Aromatic ring compounds with different conjugation degrees in boronic acid matrix to realize multicolor phosphorescence for time division colorful multiplexing

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Experimental section

Materials

2-Phenethylamine (2-Ph), 9-Aminophenanthrene (9-Ph), 1-Aminopyrene (1-Py), were obtained from Macklin Co. Ltd. Boric acid (BA) were purchased from Aladdin Chemical Co., Ltd. Deionzed water was got from a milipore purification system.

Synthesis

2-Ph@BA was synthesized based on the following method. 10 mg 2-Ph and 1 g BA were added to a beaker, then 10 ml of ultrapure water was added and stirred for 30 min to fully disperse. The beaker was covered with tin foil to avoid rapid evaporation of water, and then heated at 200℃ for

3 h. Moreover, different ratios (5 mg, 10 mg, 15 mg, 20 mg) of precursor molecules, different , reaction temperature (180℃, 200℃, 220℃, 240℃) and heating time (2 h, 2.5 h, 3 h, 3.5 h) of 2-Ph@BA were investigated. 2-Ph@BA, 9-Ph@BA and 1-Py@BA were prepared in a similar way to the above steps.

Characterization

The microstructure of samples was performed on a high-resolution transmission electron microscope (TEM, JEOL JEM-F200). The morphology and EDS spectra of samples were investigated by field emission scanning electron microscopy (SEM, FEI Quatan FEG 250) equipped with an energy dispersive spectrometer (EDS). The X-ray diffraction (XRD) patterns were obtained using the DB-ADVANCE X-ray diffraction analyzer diffractometer. Fourier transform infrared spectroscopy (FT-IR) from Thermofisher Nicolet iS10 and X-ray photoelectron spectroscopy (XPS) from Thermo Fisher ESCALAB Xi were employed to analyze the surface functional groups and the elements of the synthesized materials. The TG curves was tested by synchronous thermal analyzer using NETZSCH STA449F5. The raman spectra were obtained using a HORIBA Jobin Yvon LabRAM HR Evolution system. The photoluminescence (PL) spectra and time-resolved PL spectra were recorded on an Edinburgh Instruments FLS 1000 spectrometer. The ultraviolet-visible (UV-Vis) absorbance spectra were recorded by PE Lambda 950.

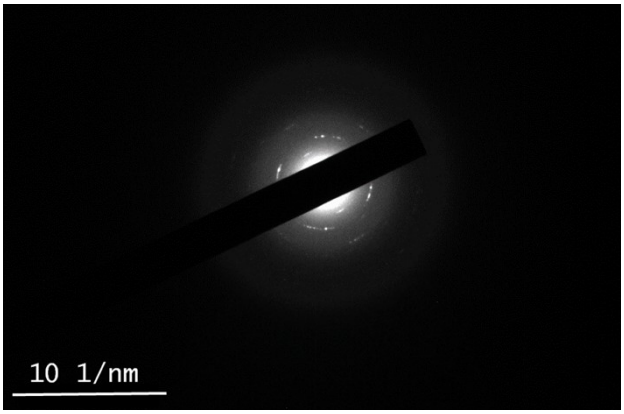

Figure S1. The SAED image of RTP CDs.

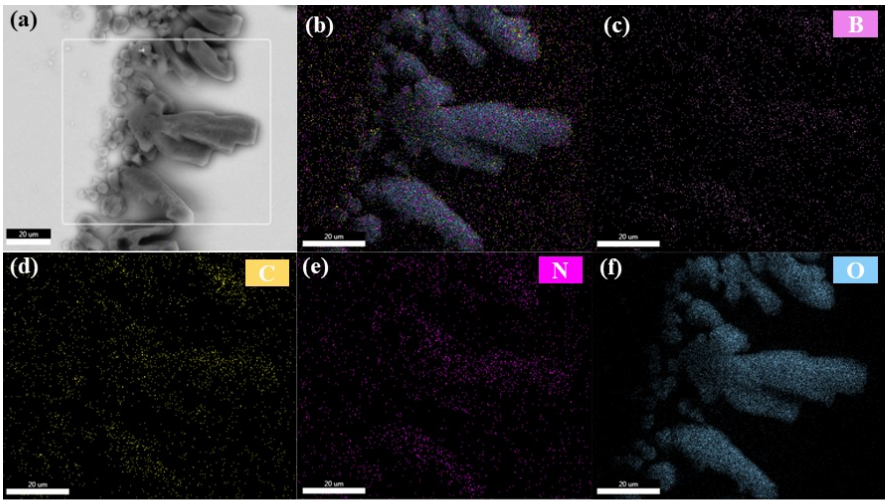

Figure S2. a) SEM image of RTP CDs. b-f) The elemental mapping (B, C, N and O) of EDS spectrum.

