Supporting Information

Three Models to Encapsulate Multi-component Dyes into Nanocrystal Pores: A New Strategy for Generating High Quality White Light

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Chemicals

Cetyltrimethylammonium bromide (CTAB, Beantown Chemical, 98%), 2-methylimidazole (Acros Organics, 99%), zinc nitrate hexahydrate ($Zn(NO_3)_2 \cdot 6H_2O$, Alfa Aesar, 99%), rhodamine B (RB, Sigma-Aldrich, 95%), fluorescein (F, Acros Organics, pure) and 7-amino-4-(trifluoromethyl)coumarin (C-151, Alfa Aesar, 99%) were purchased from the mentioned sources and used without further purification.

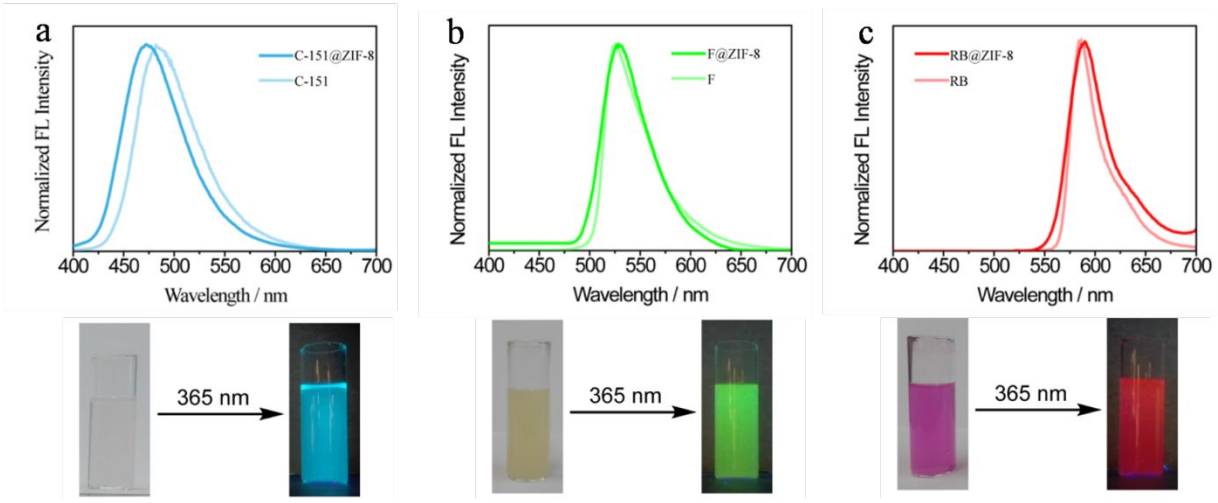

Figure S1. The liquid state fluorescence spectra of (a) C-151@ZIF-8 and C-151, (b) F@ZIF-8 and F and (c) RB@ZIF-8 and RB, and the corresponding photographs of C-151@ZIF-8, F@ZIF-8 and RB@ZIF-8 in methanol solution under daylight (left) and UV light (right).

