Figure S1. Contour plot of the photoluminescence spectra of the four different CDs samples with precursor ratio of (a) 1:0, (b) 1:0.1, (c) 1:0.5, and (d) 1:1, respectively.
Figure S2. 3D plot of the excitation spectrum and emission spectra of the four different CDs samples with precursor ratio of (a) 1:0, (b) 1:0.1, (c) 1:0.5, and (d) 1:1, respectively.
Figure S3. High-resolution C 1s XPS spectra for the four different CDs samples with precursor ratio of (a) 1:0, (b) 1:0.1, (c) 1:0.5, and (d) 1:1, respectively.
Figure S4. High-resolution O 1s XPS spectra for the four different CDs samples with precursor ratio of (a) 1:0, (b) 1:0.1, (c) 1:0.5, and (d) 1:1, respectively.
Figure S5. High-resolution N 1s XPS spectra for the four different CDs samples with precursor ratio of (a) 1:0, (b) 1:0.1, (c) 1:0.5, and (d) 1:1, respectively.

Figure S6. Fluorescence spectra of 30 µL of CDs sample with precursor ratio of 1:0 diluted into 3 mL using different common solvents.
Table S1. Content of various elements in the four different CDs samples with precursor ratio of 1:0, 1:0.1, 1:0.5, and 1:1, respectively.

| Ratio | C    | O    | N    | Zn  |
|-------|------|------|------|-----|
| 1:0   | 76.35| 4.42 | 19.23| 0.0 |
| 1:0.1 | 76.76| 21.66| 1.58 | 0.09|
| 1:0.5 | 74.62| 19.59| 5.62 | 0.18|
| 1:1   | 73.45| 16.29| 10.01| 0.25|

Table S2. Content of oxygen containing functional groups in the four different CDs samples with precursor ratio of 1:0, 1:0.1, 1:0.5, and 1:1, respectively.

| Ratio | C-C/C=O | C-O/C-N | C=O |
|-------|---------|---------|-----|
| 1:0   | 86.65   | 13.35   | 0.0 |
| 1:0.1 | 84.07   | 8.24    | 7.69|
| 1:0.5 | 64.26   | 29.70   | 6.04|
| 1:1   | 65.68   | 31.96   | 2.36|

Table S3. Content of carbon containing functional groups in the four different CDs samples with precursor ratio of 1:0, 1:0.1, 1:0.5, and 1:1, respectively.

| Ratio | C-O | C=O |
|-------|-----|-----|
| 1:0   | 100 | 0   |
| 1:0.1 | 83.47| 16.53|
| 1:0.5 | 83.83| 16.17|
| 1:1   | 89.50| 10.50|
Table S4. Content of nitrogen containing functional groups in the four different CDs samples with precursor ratio of 1:0, 1:0.1, 1:0.5, and 1:1, respectively.

| Ratio | pyrrolic N | amino N |
|-------|------------|---------|
| 1:0   | 100        | 0       |
| 1:0.1 | 100        | 0       |
| 1:0.5 | 82.01      | 17.99   |
| 1:1   | 79.55      | 20.45   |

Table S5. Radical effect on the HOMO-LUMO energy gap of CDs.

| HOMO-LUMO energy gap (eV) | 2.18 | 2.31 | 1.86 | 2.73 | 2.01 |
|---------------------------|------|------|------|------|------|
|                           | ![Image 83x417 to 163x464] | ![Image 183x419 to 260x464] | ![Image 270x417 to 342x465] | ![Image 352x417 to 430x464] | ![Image 456x418 to 523x465] |
Table S6. CDs with different radical and their HOMO-LUMO energy gap.

| CDs models | Number of radical or doped atom on CDs | HOMO-LUMO energy gap(eV) |
|------------|--------------------------------------|-------------------------|
|            | Zn | Pyridinic N | Amino N | -C=O | -C-O |                      |
| a          | 0  | 0           | 1       | 1    | 2    | 0.90                  |
| b          | 0  | 1           | 0       | 1    | 2    | 1.02                  |
| c          | 1  | 1           | 0       | 1    | 2    | 0.71                  |
| d          | 1  | 0           | 1       | 1    | 2    | 1.10                  |
| e          | 2  | 0           | 2       | 2    | 1    | 0.91                  |
| f          | 2  | 2           | 0       | 2    | 1    | 1.17                  |