Supplementary Information

Fabrication of Photoresponsive Crystalline Artificial Muscles Based on PEGylated Covalent Organic Framework Membranes

Xiuxiu Guo,† Tianhui Mao,† Zifang Wang,‡§ Peng Cheng,‡§ Yao Chen,† Shengqian Ma⊥ and Zhenjie Zhang*,†,‡,§

† State Key Laboratory of Medicinal Chemical biology, College of Chemistry, Nankai University, Tianjin 300071, China
‡ Renewable energy conversion and storage center, Nankai University, Tianjin 300071, China
§ Key Laboratory of Advanced Energy Materials Chemistry, Ministry of Education, Nankai University, Tianjin 300071, China
⊥ Department of Chemistry, University of South Florida, 4202 E. Fowler Avenue, Tampa, Florida 33620, United States
Section S1. Materials and Methods

General information
All reagents and solvents were purchased from commercial sources and used without further purification. Unless otherwise noted, all reactions were performed at ambient laboratory conditions.

Nuclear magnetic resonance spectroscopy (NMR)
\(^1\)H NMR and \(^{13}\)C NMR spectra was recorded on Bruker AV400 instruments at 400 MHz.

Solid-state \(^{13}\)C cross-polarization magic-angle-spinning (CP/MAS) NMR spectroscopy
The \(^{13}\)C CP/MAS NMR spectra were obtained on a Varian 300 MHz Solid State Infinityplus 300 NMR spectrometer.

Powder X-ray diffraction (PXRD) measurements
PXRD were recorded on a D/Max-2500 X-ray diffractometer using Cu-K\(\alpha\) radiation by depositing powder on glass substrate, from 2\(\theta\) = 2° up to 30° with 0.2° increment.

Gas sorption measurements
The adsorption measurements of gas were performed using a Micromeritics ASAP 2460. Before measurement, the samples were degassed in vacuum at 120 °C for 12 h.

Fourier transform infrared spectra (FT-IR)
FT-IR spectra were recorded on Nicolet iS 50 ATR-FTIR instrument. In situ FT-IR spectra were recorded on Bruker ALPHA II instrument.

Scanning electron microscopy (SEM)
A Hitachi SU3500 SEM instrument was used for acquiring images using a 30 kV energy source under vacuum.

Raman spectra
Raman spectra were collected using a confocal microscope (Horiba LabRAM HR Evolution) with an excitation wavelength of 633 nm, 10 \(\times\) objective, a monochromator (600 and 1800 grooves per mm grating), and an EM-CCD (Synapse EM).

X-ray photoelectron spectroscopy (XPS)
XPS measurement was performed with a Axis Ultra DLD spectrometer (Kratos Analytical Ltd).

LED lamp
All the light irradiation using UV light with \(\lambda_{\text{irr}} = 370\) nm (288 mW/cm\(^2\), Kessil) and blue light LED lamp with \(\lambda_{\text{irr}} = 440\) nm (288 mW/cm\(^2\), Kessil).
Section S2. Synthesis of Compounds and COFs

Synthesis of 1,3,5-triformylbenzene (TB)

1,3,5-triformylbenzene was synthesized according to a previously reported procedure.\textsuperscript{1} \textsuperscript{1}H NMR (400 MHz, DMSO) δ 10.22 (s, 3H), 8.70 (s, 3H). \textsuperscript{13}C NMR (101 MHz, DMSO) δ 192.62, 137.82, 134.93.

Synthesis of 2,5-diethoxy-terephthalohydrazide (DTH)

2,5-diethoxy-terephthalohydrazide (DTH) was synthesized according to the literature.\textsuperscript{2} \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 9.20 (s, 2H), 7.85 (s, 2H), 4.26 (q, \textit{J} = 7.0 Hz, 4H), 4.18 (s, 4H), 1.51 (t, \textit{J} = 7.0 Hz, 6H).

Synthesis of dimethyl 2-hydroxyterephthalate

2-hydroxyterephthalic acid was synthesized according to the literature.\textsuperscript{3} Yield: 3.4 g (85%). \textsuperscript{1}H NMR (400 MHz, DMSO) δ 13.35 (s, 1H), 7.88 (d, \textit{J} = 8.1 Hz, 1H), 7.47 – 7.39 (m, 2H). \textsuperscript{13}C NMR (101 MHz, DMSO) δ 166.90, 161.09, 137.03, 131.12, 119.79, 118.08.

