Supporting information for Rapidly, sensitively and reliably monitoring trace organochlorine pesticides with self-supporting fluorine - functionalized covalent organic framework membrane in water

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1 Experimental Sections

1.1 Main chemical reagents and experimental instruments

The main chemicals involved in this experiment, their grades and manufacturers are shown in Table S1.

Table S1 List of chemicals and reagents

Drugs	Specification	Manufacturer
TFTA	97%	Shanghai Aladdin Biochemical Technology Co., Ltd
TAPB	97%	Shanghai Maclean's Biochemical Technology Co., Ltd
PAN	Mw 85000	Shanghai Aladdin Biochemical Technology Co., Ltd
DMF	99%	Shanghai Aladdin Biochemical Technology Co., Ltd
ACN	99%	Shanghai Maclean's Biochemical Technology Co., Ltd
HAc	99.50%	Shanghai Aladdin Biochemical Technology Co., Ltd
Acetone	≥ 99.5%	Sinopharm Chemical Reagent Co., Ltd
Sodium hydroxide (flakes)	≥ 96.0%	Sinopharm Chemical Reagent Co., Ltd
HCl	36.0~38.0%	Sinopharm Chemical Reagent Co., Ltd
MtOH	≥ 99.7%	Sinopharm Chemical Reagent Co., Ltd
THF	99%	Sinopharm Chemical Reagent Co., Ltd
N-hexane	色谱纯	Shanghai Aladdin Biochemical Technology Co., Ltd
NaCl	99.50%	Shanghai Aladdin Biochemical Technology Co., Ltd

Table S1, continued List of chemicals and reagents

Drugs	Specification	Manufacturer
OCPs	500 μg mL^{-1}	Beijing Wanjia Shouhua Biotechnology Co., Ltd
Type 304 stainless steel wire	0.3 mm	VATS Stainless Steel Materials Co., Ltd
GC microsampler	5 μL	Shanghai Gaoge Industry and Trade Co., Ltd

The organochlorine pesticide mixture solution contains 20 OCPs homologues, and their detailed names and physicochemical properties are shown in Table S2.

Table S2 Compound names and physicochemical properties of organochlorine pesticides

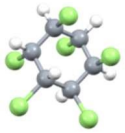
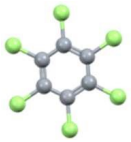
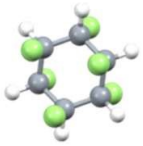
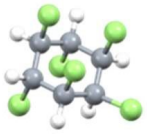
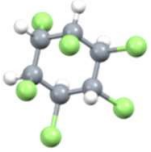
Analytes	Molecular Formula	Molecular Weight（g mol^{-1}）	Chemical Structure	Boiling Point（℃）	Log Kow
α-BHC	$C_6H_6Cl_6$	290.83		288.0±0.0	4.26
Hexachlorobenznze	C_6Cl_6	284.78		324.5±0.0	5.86
β-BHC	$C_6H_6Cl_6$	290.83		288.0±0.0	4.26
γ-BHC	$C_6H_6Cl_6$	290.83		288.0±0.0	4.26
σ-BHC	$C_6H_6Cl_6$	290.83		288.0±0.0	4.26

Table S2, continued Compound names and physicochemical properties of organochlorine pesticides

