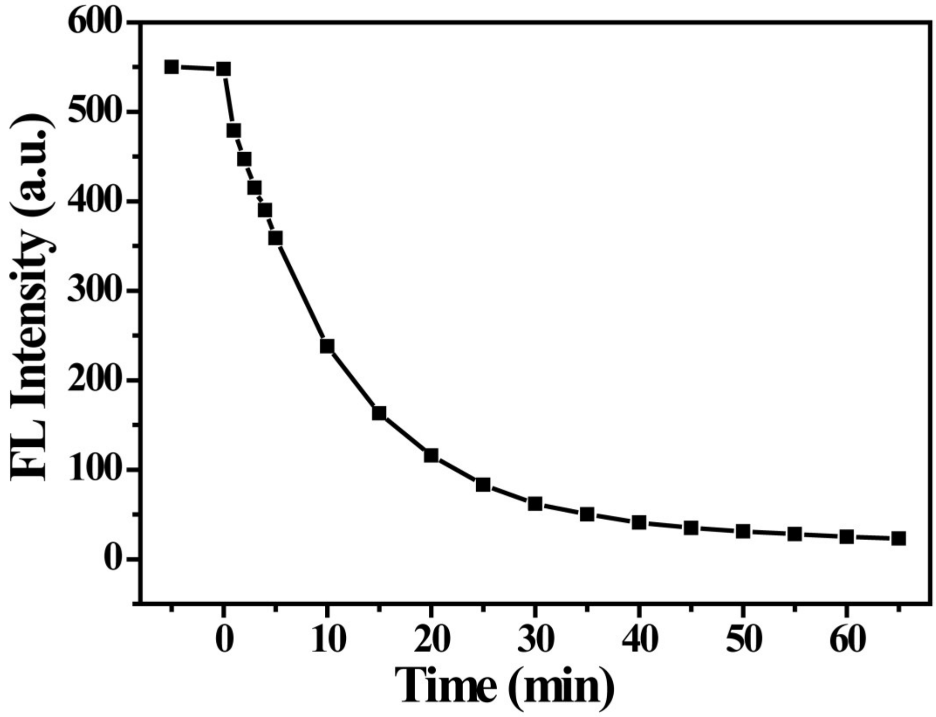


**Fig. S6** Effect of reaction time on fluorescence intensity of the red-band of D-CDs in the presence of $Cu^{2+}$.

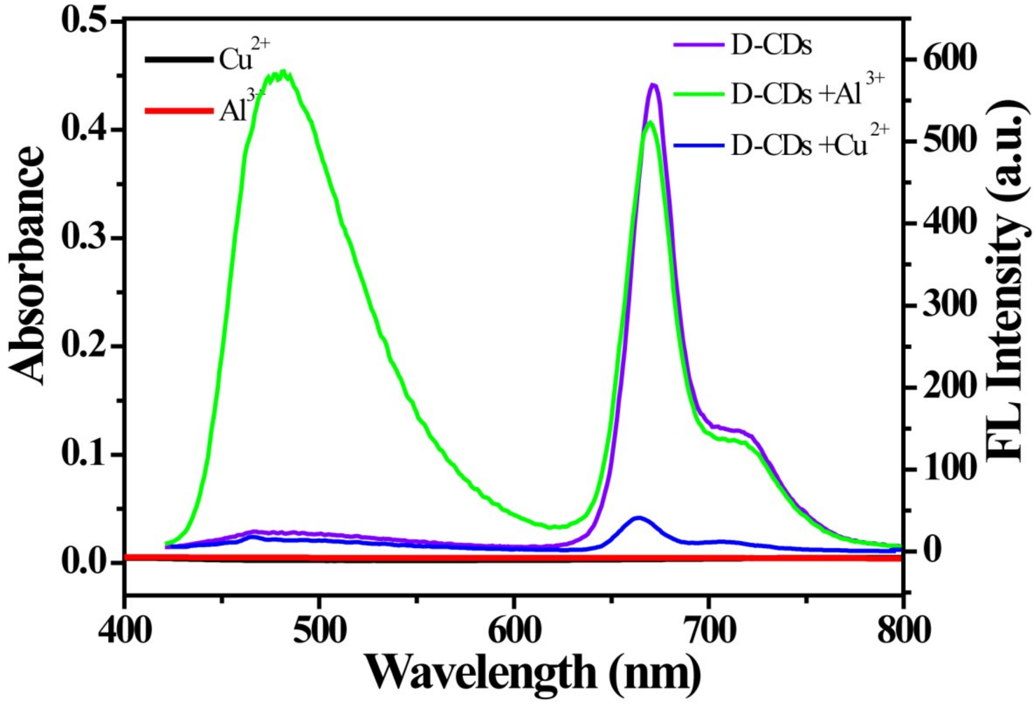


**Fig. S7** The UV absorption spectra of $Al^{3+}$ (red curve) and $Cu^{2+}$ (black curve), and the FL emission spectra of D-CDs in the absence and presence of $Al^{3+}$ and $Cu^{2+}$.