Dimethyl 2-hydroxyterephthalate was synthesized according to the literature.\textsuperscript{4} Yield: 0.83 g (72%). \textsuperscript{1}H NMR (400 MHz, DMSO) δ 10.59 (s, 1H), 7.85 (d, \textit{J} = 8.2 Hz, 1H), 7.59 – 7.39 (m, 2H), 3.88 (d, \textit{J} = 8.7 Hz, 6H).

Synthesis of DTH-dimer-150

![](image)

Dimethyl 2-hydroxyterephthalate (1.1 g, 5.2 mmol), 1,2-bis(2-bromoethoxy)ethane (1.07 g, 3.9 mmol) and K\textsubscript{2}CO\textsubscript{3} (2.2 g, 16 mmol) was added into a schlenk flask. Subsequently, 35 mL of acetone was added under N\textsubscript{2} atmosphere. The reaction mixture was heated to reflux with stirring for 24 h. After cooling the reaction to room temperature, acetone was removed under vacuum. The crude solid was extracted with ethyl acetate and washed with H\textsubscript{2}O and brine. The organic layers was combined, dried over anhydrous MgSO\textsubscript{4}, and purified by using silica gel chromatography with hexane/EtOAc as eluent to afford DTH-dimer-150-ester as a yellow solid. Yield: 0.503 g (36%). \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) δ 7.81 (d, \textit{J} = 8.3 Hz, 2H), 7.65 (dt, \textit{J} = 4.4, 1.4 Hz, 4H), 4.31 – 4.24 (m, 4H), 4.01 – 3.92 (m, 10H), 3.90 (s, 6H), 3.81 (s, 4H). The product of DTH-dimer-150-ester was dissolved in 30.0 mL of ethanol and 2.4 mL of hydrazine hydrate. The mixture was stirred and heated to 90 °C for 48 h. After cooling to room temperature, the resulting white precipitate was collected by centrifugation and washed with ethanol to yield DTH-dimer-150 as a white solid. Yield: 494 mg (46%). \textsuperscript{1}H NMR (400 MHz, DMSO) δ 9.88 (s, 2H), 9.28 (s, 2H), 7.79 (d, \textit{J} = 8.0 Hz, 2H), 7.57 – 7.40 (m, 4H), 4.56 (d, \textit{J} = 12.0 Hz, 8H), 4.33 – 4.23 (m, 4H), 3.87 – 3.79 (m, 4H), 3.72 (s, 4H). \textsuperscript{13}C NMR (101 MHz, DMSO) δ 165.30, 164.42,
PEG-400 (24.0 g, 60 mmol) and tosyl chloride (28.6 g, 150 mmol) were suspended in 150.0 mL of THF and cooled down to 0 °C. KOH (13.5 g, 240 mmol) was dissolved in 30.0 mL of water and then slowly added. The reaction mixture was stirred at room temperature for 24 h. The volatiles were removed via vacuuming, and the residue was extracted with ethyl acetate and washed with brine. The organic phase was dried over anhydrous MgSO₄ and evaporated under reduced pressure to afford 1 as a pale-yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.80 (d, J = 8.2 Hz, 4H), 7.34 (d, J = 8.1 Hz, 4H), 4.18 – 4.13 (m, 4H), 3.72 – 3.54 (m, 25H), 2.45 (s, 6H). ¹³C NMR (101 MHz, CDCl₃) δ 144.85, 132.91, 129.85, 127.96, 70.70, 70.56, 70.51, 70.46, 69.29, 68.64, 21.65.

Dimethyl 2-hydroxyterephthalate (5.04 g, 24 mmol), 1 (5.66 g, 8 mmol) and K₂CO₃ (4.4 g, 32 mmol) was charged into a schlenk flask. Subsequently, 70.0 mL of acetone was added under N₂ atmosphere. The reaction mixture was heated to reflux with stirring for 48 h. After cooling the reaction to room temperature, acetone was removed under vacuum. The crude solid was extracted with ethyl acetate and washed with sodium hydroxide solution. The organic layers was combined, dried over anhydrous MgSO₄, and purified by using silica gel chromatography with CH₂Cl₂/EtOAc as eluent to afford DTH-dimer-400-ester as a pale-yellow oil. ¹H NMR (400 MHz, DMSO) δ 7.73 (d, J = 7.9 Hz, 2H), 7.66 – 7.48 (m, 4H), 4.22 (d, J = 3.3 Hz, 4H), 3.88 (s, 6H), 3.81 (s, 6H), 3.76 (s, 4H), 3.63 – 3.59 (m, 4H), 3.56 – 3.45 (m, 16H).