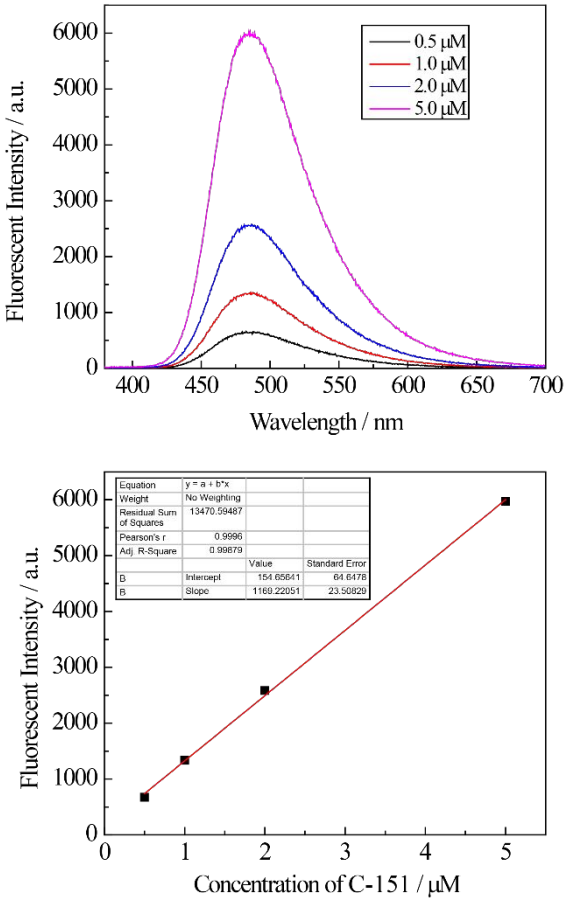

Figure S2. The relationship of concentration and fluorescent intensity of C-151.

The content of C-151 in C-151@ZIF-8[2] was calculated as following:

Different amount of C-151@ZIF-8[2] was dispersed in 2 mL methanol containing 1 drop of diluted HCl. Then the fluorescent intensity was measured and the content was calculated using the concentration-intensity equation as shown in Figure S2 inset.

Table S1. The related parameters of C-151 in C-151@ZIF-8[2].

C-151 solution (mL)	0.10	0.37	0.5	0.75
Quantity (mg)	14.0	16.1	14.0	13.0
Fluorescent intensity	1597	5789	6267	7338
Mass ratio (wt%)	0.0040	0.0137	0.0171	0.0217
Quantum yield	0.267	0.419	0.208	0.166

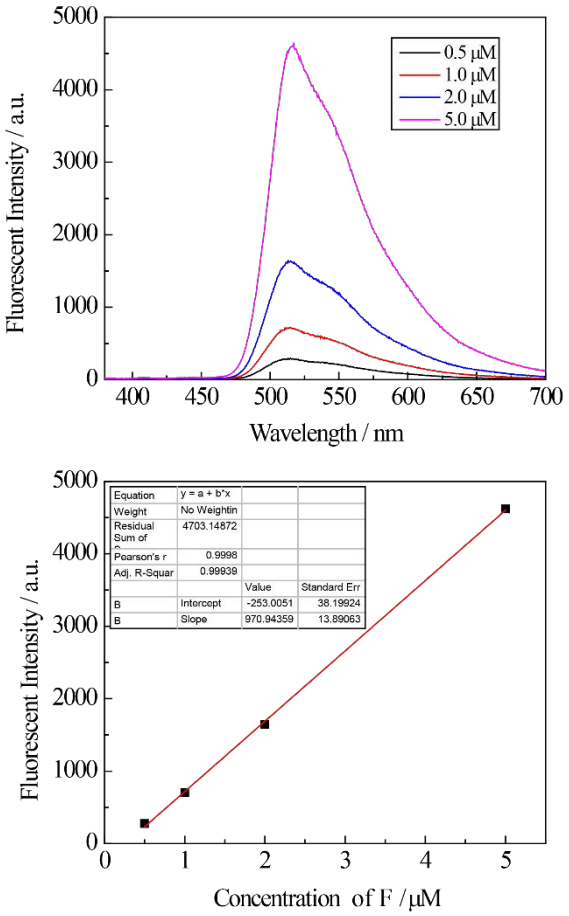

Figure S3. The relationship of concentration and fluorescent intensity of F.

The content of F in F@ZIF-8[2] was calculated using the same method as C-151.

Table S2. The related parameters of F in F@ZIF-8[2].

