## Supporting Information

### Self-Assembled Nanohelix for White Circularly Polarized

Luminescence via Chirality and Energy Transfer

Sijia Ma, <sup>ab</sup> Jian Jiang, \*<sup>b</sup> Zongwen Liu, <sup>b</sup> Yuqian Jiang, <sup>b</sup> Zhanpeng Wu\*<sup>a</sup> and Minghua Liu\*<sup>bc</sup>

a Key Laboratory of Carbon Fiber and Functional Polymers (Beijing University of Chemical Technology), Ministry of Education, Beijing 100029, China. Email: wuzp@mail.buct.edu.cn.

b CAS Center for Excellence in Nanoscience, CAS Key Laboratory of Nanosystem and Hierarchical Fabrication, Division of Nanophotonics, National Center for Nanoscience and Technology (NCNST), No. 11 ZhongGuanCun BeiYiTiao, Beijing 100190, P. R. China. E-mail: jiangj@nanoctr.cn; liumh@iccas.ac.cn.

c Beijing National Laboratory for Molecular Science, CAS Key Laboratory of Colloid, Interface and Chemical Thermodynamics, Institute of Chemistry, Chinese Academy of Sciences, No. 2 ZhongGuanCun BeiYiJie, 100190, Beijing, P. R. China.

#### **S1. Synthetic Procedures.**



#### Scheme S1. Synthetic routes of bola-1

1,12-Diaminododecane (1.0g,4.99mmol) was dissolved in dichloromethane (100 mL) at 25 °C.

Then (R)-(-)-1-(1-Naphthyl)ethyl Isocyanate (2.0g,10.14mmol) which has already dissolved in Dichloromethane (20 mL) was added into the mixture and stirred for 3h. White precipitate (2.80 g) was obtained after filtration and filtered by filter paper. The solvent was removed under reduced pressure to give a crude product. Further more, the crude product was rinsed with excess solvent dichloromethane to remove the (R)-(-)-1-(1-Naphthyl) ethyl Isocyanate of the mixture system. Repeat three times and a bit of organic solvent was removed using vacuum oven giving pure product. yield 94.3 %.

Compounds **bola-1** were simply purified via filtration or precipitation and characterized with <sup>1</sup>H NMR, MALDI-TOF.

<sup>1</sup>H NMR for bola-1 (400 MHz, DMSO- $d_6$ ,  $\delta$ , ppm)  $\delta$  8.13 (d, J = 8.2 Hz, 2H), 7.93 (d, J = 7.7 Hz, 2H), 7.81 (d, J = 7.2 Hz, 2H), 7.60 – 7.43 (m, 8H), 6.38 (d, J = 8.1 Hz, 2H), 5.75 (t, J = 5.6 Hz, 2H), 5.60 – 5.48 (m, 2H), 2.97 (q, J = 6.4 Hz, 4H), 1.45 (d, J = 6.8 Hz, 6H), 1.39 – 1.28 (m, 4H), 1.22 (s, 16H).

MALDI-TOF-MS: calculated for C<sub>38</sub>H<sub>50</sub>N<sub>4</sub>O<sub>2</sub>, 594.8, found 617.2 [C<sub>38</sub>H<sub>49</sub>N<sub>4</sub>O<sub>2</sub>-Na]<sup>+</sup>.