The product of DTH-dimer-400-ester was dissolved in 100.0 mL of ethanol and 4.0 mL of hydrazine hydrate. The mixture was stirred and heated to 90 °C for 48 h. After cooling to room temperature, the resulting yellow solid was collected by a rotavap. ¹H NMR (400 MHz, DMSO) δ 9.90 (s, 2H), 9.29 (s, 2H), 7.81 (d, J = 8.0 Hz, 2H), 7.57 – 7.43 (m, 4H), 4.59 (s, 8H), 4.29 (s, 4H), 3.81 (s, 5H), 3.66 – 3.53 (m, 11H), 3.52 – 3.46 (m, 18H). ¹³C NMR (101 MHz, DMSO) δ 165.28, 164.26, 156.31, 137.03, 130.93, 124.69, 120.08, 112.51, 70.33, 70.22, 70.18, 68.85, 68.78.

**Synthesis of DTH-dimer-600**
PEG-600 (36.0 g, 60 mmol) and tosyl chloride (28.6 g, 150 mmol) were suspended in 150.0 mL of THF and cooled down to 0 °C. KOH (13.5 g, 240 mmol) was dissolved in 30.0 mL of water and then slowly added. The reaction mixture was stirred at room temperature for 24 h. The volatiles were removed via vacuuming, and the residue was extracted with ethyl acetate and washed with brine. The organic phase was dried over anhydrous MgSO₄ and evaporated under reduced pressure to afford 2 as a colorless oil. ¹H NMR (400 MHz, CDCl₃) δ 7.82 (d, J = 8.3 Hz, 4H), 7.36 (d, J = 8.0 Hz, 4H), 4.20 – 4.15 (m, 4H), 3.73 – 3.58 (m, 52H), 2.47 (s, 6H). ¹³C NMR (101 MHz, CDCl₃) δ 144.82, 132.93, 129.84, 127.97, 70.70, 70.57, 70.51, 70.47, 69.27, 68.65, 21.65.

Dimethyl 2-hydroxyterephthalate (5.04 g, 24 mmol), 2 (7.26 g, 8 mmol) and K₂CO₃ (4.4 g, 32 mmol) was charged into a schlenk flask. Subsequently, 70.0 mL of acetone was added under N₂ atmosphere. The reaction mixture was heated to reflux with stirring for 48 h. After cooling the reaction to room temperature, acetone was removed under vacuum. The crude solid was extracted with ethyl acetate and washed with sodium hydroxide solution. The organic layers was combined, dried over anhydrous MgSO₄, and purified by using silica gel chromatography with CH₂Cl₂/EtOAc as eluent to afford DTH-dimer-600-ester as a yellow oil. ¹H NMR (400 MHz, DMSO) δ 7.74 (d, J = 7.9 Hz, 2H), 7.67 – 7.52 (m, 4H), 4.27 – 4.19 (m, 4H), 3.88 (s, 6H), 3.82 (s, 6H), 3.79 – 3.73 (m, 4H), 3.64 – 3.60 (m, 4H), 3.56 – 3.45 (m, 34H).

The product of DTH-dimer-600-ester was dissolved in 100.0 mL of ethanol and 4.0 mL of hydrazine hydrate. The mixture was stirred and heated to 90 °C for 48 h. After cooling to room temperature, the resulting yellow oil was collected by a rotavap. ¹H NMR (400 MHz, DMSO) δ 9.90 (s, 2H), 9.29 (s, 2H), 7.82 (d, J = 8.0 Hz, 2H), 7.51 (dd, J = 17.1, 9.1 Hz, 4H), 4.58 (s, 8H), 4.33 – 4.28 (m, 4H), 3.85 – 3.79 (m, 4H), 3.60 (dd, J = 20.9, 11.8, 9.3 Hz, 11H), 3.54 – 3.47 (m, 38H). ¹³C NMR (101 MHz, DMSO) δ 165.26, 164.24, 156.32, 137.03, 130.93, 124.68, 120.08, 112.51, 70.34, 70.25, 70.23, 70.21, 68.86, 68.79.

Synthesis of DTH-dimer-800
PEG-800 (12.0 g, 15 mmol) and tosyl chloride (7.15 g, 37.5 mmol) were suspended in 40.0 mL of THF and cooled down to 0 °C. KOH (3.36 g, 60 mmol) was dissolved in 15.0 mL of water and then slowly added. The reaction mixture was stirred at room temperature for 24 h. The volatiles were removed via vacuuming, and the residue was extracted with ethyl acetate and washed with brine. The organic phase was dried over anhydrous MgSO$_4$ and evaporated under reduced pressure to afford 3 as a colorless oil.