F solution (mL)	0.10	0.25	0.75	1.00
Quantity (mg)	13.3	12.9	13.4	13.8
Fluorescent intensity	340	1101	2600	3386
Mass ratio (wt%)	0.0030	0.0072	0.0146	0.0180
Quantum yield	0.595	0.626	0.459	0.428

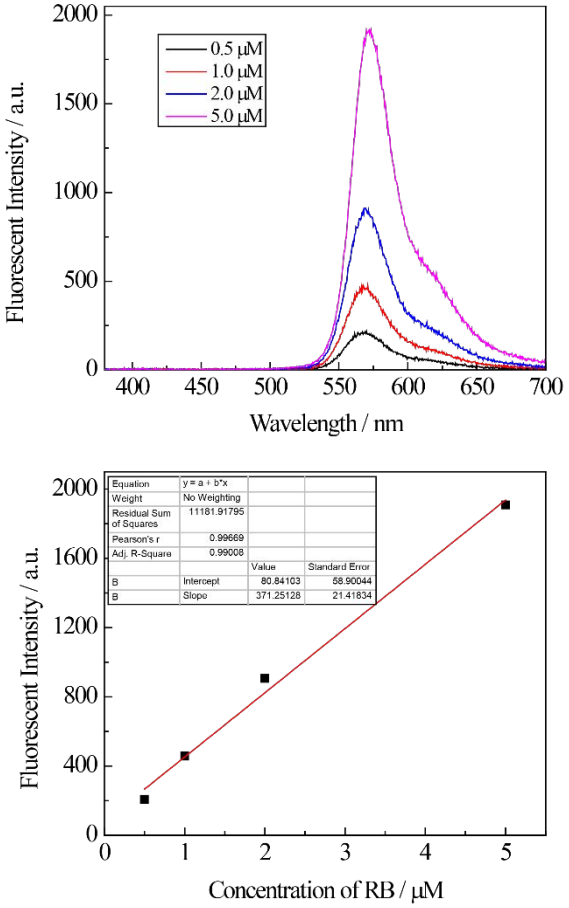

Figure S4. The relationship of concentration and fluorescent intensity of RB.

The content of RB in RB@ZIF-8[2] was calculated using the same method as C-151.

Table S3. The related parameters of RB in RB@ZIF-8[2].

RB solution (mL)	0.10	0.25	0.50	0.75
Quantity (mg)	13.5	14.0	12.1	13.4
Fluorescent intensity	775	2104	3361	4253
Mass ratio (wt%)	0.0132	0.0372	0.0705	0.0803
Quantum yield	0.492	0.601	0.369	0.232

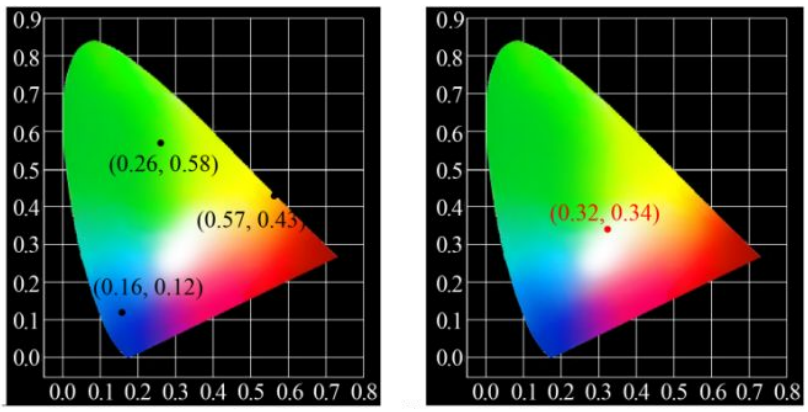

Figure S5. The CIE chromaticity coordinates of C-151@ZIF-8[2], F@ZIF-8[2] and RB@ZIF-8[2] (left) and the corresponding CIE chromaticity coordinates of white light emission (a grinding mixture of 0.0137 wt% C-151@ZIF-8[2], 0.0146 wt% F@ZIF-8[2] and 0.0372wt% RB@ZIF-8[2] with mass ratio 2:1:3) (right).