| Table S1. the gel behavior of bolaamphiphile in variety of solvents |  |   |  |  |
|---|--|---|--|--|
| Solvent   | 1  | CGC   |  |  |
| Litty Solvent I   | •  | (mg/mL)   |  |  |
| n-hexane  | G  | -   |  |  |
| toluene   | G  | 3   |  |  |
| $CH_2Cl_2$  | Ι  | 2   |  |  |
| CH <sub>3</sub> CN  | G  | 1   |  |  |
| EtOH  | G  | 3   |  |  |
| THF   | G  | 6   |  |  |
| DMF   | S  | -   |  |  |
| DMSO  | S  | -   |  |  |
| H <sub>2</sub> O  | Ι  | -   |  |  |
| DMSO-H <sub>2</sub> O 1-1   | G  | 0.5   |  |  |
| DMSO-H <sub>2</sub> O 2-1   | G  | 1.5   |  |  |
| DMSO-H <sub>2</sub> O 3-1   | G  | 2   |  |  |
| DMSO-H <sub>2</sub> O 4-1   | G  | 2.5   |  |  |
| DMSO-H <sub>2</sub> O 5-1   | G  | 3   |  |  |
| DMF-H <sub>2</sub> O 1-1  | G  | 1   |  |  |
| DMF-H <sub>2</sub> O 2-1  | G  | 1.5   |  |  |
| DMF-H <sub>2</sub> O 3-1  | G  | 2   |  |  |
| DMF-H <sub>2</sub> O 4-1  | G  | 2.5   |  |  |
|   | Solvent<br>Solvent<br>n-hexane<br>toluene<br>$CH_2Cl_2$<br>$CH_2Cl_2$<br>$CH_3CN$<br>EtOH<br>THF<br>DMF<br>DMF<br>DMSO<br>$H_2O$<br>DMSO- $H_2O$ 1-1<br>DMSO- $H_2O$ 1-1<br>DMSO- $H_2O$ 3-1<br>DMSO- $H_2O$ 3-1<br>DMSO- $H_2O$ 3-1<br>DMSO- $H_2O$ 3-1<br>DMSO- $H_2O$ 3-1<br>DMSO- $H_2O$ 3-1<br>DMF- $H_2O$ 3-1<br>DMF- $H_2O$ 3-1<br>DMF- $H_2O$ 3-1<br>DMF- $H_2O$ 3-1 | Solvent 1   n-hexane G   toluene G   CH <sub>2</sub> Cl <sub>2</sub> I   CH <sub>3</sub> CN G   EtOH G   DMF S   DMSO S   H <sub>2</sub> O I   DMSO-H <sub>2</sub> O 1-1 G   DMSO-H <sub>2</sub> O 3-1 G   DMSO-H <sub>2</sub> O 5-1 G   DMF-H <sub>2</sub> O 1-1 G   DMSO-H <sub>2</sub> O 1-1 G   DMSO-H <sub>2</sub> O 3-1 G   DMSO-H <sub>2</sub> O 3-1 G   DMSO-H <sub>2</sub> O 3-1 G   DMF-H <sub>2</sub> O 3-1 G |  |  |

# S2. Supplementary Figures and Data.

I =insoluble, G =gel, S =soluble



**Figure S1.** SEM images of R -**bola-1** gel in kinds of organic solvents. (a.CH<sub>2</sub>Cl<sub>2</sub> b. toluene c. CH<sub>3</sub>CN d. THF e. EtOH f. DMF/H<sub>2</sub>O)



**Fig. S2**. (a) XRD patten of bola-1 based gel and **D2/bola-1** co-assembled gel, (b) FT-IR spectra of bola-1 and **D2/bola-1** co-assembled gel.



Figure S3. CD spectra of bola-1 dissolved in DMSO.



**Figure. S4.** Fluorescence emission spectrum of dyes dissolved in  $DMSO/H_2O=4/1$  (Ex=365nm). Pyren-1-amine (**D1**), pyrene-1-carboxylic acid (**D2**), Rhodamine 110 (**D3**), Rhodamine B (**D4**).



**Figure. S5.** Commission International de l'Eclairage coordinate value of the dyes. Ex=365nm



Fig S6. Emission decay curves of the hydrogel of (a) **bola-1** and **bola-1** co-assembled with **D2** in different proportion  $\lambda ex = 280$  nm and the concentrations of donor and acceptors are [**bola-1**] = 6.7 mM, [**D2**] = 0.67 mM (10%), 3.35mM (50%)

| Sample               | τ1                   | τ2                   | τ        | $\chi^2$ |  |
|----------------------|----------------------|----------------------|----------|----------|--|
| bola-1               | 29.28 ns<br>(60.23%) | 12.99 ns<br>(39.77%) | 22.80 ns | 1.273    |  |
| <b>bola-1-D2</b> 10% | 20.81 ns<br>(46.18%) | 7.64 ns<br>(53.82%)  | 13.72 ns | 1.758    |  |
| <b>bola-1-D2</b> 50% | 6.58 ns<br>(50.49%)  | 36.86 ns<br>(49.51%) | 8.44 ns  | 1.222    |  |