Dimethyl 2-hydroxyterephthalate (5.04 g, 24 mmol), 3 (8.87 g, 8 mmol) and K$_2$CO$_3$ (4.4 g, 32 mmol) was charged into a schlenk flask. Subsequently, 70.0 mL of acetone was added under N$_2$ atmosphere. The reaction mixture was heated to reflux with stirring for 48 h. After cooling the reaction to room temperature, acetone was removed under vacuum. The crude solid was extracted with ethyl acetate and washed with sodium hydroxide solution. The organic layers were combined, dried over anhydrous MgSO$_4$, and purified by using silica gel chromatography with hexane/EtOAc as eluent to afford DTH-dimer-800-ester as a yellow oil.

DTH-dimer-800-ester (2.2 g, 1.85 mmol) and hydrazine hydrate (3.7 g, 74 mmol) was dissolved in 30 mL of ethanol. The mixture was stirred and heated to 90 °C for 48 h. After cooling to room temperature, the resulting yellow oil was collected by a rotavap. $^1$H NMR (400 MHz, DMSO) $\delta$ 9.91 (s, 2H), 9.31 (d, $J = 13.4$ Hz, 2H), 7.83 (t, $J = 6.2$ Hz, 2H), 7.57 – 7.48 (m, 4H), 4.48 (d, $J = 91.9$ Hz, 8H), 4.33 – 4.28 (m, 4H), 3.86 – 3.78 (m, 5H), 3.62 (dq, $J = 5.7, 3.1$ Hz, 9H), 3.49 (dd, $J = 3.4, 1.6$ Hz, 59H). $^{13}$C NMR (101 MHz, DMSO) $\delta$ 165.24, 164.23, 156.32, 137.03, 130.93, 124.67, 120.08, 112.52, 70.34, 70.25, 70.22, 68.86, 68.79.

**Synthesis of the model compound**
In a 100 mL round bottom flask, DTH-dimer-150 (0.08 g, 0.15 mmol) was dissolved in methanol (40.0 mL). Then benzaldehyde (0.054 g, 0.51 mmol) was added slowly, and the mixture was refluxed at 70 °C for 24 h. After cooling to room temperature, the resulting precipitate was collected by centrifugation and washed with MeOH to yield the product as a white solid. $^1$H NMR (400 MHz, DMSO-d$_6$) $\delta$ 11.95 (s, 2H), 11.52 (s, 2H), 8.50 (d, $J = 5.3$ Hz, 2H), 8.27 (s, 2H), 7.89 – 7.26 (m, 27H), 4.43 – 4.15 (m, 4H), 3.82 (s, 4H), 3.66 (s, 3H).

**Synthesis of PEG-COF-42 membranes**

PEG-COF-42 membranes were synthesized in a 25 mL glass beaker. Firstly, 0.0375 mmol of DTH-dimer dissolved in the mixture solvent of 1.0 mL of H$_2$O and 1.0 mL of dioxane was added as a bottom layer in the beaker. TB (0.025 mmol, 4.0 mg) and 525 µL of CH$_3$COOH were dissolved in 3.0 mL of mesitylene was slowly added on the top of the hydrazine layer. The system was kept at room temperature for 48 h without disturbance. The membranes were formed at the interface and then transferred into CH$_3$OH. The membranes were washed with CH$_3$OH in a Soxhlet extractor for 48 h and then dried by a surpercritical carbon dioxide dryer.
Synthesis of Reference COFs

The COF-42 membrane was synthesized according to the literature.\textsuperscript{5}

TB-Th COF was synthesized according to the literature method but with some modification.\textsuperscript{6}
Pyrex tube was charged with 1,3,5-triformylbenzene (8.1 mg, 0.05 mmol), terephthalohydrazide (14.5 mg, 0.075 mmol), 1,2-dichlorobenzene (0.5 mL), 1-butanol (0.5 mL) and 3 M aqueous acetic acid (0.1 mL). The mixture was firstly sonicated for 15-20 minutes in order to get a homogenous dispersion. The tube was then flash frozen at 77 K (liquid N\textsubscript{2} bath) and degassed by three freeze-pump-thaw cycles. The tube was sealed under vacuum and then placed in an oven at 120 °C for 72 h. After the reaction, the TB-Th COF powders were filtered and washed with THF. Then it dried at 120 °C under vacuum for 12 h to give a white powder.