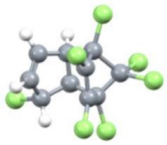
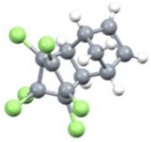
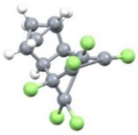
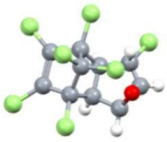
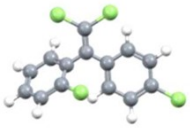
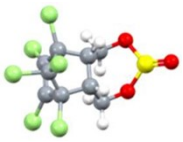
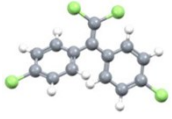
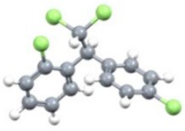
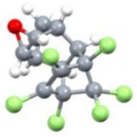
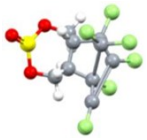
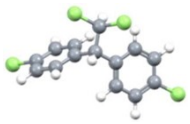
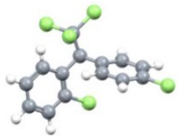
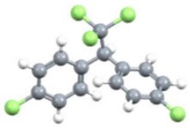
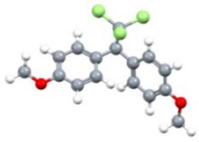
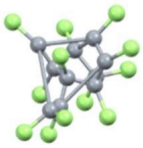
Analytes	Molecular Formula	Molecular Weight (g mol^{-1})	Chemical Structure	Boiling Point (℃)	Log Kow
Heptachlor	$C_{10}H_5Cl_7$	373.32		392.3±42.0	4.56
Aldrin	$C_{12}H_8Cl_6$	364.91		384.9±42.0	6.75
Isodrin	$C_{12}H_8Cl_6$	364.91		384.9±42.0	5.86
Heptachlor epoxide	$C_{10}H_5Cl_7O$	389.32		425.5±45.0	6.5
o, p'-DDE	$C_{14}H_8Cl_4$	318.03		380.6±37.0	6
Endosulfan I	$C_9H_6Cl_6O_3S$	406.93		449.7±45.0	/
p, p'-DDE	$C_{14}H_8Cl_4$	318.03		383.1±37.0	6
o, p'-DDD	$C_{14}H_{10}Cl_4$	320.04		398.9±37.0	5.87

Table S2, continued Compound names and physicochemical properties of organochlorine pesticides

Analytes	Molecular Formula	Molecular Weight (g mol^{-1})	Chemical Structure	Boiling Point (℃)	Log Kow
Endrin	$C_{12}H_8Cl_6O$	380.91		416.2±45.0	5.45
Endosulfan II	$C_9H_6Cl_6O_3S$	406.93		449.7±45.0	3.5
p, p'-DDD	$C_{14}H_{10}Cl_4$	320.04		405.7±40.0	5.87
o, p'-DDT	$C_{14}H_9Cl_5$	354.49		409.6±40.0	6.79
p, p'-DDT	$C_{14}H_9Cl_5$	354.49		416.2±40.0	6.79
Methoxychlor	$C_{16}H_{15}Cl_3O_2$	345.65		436.2±45.0	5.67
Mirex	$C_{10}Cl_{12}$	545.54		421.1±40.0	/

The detailed information of the various instruments, models and manufacturers used in the experimental process in this paper is shown in Table S3.

Table S3 Summary of experimental instruments

Instrument name	Model	Manufacturer
Magnetic stirrer	Color squid	Instrument GmbH of IKA GmbH, Germany
Thermostatic magnetic heating stirrer	RCT basic	Instrument GmbH of IKA GmbH, Germany
Electric blast drying oven	DHG-9053A	Wuxi Marit Technology Co., Ltd
Electrospinning machine	ET-2535H	Beijing Yongkang Leye Technology Development Company
Micro vortex mixer	VM-M1	Shanghai Titan Technology Co., Ltd
Tabletop high-speed centrifuge	H2-16K	Hunan Kecheng Instrument Equipment Co., Ltd
Vacuum drying oven	DZF-6050	Shanghai Jinghong Experimental Equipment Co., Ltd
Gas chromatography-mass spectrometer	GCMS-QP2020 NX	Shimadzu Scientific Equipment Co., Ltd., Japan

1.2 Preparation of functional materials

1.2.1 Preparation of self-supporting F-COF membranes

This chapter details the preparation of self-supporting fluorinated covalent organic framework (F-COF) nanofibrous membranes through an electrospinning process combined with a polymer sacrificial template strategy. Using 1,3,5-tris(4-aminophenyl) benzene (TAPB) and 2,3,5,6-tetrafluoroterephthalaldehyde (TFTA) as monomers, the membranes were synthesized via in situ polymerization, exhibiting high crystallinity and excellent flexibility.