**Table S2.** The life times of **bola-1** in the absence and presence of acceptor **D2** 



Fig. S7. Fluorescence spectra of the hydrogel of **bola-1**, **bola-1/D2**. (a) black line was the emission spectrum of donor **bola-1** ( $\lambda$ ex = 280 nm), red line ( $\lambda$ ex = 280 nm) and green line ( $\lambda$ ex = 350 nm) were the emission spectra of **bola-1/D2** co-assemblies using different excitation wavelength. The concentrations of donor or acceptors are as follows: [**bola-1**] = 6.7 mM, [**D2**] = 0.67 mM



Fig. S8. Fluorescence spectra of the co-gels of **bola-1** co-assembled with dyes in different proportion. (black line:5%. red line: 10% and blue line 20%). The four dyes are (a) pyren-1-amine (D1), (b) pyrene-1-carboxylic acid (D2), Rhodamine 110 (D3), Rhodamine B (D4). The concentrations of donor or acceptors are as follows: [bola-1] = 6.7 mM, [dyes] = 0.67 mM (10%). Ex=365nm



**Fig. S9.** SEM images of nanohelix of (a) *S*-**bola-1-D1**, (b) *S*-**bola-1-D3**, (c) *S*-**bola-1-D4**, (d) *R*-**bola-1-D1**, (e) *R*-**bola-1-D3**, and (f) *R*-**bola-1-D4**, respectively.



Fig. S10. Combined spectra of CD and UV-vis measured from the co-gels composed of (a) **bola-1** co-assemble with Rhodamine 110 (D4). the CPL spectra of co-gels (b) **bola-1** co-assemble with D4 where the red line is *S*-bola-1 co-gel and the blue line is *R*-bola-1 co-gel, the gray line is the CPL spectra of **bola-1** and dyes dissolved in DMSO. Ex=280nm



Fig. S11. the CPL spectra of co-gels (b)bola-1 co-assemble with D1, (d) bola-1 co-assemble with D3 and (b)bola-1 co-assemble with D4. Where the red line is *S*-bola-1 co-gel and the blue line is *R*-bola-1 co-gel. Ex=365nm.

| <b>Table S3.</b> g <sub>lum</sub> values of the co-gels (Ex=280nm) |                      |                        |  |  |
|--|----------------------|------------------------|--|--|
| Sample   | S                    | R                      |  |  |
| bola-1-D2  | 3.5×10 <sup>-3</sup> | -2.3×10 <sup>-3</sup>  |  |  |
| bola-1-D3  | 2.5×10 <sup>-3</sup> | -2.9×10 <sup>-3</sup>  |  |  |
| bola-1-D4  | 4.4×10 <sup>-3</sup> | -3.1×10 <sup>-3</sup>  |  |  |
| <b>Table S4.</b> $g_{lum}$ values of the co-gels (Ex=365nm)        |                      |                        |  |  |
| Sample   | S                    | R                      |  |  |
| bola-1-D2  | 1.2×10 <sup>-3</sup> | -5.93×10 <sup>-4</sup> |  |  |
| bola-1-D3  | 1.2×10 <sup>-3</sup> | -9.09×10 <sup>-4</sup> |  |  |
| bola-1-D4  | 3.0×10 <sup>-4</sup> | -3.21×10-4             |  |  |



**Fig. S12.** (a) Fluorescence spectra of the white chiral co-gel (Ex=365 nm). (b) CPL spectra of the white chiral co-gel (Ex=365 nm). (c) Commission International de I'Eclairage coordinate value of the white-light-emitting co-gel. (d) SEM images of the white chiral co-gel.