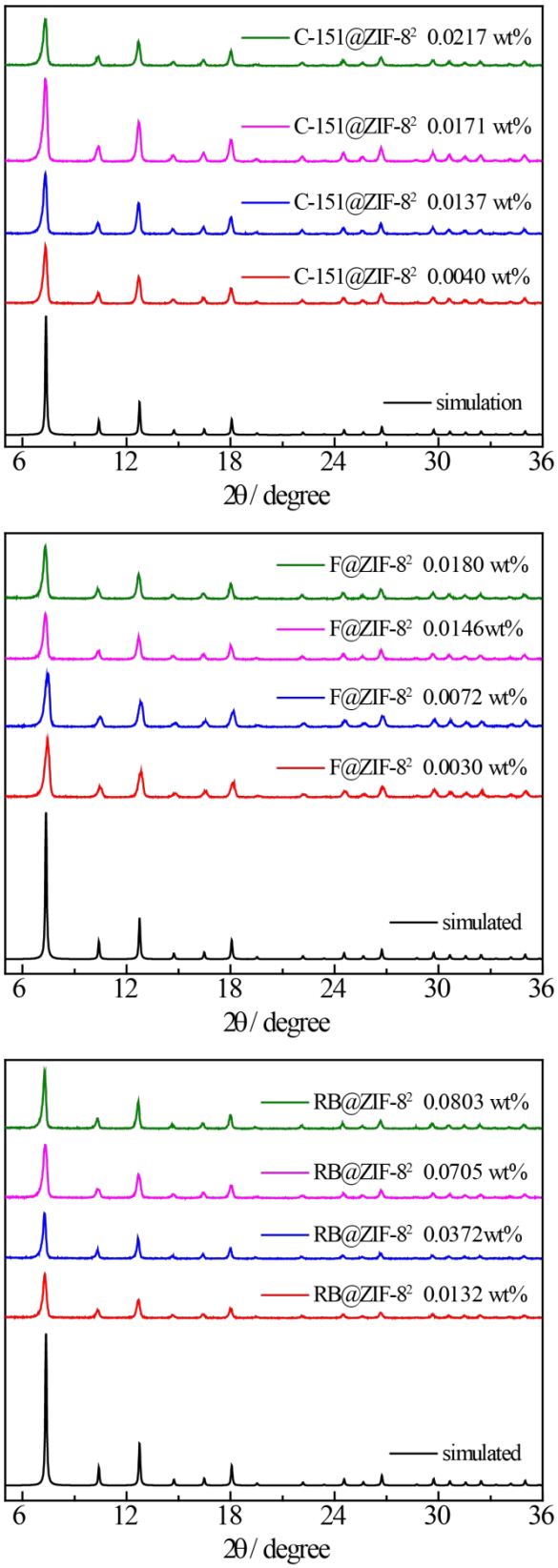

Figure S6. The PXRD patterns of C-151@ZIF-8² (top), F@ZIF-8² (middle) and RB@ZIF-8² (below) with different dye concentrations.

Figure S7. The photographs of methanol solution of C-151@ZIF-8^2 (top), F@ZIF-8^2 (middle) and RB@ZIF-8^2 (below) with different dye concentration under daylight (left) and UV light (right).