1.2.1.1 Preparation of PAN/TAPB electrospun nanofibrous membranes

A homogeneous PAN/TAPB spinning solution was prepared by adding 0.75 g of PAN powder and 0.2 g of TAPB into a beaker containing 6 mL of DMF. The mixture was ultrasonically dispersed for 10 min and then magnetically stirred at room

temperature for 5 h to achieve uniformity. The blended spinning solution was drawn into a 5 mL syringe equipped with a 21 G (0.21 mm) metal needle and mounted onto an electrospinning device. During the electrospinning process, the ejection height was set to 43.5 cm, with the distance between the receiver and needle maintained at 20 cm. Silicone-free paper was attached to the roller for membrane collection. The 0.21 mm (21 G) metal needle and aluminum foil-covered roller receiver (60 rpm) were connected to the positive and negative terminals of the power supply, respectively, with the voltage adjusted to 15 kV. Additional parameters included an injection speed of 0.09 mm min^{-1}, translation speed of 200 mm min^{-1}, ambient temperature of 30°C, and relative humidity of 30%. Continuous electrospinning was conducted for 6 h. Subsequently, the PAN/TAPB fibrous membrane was removed from the roller collector and vacuum-dried at 60°C for 12 h to eliminate residual solvents on the membrane surface.

1.2.1.2 Preparation of PAN/F-COF nanofiber membranes

Exactly 105.45 mg of TFTA powder was dissolved in 30 mL of acetonitrile and ultrasonicated for 5 min to achieve homogeneous dispersion. To this solution, 1.8 mL of glacial acetic acid was added as a catalyst, followed by vortex mixing for 30 s. Subsequently, 100 mg of PAN/TAPB electrospun fibrous membrane was introduced to initiate the Schiff base reaction between TFTA and TAPB immobilized on the PAN/TAPB electrospun nanofibrous membrane. The mixture was sealed and allowed to react at room temperature for 24 h. Post-reaction, the nanofibrous membrane was separated from the solution, thoroughly washed sequentially with acetonitrile and anhydrous ethanol, and vacuum-dried at 60°C for 12 h to yield the final product.

1.2.1.3 Preparation of fluorinated F-COF nanofiber membranes

A 100 mg PAN/F-COF fibrous membrane sample was wrapped in filter paper and placed into an extraction thimble. A round-bottom flask containing 150 mL of DMF was assembled on an oil bath with several boiling chips, and the Soxhlet extraction apparatus was configured. Continuous extraction proceeded at 165°C for 24 h to completely remove PAN from the membrane. The resulting membrane was thoroughly rinsed with ultrapure water to eliminate residual solvents and vacuum-dried at 80°C for

12 h, yielding a golden-yellow free-standing porous COF membrane designated as F-COF.

1.2.2 Preparation of F-COF powder

The synthesis of F-COF powder was conducted as follows. TFTA (0.3 mmol, 61.9 mg), TAPB (0.2 mmol, 70.3 mg), and DMF (4 mL) were added to a beaker containing 30 mL of acetonitrile (ACN). The mixture was ultrasonicated for 5 min to ensure homogeneity, followed by the addition of glacial acetic acid (1.8 mL) as a catalytic agent. Vigorous shaking was performed until the solution transitioned to a bright yellow hue, after which it was left undisturbed at room temperature for 24 h. Upon reaction completion, the precipitated powder was collected via high-speed centrifugation and sequentially washed four times with acetonitrile and anhydrous ethanol. Purification was achieved through Soxhlet extraction with tetrahydrofuran (THF) for 24 h to remove unreacted TFTA and TAPB monomers. The resulting product was vacuum-dried at 60°C for 12 h, yielding a pale-yellow powder designated as F-COF.