DFDM-THz COF was synthesized according to the literature.\textsuperscript{7}

Poly\textsubscript{35/6}COF-42 was synthesized according the literature.\textsuperscript{5}
S2. Supplementary Figures and tables

Figure S1. The photographs showing the process to prepare COF-42 and PEG-COF-42 membranes.

COF-42 membrane was not transparent, while PEG-COF-42 membranes are transparent.

Figure S2. PXRD patterns of COF-42, PEG-COF-42 and amorphous products formed by DTH-dimer-150 and DTH-dimer-800.
Figure S3. (a) Proposed structure of PEG-COF-42 and list the calculated length for PEG-150, PEG-400, PEG-600 and PEG-800 with ideal straight chains. For PEG-150, the length is too short to connect the two sides of the hexagonal channel, while PEG-800 is too long to be accommodated by the pore space of the hexagonal channels. (b) Cartoon representation of the possible location of PEG chains in PEG-COF-42. Beside of the ideal intralayer cross-linking modes, it should be noted that the cross-linking of different COF layers by PEG is also possible.
Figure S4. (a) N₂ sorption isotherms of COF-42 and PEG-COF-42 at 77 K. (b) Pore size distribution of COF-42 and PEG₄₀₀-COF-42. (c) FT-IR spectra of COF-42 and PEG-COF-42.

Figure S5. Top view and cross-section SEM images of COF-42 and PEG-COF-42 membranes.
Table S1. Comparison of the mechanical properties of PEG-COF-42 vs. reported COFs membranes.

| Sample               | Ultimate Stress (MPa) | Reference                                      |
|----------------------|-----------------------|-----------------------------------------------|
| COF-42               | 0.27                  |                                               |
| PEG<sub>400</sub>-COF-42 | 28                    | This work                                     |
| PEG<sub>600</sub>-COF-42 | 32                    |                                               |
| poly<sub>1/6</sub>COF-42 | 7                     |                                               |
| poly<sub>2/6</sub>COF-42 | 32                    |                                               |
| poly<sub>3/6</sub>COF-42 | 42                    | ACS Cent. Sci. 2019, 5, 8, 1352-1359          |
| poly<sub>4/6</sub>COF-42 | 33                    |                                               |
| poly<sub>5/6</sub>COF-42 | 24                    |                                               |
| polyPEG-400          | 19                    |                                               |
| PTSA@TpAzoCPFM       | 17                    | Angew. Chem. Int. Ed. 2018, 57, 10894-10898   |
| TpPa-1               | 20.8                  |                                               |
| TpBD                 | 21.2                  | Nat. Commun., 2019, 10, 2101                 |
| TpHZ                 | 14.6                  |                                               |
| TpBD(OH)<sub>2</sub> | 25.3                  |                                               |
| Tp-Bpy               | No detectable         | J. Am. Chem. Soc. 2017, 139, 37, 13083-13091 |
| DaTp                 | 12                    | ACS Appl. Matter. Interfaces, 2018, 10 28139-28146 |
| D<sub>q1</sub>D<sub>a1</sub>Tp | 7                     |                                               |
| D_{q1}D_{a2}Tp | 6 |
|---------------|---|
| D_{q}Tp       | 2 |
| TAPB-PDA COF  | No detectable | Our result |

**Figure S6.** Illustration of the photoresponsive bending behavior of PEG-COF-42.

**Figure S7.** Solid-sate UV-Vis absorption spectra of COF-42 and PEG-COF-42.
Figure S8. (a) Illustration of the vapor-responsive bending behavior of PEG$_{400}$-COF-42. (b) The repeatability of the reversible bending of PEG$_{400}$-COF-42 membrane (20 mm × 3 mm × 12 μm) exposure to acetone vapor.

Figure S9. The repeatability of the reversible bending of PEG$_{600}$-COF-42 membrane (14 mm × 3 mm × 14 μm) exposure to acetone vapor.
Figure S10. Top view (a) and cross-section (b) SEM images of PEG\textsubscript{400}-COF-42 before and after UV irradiation. The result indicated there was no obvious physical damage for the membrane.

Figure S11. Solid-State $^{13}$C NMR of PEG\textsubscript{400}-COF-42 before and after UV irradiation.
**Figure S12.** PXRD patterns of PEG\textsubscript{400}-COF-42 before and after UV irradiation. The existence of the characteristic of PEG\textsubscript{400}-COF-42 after UV irradiation is possibly because only the membrane close to UV light conducted the photoreaction.