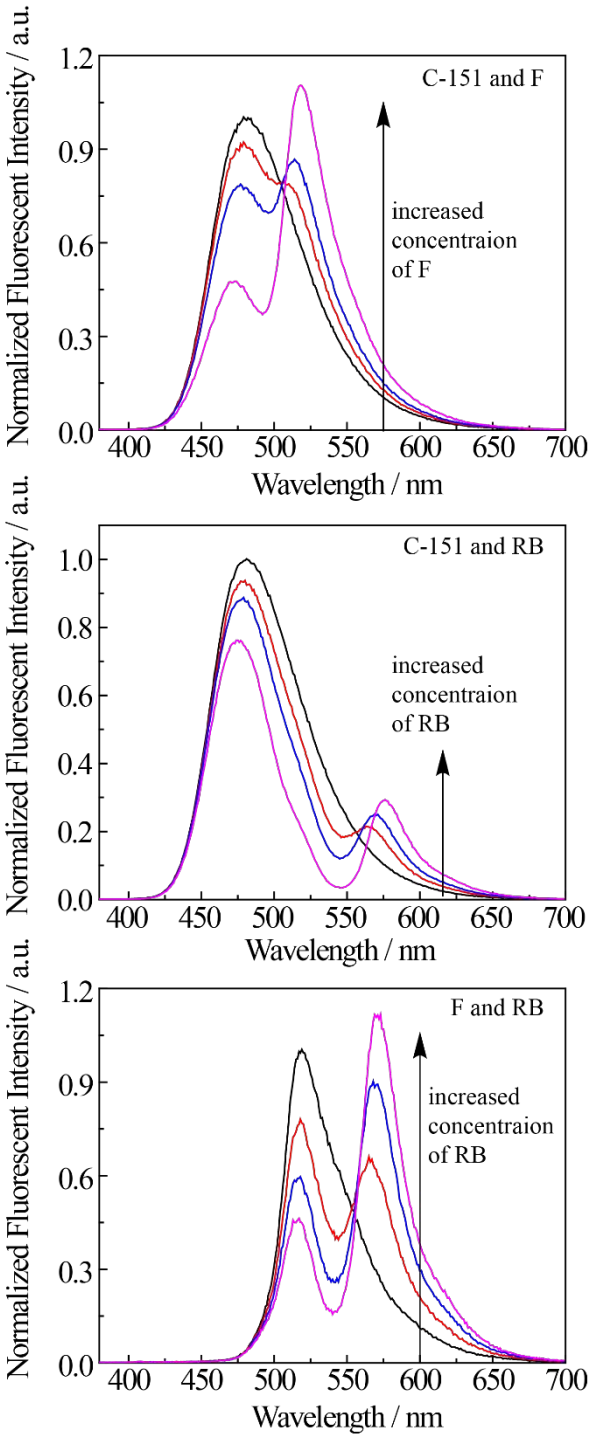

Figure S8. The Fluorescence Resonance Energy Transfer (FRET) measurements between C-151 and F (top), C-151 and RB (middle) and F and RB (below).

As shown in Figure S8, in the case of C-151 and F, the fluorescent intensity of C-151 (donor) exhibits a significant decrease with increase concentration of F (acceptor). Therefore, it is clear that there exist strong energy transfer between C-151 and F in methanol solution. The similar results were also observed between C-151 and RB, F and RB.

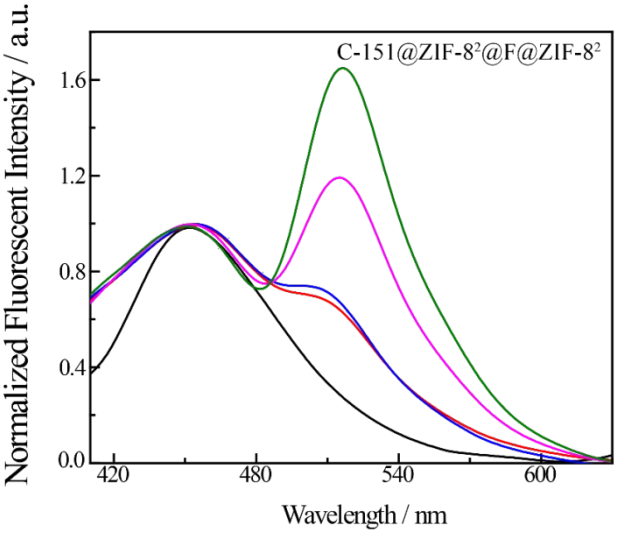

Figure S9. The fluorescence spectra of C-151@ZIF-8²@F@ZIF-8² with increased concentrations of F.