1.3 Enrichment experiments

1.3.1 Preparation of F-COF film-coated SPME fibers

The homemade SPME device was constructed from a modified 5 μL syringe through the following protocol. First, the distal end (≈2 cm length) of a stainless-steel wire was immersed in aqua regia at room temperature for 10 min to achieve surface etching. The etched wire was ultrasonically cleaned sequentially with acetone, ethanol, and ultrapure water (10 min each) to remove contaminants, followed by drying at 80°C for 1 h. A thin layer of polyimide sealant resin was uniformly applied to the etched wire, which was then gently rotated within the prepared F-COF membrane (non-fluorinated COF, PAN/F-COF, or PAN/TAPB membranes) to achieve the desired coating thickness. The F-COF-coated fiber was thermally cured at 150°C for 3 h and

assembled into the 5 μL syringe. Finally, the custom SPME fiber was conditioned in the GC injection port at 260°C for 2 h to stabilize and purify the coating.

1.3.2 Preparation of organochlorine pesticide standard working solution

A stock solution containing 20 organochlorine pesticide congeners (500 mg L^{-1}) was vortex-mixed for 30 s to ensure homogeneity. A specific aliquot of this stock was transferred to a 10 mL volumetric flask, and serial dilutions were performed using n-hexane as the solvent to prepare mixed standard stock solutions at concentrations of 50, 5, and 0.5 mg L^{-1}. The prepared stock solutions were stored sealed at 4°C for subsequent use. For SPME experiments, the stock solutions were diluted with ultrapure water to desired concentrations, yielding OCPs standard working solutions. This protocol ensured precise analyte concentrations while maintaining chemical stability throughout the analytical workflow.

1.3.3 Solid-phase microextraction procedure

All enrichment experiments were conducted using the direct immersion solid-phase microextraction (DI-SPME) mode. A 20 mL OCPs mixed standard working solution (0.0005 mg L^{-1}) was prepared and transferred into a 25 mL headspace vial placed on a magnetic stirrer. The SPME device needle was vertically inserted through the septum of the sealed vial, and the coated fiber was slowly extended to ensure complete immersion in the working solution. Extraction proceeded for 40 min under magnetic stirring at 40°C and 600 rpm. Following extraction, the fiber was retracted into the needle and immediately inserted into the GC-MS injection port for thermal desorption at 250°C for 6 min. Subsequent GC-MS analysis enabled the separation and detection of 20 OCP congeners. To eliminate residual carryover and memory effects, the coated fiber was conditioned in the GC injection port at 250°C for 5 min between consecutive SPME runs.

1.3.4 Optimization of extraction conditions

Based on prior research, key operational parameters in the SPME process significantly influence the extraction efficiency of F-COF membrane coatings toward OCPs. To establish optimal experimental conditions, a systematic optimization study was conducted, focusing on six critical variables: desorption time (3–7 min), extraction temperature (30–60°C), extraction duration (20–50 min), agitation speed (400–800 rpm), solution pH (2–10), and ionic strength (0–20% w/v). All optimizations were performed using a target OCPs concentration of 0.0005 mg L^{-1}.

Initial experimental parameters were set as follows: 30-min extraction at 40°C with 500 rpm agitation, 6-min desorption time, 0% ionic strength (w/v), and neutral pH.

1.3.5 Stability experiments

1.3.5.1 Thermal stability analysis

Samples of PAN membrane, PAN/TAPB membrane, PAN/F-COF membrane, F-COF membrane, and F-COF powder were subjected to thermogravimetric analysis. Prior to testing, all samples were dried in an oven at 80°C for 12 h to ensure complete moisture removal. For each measurement, 20 mg of the sample was placed in a flowing crucible under a nitrogen atmosphere. The temperature program was executed at a heating rate of 15°C min^{-1} across a range of 30–900°C to evaluate thermal stability and decomposition profiles.