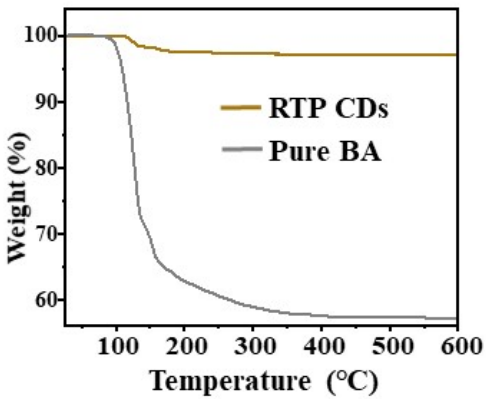

Figure S3. TG curves of RTP CDs and pure BA from 25 to 600°C.

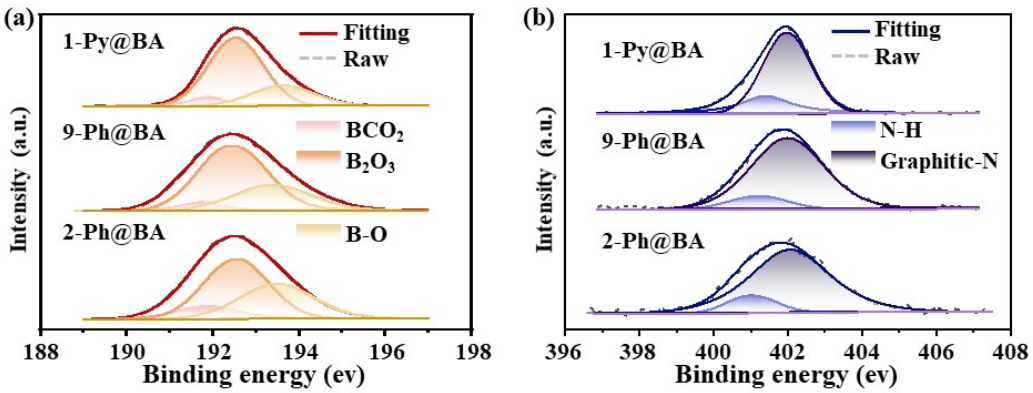

Figure S4. a,b) The high-resolution XPS spectra of B 1s and N 1s of 2-Ph@BA, 9-Ph@BA and 1-Py@BA.

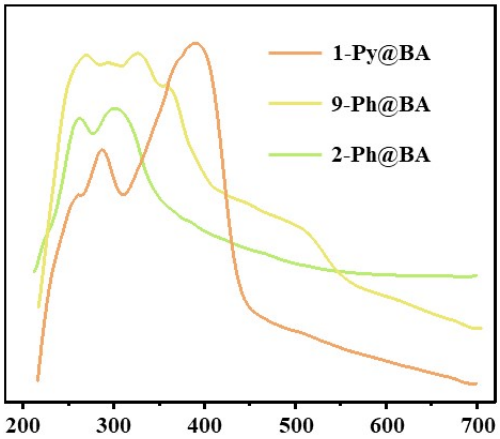

Figure S5. UV-vis adsorption spectra of of 2-Ph@BA, 9-Ph@BA and 1-Py@BA.