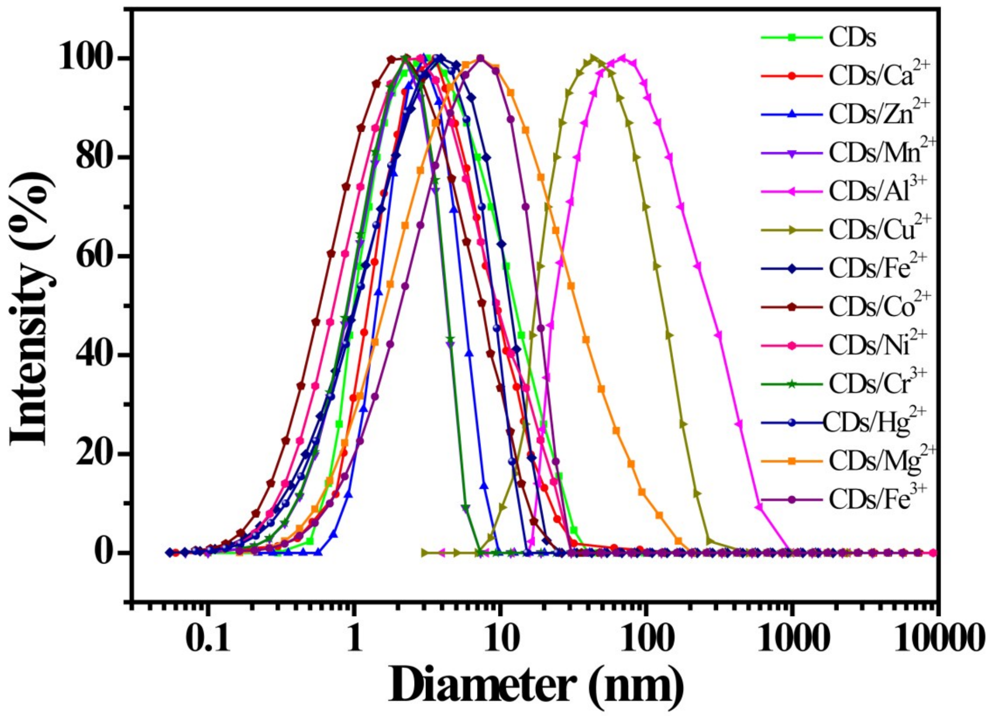


**Fig. S8** Particle size distribution profiles of D-CDs in ethanol solution in the absence and presence of different metal ions.

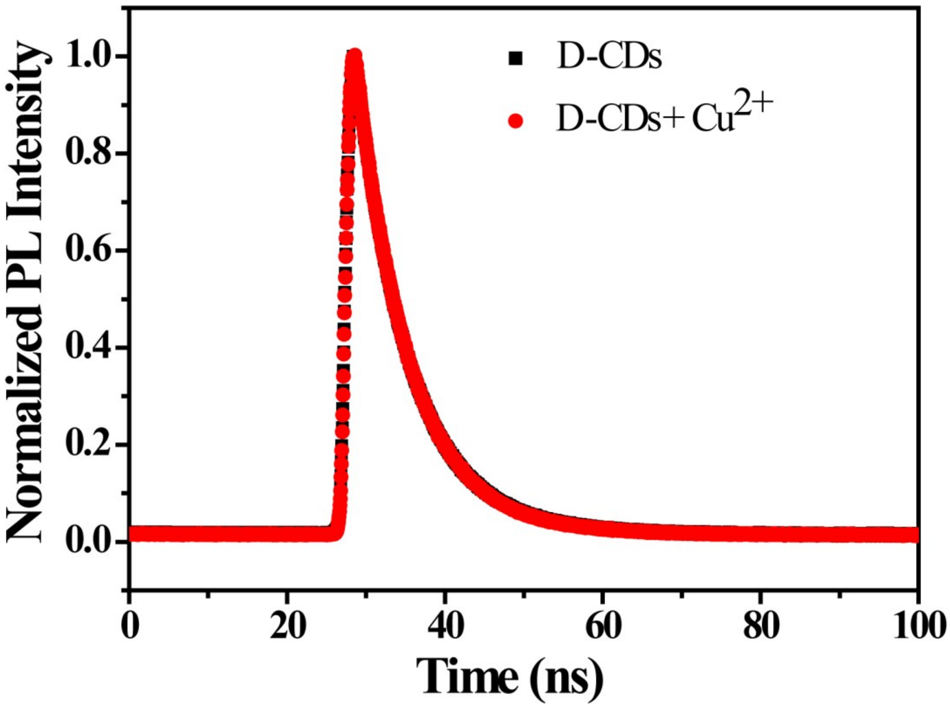


**Fig. S9** Time-resolved FL decay curves of D-CDs ethanol solution in the absence and presence of $Cu^{2+}$ ($\lambda_{ex}$ = 410 nm, $\lambda_{em}$ = 670 nm).