**Figure S13.** Fluorescence spectral changes of PEG\textsubscript{400}-COF-42 before and after UV irradiation. The excitation wavelength is 365 nm.
Figure S14. The absorbance changes of the characteristic peak (1540 cm\(^{-1}\)) in PEG\(_{400}\)-COF-42 under UV irradiation measured by in-situ FT-IR.

Figure S15. Raman spectra of PEG\(_{400}\)-COF-42 before and after UV irradiation.
Figure S16. The absorbance changes of the characteristic peak (1540 cm$^{-1}$) in PEG$_{400}$-COF-42(Z) heated at 100 °C measured by in-situ FT-IR.

Figure S17. O 1s and C 1s signals of XPS for PEG$_{400}$-COF-42 before (a,c) and after (b,d) UV irradiation. For O 1s signals, the intensity of C=O obviously decreased compared with that of C-O. For all C 1s signals, there is no obvious difference observed before and after UV irradiation.
Figure S18. PXRD pattern of COF-42 compared with simulated pattern.

Figure S19. PXRD pattern of TB-Th COF compared with simulated pattern.
Figure S20. PXRD pattern of DFDM-THz COF compared with simulated pattern.

Figure S21. FT-IR spectra of TB-Th COF before and after UV irradiation.
Figure S22. FT-IR spectra of DFDM-THz COF before and after UV irradiation.

Figure S23. FT-IR spectra of the model compound before and after UV irradiation. The result indicated the framework structure of COFs is necessary for the photo-induced isomerization.
Figure S24. Solid state UV-Vis absorption spectra of COF-42 before and after UV irradiation.

Figure S25. FT-IR spectra of COF-42 membranes before and after UV irradiation.
**Figure S26.** Fluorescence spectral changes of COF-42 before and after UV irradiation. The excitation wavelength is 400 nm.

**Figure S27.** O 1s and N 1s signals of XPS for COF-42 before (a,c) and after (b,d) UV irradiation. For O 1s signals, the intensity of C=O obviously decreased compared with that of C-O. For C 1s signals, there is no obvious difference observed before and after UV irradiation.
Figure S28. The photographs of COF-42 membrane under UV irradiation for 12 h. There is no bending behavior observed during the light irradiation.

Supplementary references
(1) Lauer, J. C.; Zhang, W.-S.; Rominger, F.; Schröder, R. R.; Mastalerz, M. Shape-Persistent [4+4] Imine Cages with a Truncated Tetrahedral Geometry. Chem. Eur. J. 2018, 24, 1816–1820.
(2) Uribe-Romo, F. J.; Doonan, C. J.; Furukawa, H.; Oisaki, K.; Yaghi, O. M. Crystalline Covalent Organic Frameworks with Hydrazone Linkages. J. Am. Chem. Soc. 2011, 133, 11478–11481.
(3) Himsl, D.; Wallacher, D.; Hartmann, M. Improving the Hydrogen-Adsorption Properties of a Hydroxy-Modified MIL-53(Al) Structural Analogue by Lithium Doping. Angew. Chem., Int. Ed. 2009, 48, 4639–4642.
(4) Tanabe, K. K.; Allen, C. A.; Cohen, S. M. Photochemical Activation of a Metal-Organic Framework to Reveal Functionality. Angew. Chem., Int. Ed. 2010, 49, 9730–9733.
(5) Wang, Z.; Yu, Q.; Huang, Y.; An, H.; Zhao, Y.; Feng, Y.; Li, X.; Shi, X.; Liang, J.; Pan, F.; Cheng, P.; Chen, Y.; Ma, S.; Zhang, Z., PolyCOFs: A New Class of Freestanding Responsive Covalent Organic Framework Membranes with High Mechanical Performance. ACS Cent. Sci. 2019, 5, 1352–1359.
(6) Wu, M.; Chen, G.; Liu, P.; Zhou, W.; Jia, Q. Polydopamine-Based Immobilization of a Hydrazone Covalent Organic Framework for Headspace Solid-Phase Microextraction of Pyrethroids in Vegetables and Fruits. J. Chromatogr. A 2016, 1456, 34–41.
(7) Li, X.; Gao, Q.; Wang, J.; Chen, Y.; Chen, Z. H.; Xu, H. S.; Tang, W.; Leng, K.; Ning, G. H.; Wu, J.; Xu, Q. H.; Quek, S. Y.; Lu, Y.; Loh, K. P. Tuneable Near White-Emissive Two-Dimensional Covalent Organic Frameworks. Nat. Commun. 2018, 9, 2335–2343.