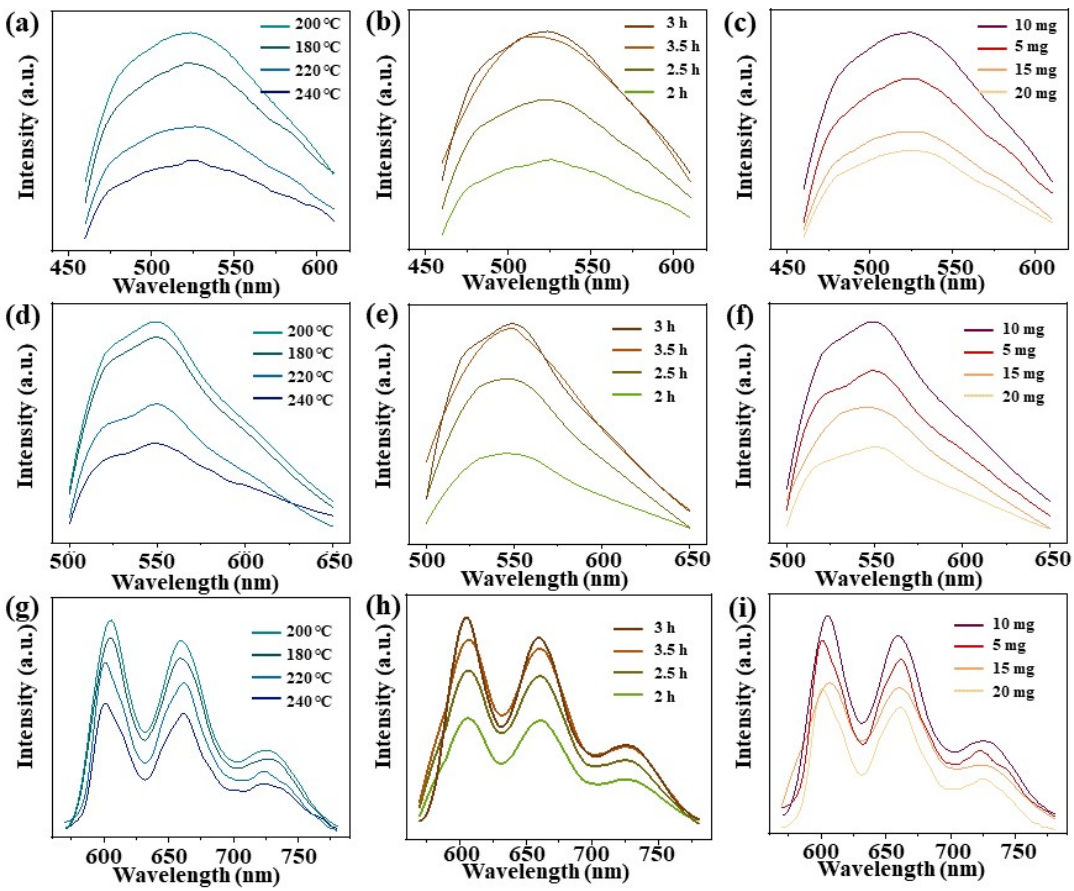

Figure S6. The different synthesis temperatures, heating times and raw material ratios of 2-Ph@BA (a, b, c), 9-Ph@BA (d, e, f) and 1-Py@BA (g, h, i).

Table S1. The fitting constants of 2-Ph@BA, 9-Ph@BA and 1-Py@BA

Sample	τ_1 (ms)	τ_2 (ms)	B_1	B_2	τ_{avg} (ms)
2-Ph@BA	909	113	2183	419	890.4
9-Ph@BA	1327	84	1625	783	1290
1-Py@BA	348	74	1468	116	343

Table S2. The synthesis conditions, RTP properties and application of multicolor RTP CDs.

Matrix	Reaction parameter	Afterglow lifetime	Afterglow color	QY	Application	Ref
Urea	Hydrothermal, 150 °C, 5 h /Solvothermal, 160 °C, 6 h	445 ms 281 ms	Yellow-green (565 nm) Orange (605 nm)	-	Anticounterfeiting and information encryption	[1]
NaOH	Microwave, 750 W, 2.5 min	398 ms 347 ms 58 ms	Blue (483 nm) Green (517 nm) Red (635 nm)	9.05 % 4.4 % 0.63 %	Information encryption	[2]
SiO_2	Hydrothermal, 180 °C, 10 h/ Hot-urea-bath, 150 °C,2 h	2030 ms 480 ms 400 ms	Blue (445 nm) Green (550 nm Red (615 nm)	50.17%	Fingerprint detection Temperature sensing	[3]
B_2O_3	Solvothermal, 200 °C, 5 h /Heat, 180 °C, 5 h	423.5 ms 455.9 ms	Blue (475 nm) Yellow-green (555 nm)	17.6%	Temperature sensing/Latent fingerprint identification	[4]
B_2O_3	Solvothermal, 200 °C, 3 h	1290 ms 890 ms 340 ms	Green (495 nm) Yellow (560 nm) Red (605 nm)	24.59%, 32.57% 8.62%	Information encryption Time division colorful multiplexing	This work

References

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