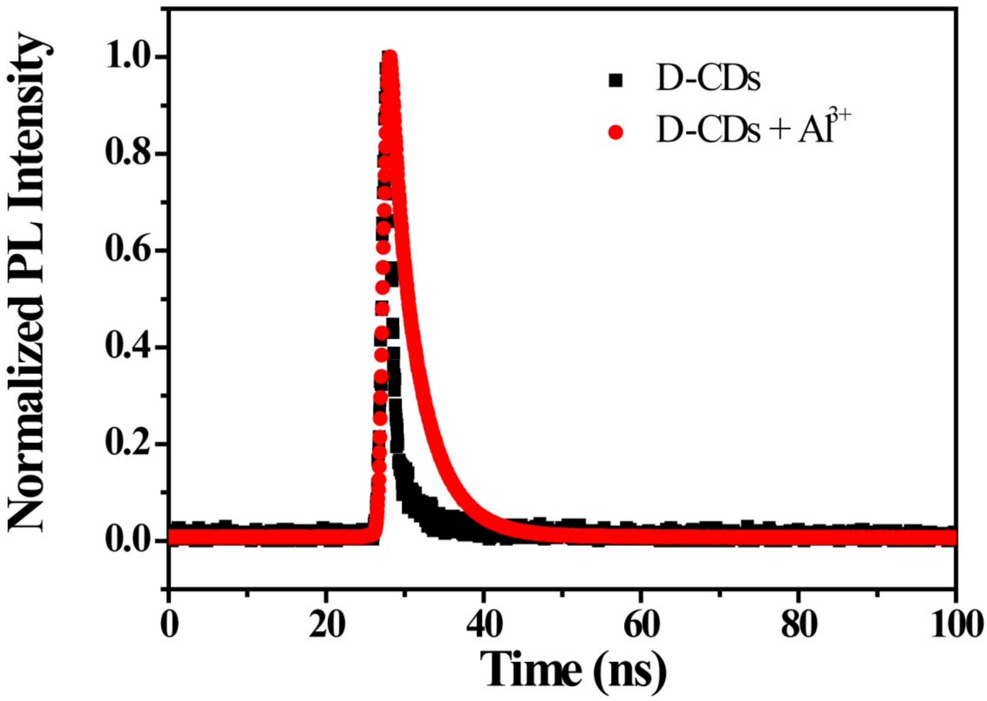


**Fig. S10** Time-resolved FL decay curves of D-CDs ethanol solution in the absence and presence of $Al^{3+}$ ($\lambda_{ex}$ = 410 nm, $\lambda_{em}$ = 470 nm).

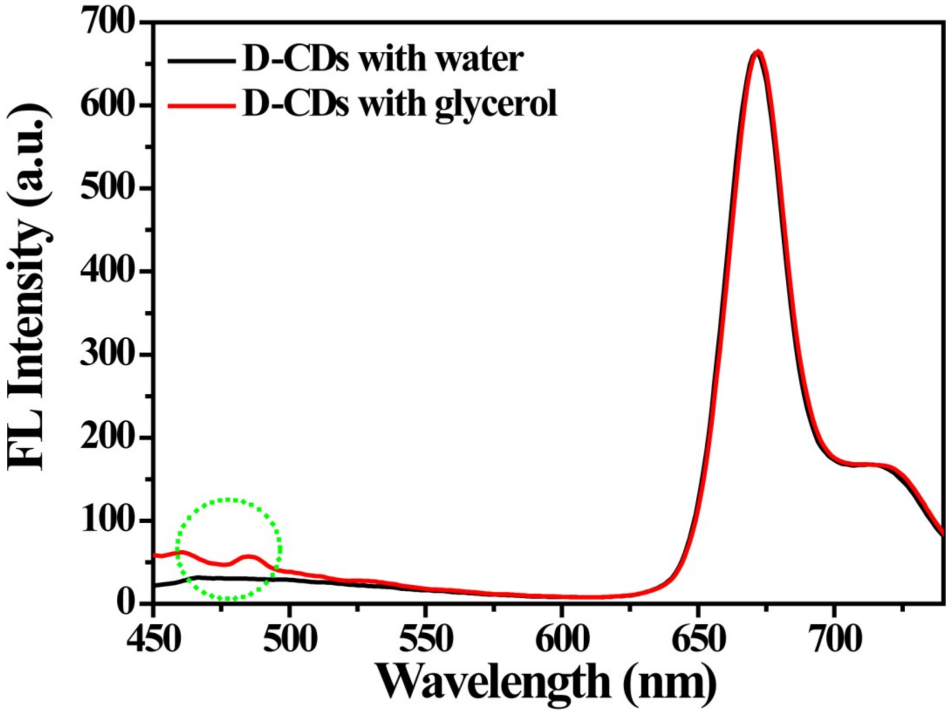


**Fig. S11** The FL emission spectra of D-CDs in aqueous solution and 25% glycerol solution.