Table S4 Summary of thermal properties of PAN, PAN/TAPB, PAN/F-COF, F-COF membrane and F-COF powder

Sample	$T_{5\%}$ (°C)	Residue at 900 °C
PAN membranes	309	44.30%
PAN/TAPB membranes	306	41.50%
PAN/F-COF membranes	283	43.90%
F-COF membranes	317	43.10%

F-COF power	285	60.90%

1.3.5.2 Chemical stability analysis

To evaluate the chemical stability of F-COF membranes, 50 mg of the material was immersed in ultrapure water, acetone, methanol, n-hexane, 0.1 M HCl, and 0.1 M NaOH solutions for 72 h. Following immersion, the membranes were thoroughly rinsed with ultrapure water to remove residual solvents or reagents. Structural integrity was assessed via FTIR spectroscopy and XRD analysis to confirm retention of characteristic functional groups (-C=N-, -F) and crystallinity after chemical exposure.

1.3.6 Coated fiber durability experiments

Repeated adsorption-desorption cycles were performed on OCPs standard working solutions following the solid-phase microextraction (SPME) procedure described in Section 1.3.3. Chromatograms were sequentially recorded after each cycle to monitor extraction performance. The peak areas of OCPs were used as evaluation metrics to compare the extraction efficiency between fresh fibers and fibers reused for different cycles, thereby assessing the durability of the F-COF membrane-coated SPME fibers.

1.3.7 Actual water sample analysis

To validate the practical applicability and accuracy of F-COF membranes, environmental water samples—including river water (Minjiang River, Minhou County, Fuzhou), lake water (Qishan Lake Park, Fuzhou), and seawater (Weitou Bay, Jinjiang, Quanzhou)—were analyzed for 20 OCP congeners.

Prior to analysis, water samples were pre-treated through sequential filtration: first using a 500-mesh stainless-steel sieve to remove planktonic organisms and suspended solids, followed by 0.45 μm aqueous-phase membrane filters to eliminate insoluble particulates. Processed samples were stored in amber glass bottles at 4°C to prevent photochemical degradation and microbial activity. This protocol ensured matrix

compatibility while preserving target analyte integrity throughout the analytical workflow.