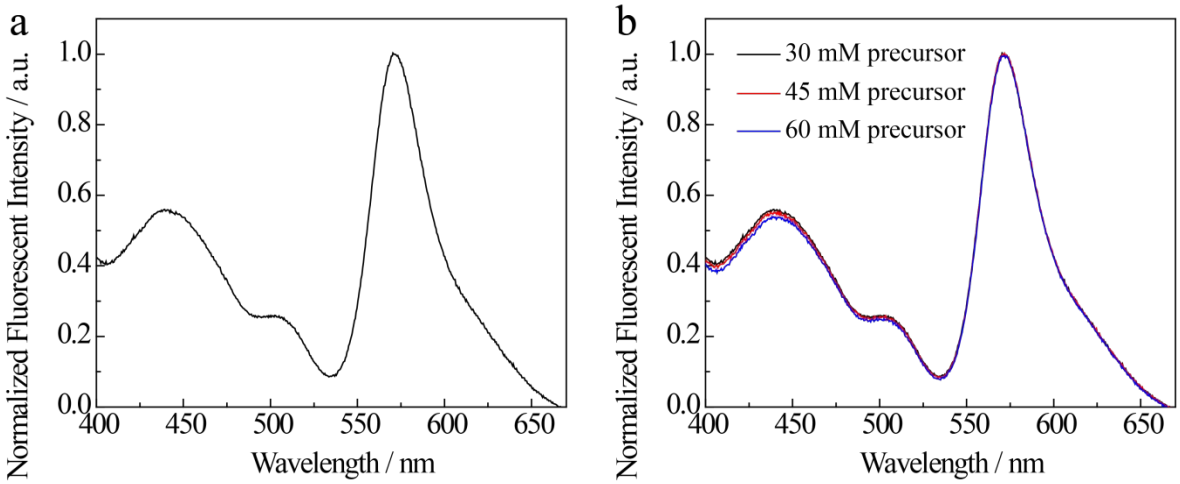

Figure S10. (a) The fluorescence spectrum of RB@ZIF-8^2@F@ZIF-8^2@C-151@ZIF-8^2 with a CIE chromaticity coordinates of (0.35, 0.33). (b) The fluorescence spectra of RB@ZIF-8^2@F@ZIF-8^2@C-151@ZIF-8^2 with increasing out-shell thickness of ZIF-8. The corresponding precursor concentrations are 30 mM (black), 45 mM (red) and 60 mM (blue), respectively, for the overgrowth of the out-shell ZIF-8.

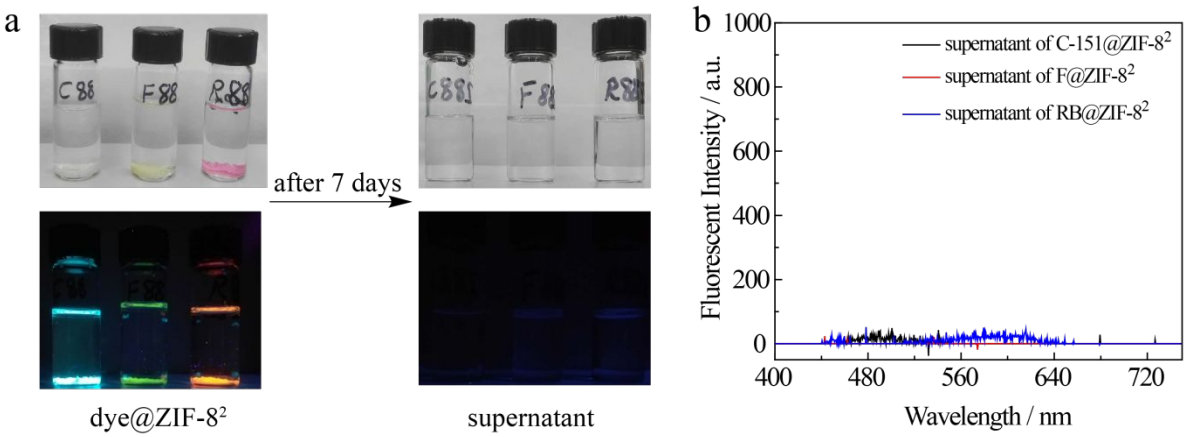

Figure S11. (a, left) The photographs of C-151@ZIF-8², F@ZIF-8² and RB@ZIF-8² soaked methanol solution under daylight (top) and UV light (bottom); (a, right) the photographs of supernatants of C-151@ZIF-8², F@ZIF-8² and RB@ZIF-8² soaked methanol solution after 7 days under daylight (top) and UV light (bottom); (b) the fluorescence spectra of supernatants of C-151@ZIF-8², F@ZIF-8² and RB@ZIF-8² soaked methanol solution after 7 days.