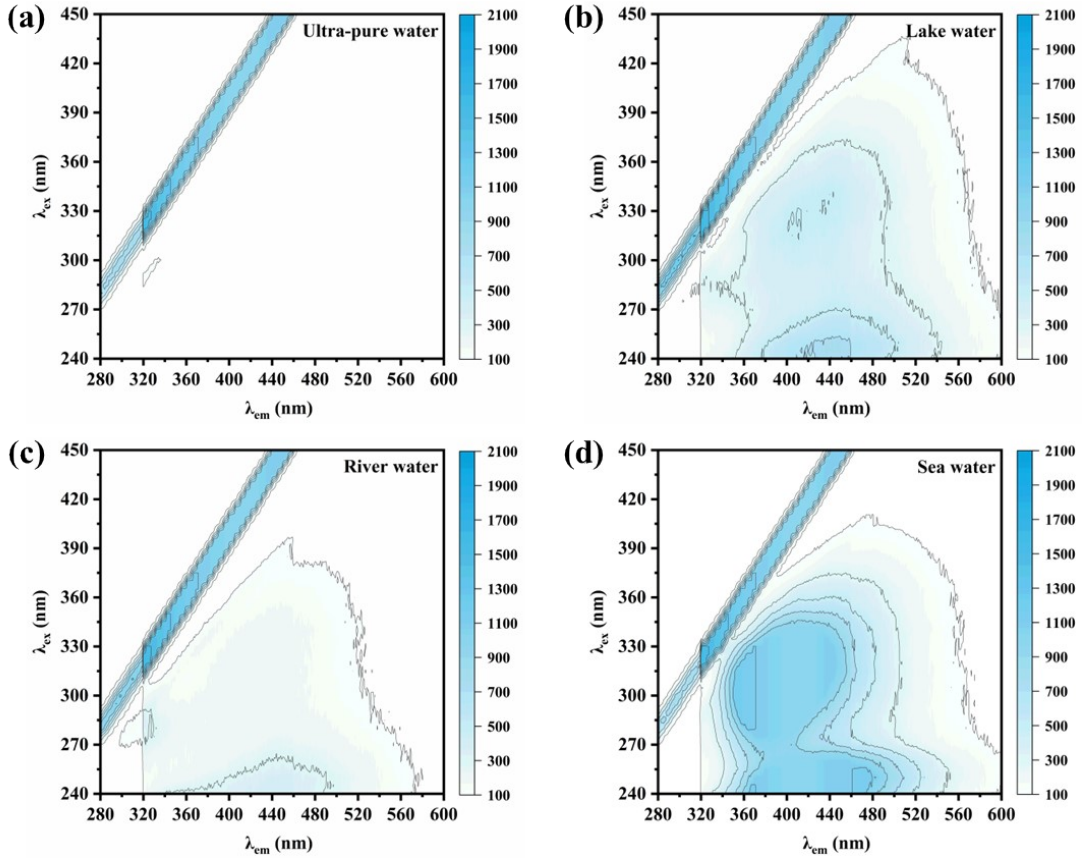


Figure S1 Three-dimensional fluorescence spectra in four different actual water samples

1.4 Characterization analysis methods

1.4.1 Field-emission scanning electron microscopy (FESEM) analysis

To investigate the in situ growth and microstructural morphology of COF within the fibers, field-emission scanning electron microscopy (FESEM) was performed using a Thermo Fisher Scientific Verios G4 ultra-high-resolution instrument under vacuum with high-energy electron beam irradiation. Cross-sectional images of PAN/F-COF and F-COF membranes were acquired after cryo-fracturing the samples in liquid nitrogen. Prior to imaging, specimens were sputter-coated with gold using an SCD 040 Balzers Union system to enhance conductivity. Elemental composition and distribution were analyzed via energy-dispersive X-ray spectroscopy (EDS) integrated with the FESEM system.

1.4.2 Brunauer-emmet-teller (BET) analysis

Surface area and porosity of PAN/TAPB, PAN/F-COF, and F-COF membranes were characterized using an automated surface area and porosity analyzer (ASAP 2460, Micromeritics, USA) with nitrogen as the adsorbate at 77 K. Prior to analysis, membrane samples were cryogenically fractured into small pieces in liquid nitrogen and vacuum-degassed at 120°C for 8 h. Nitrogen adsorption-desorption isotherms were recorded and analyzed via the Brunauer-Emmet-Teller (BET) method for specific surface area determination, while pore size distributions were derived from the Barrett-Joyner-Halenda (BJH) model based on cumulative adsorption data.

1.4.3 X-ray diffraction (XRD) analysis

Crystallographic diffraction data were acquired using a Rigaku SmartLab MiniFlex 600 X-ray diffractometer (JEOL Ltd., Japan). The dried material was placed into the groove of the sample holder and pressed firmly with a glass slide to ensure a flush surface between the material and holder. The sample holder containing the test material was subsequently mounted and secured on the instrument's sample stage. Data collection parameters were set as follows: Cu Kα radiation (λ = 1.540598 Å), 2θ range of 1.5–40°, step size of 0.02°, and scanning speed of 2° min^{-1}.

1.4.4 Fourier-transform infrared (FTIR) analysis

Molecular structural and chemical compositional changes during F-COF membrane fabrication were analyzed using a Nicolet AVST-AR 360 Fourier-transform infrared spectrometer (Thermo Fisher Scientific, USA) equipped with an attenuated total reflectance (ATR) module. Testing parameters were configured as follows: film dimensions of 2 cm × 2 cm, powder mass of 20 mg, wavenumber range of 600–4000 cm^{-1}, spectral resolution of 4 cm^{-1}, and 32 cumulative scans per measurement.

1.4.5 Solid-state nuclear magnetic resonance (NMR) analysis

The carbon environments of the synthesized materials were analyzed using a Bruker Avance III 13C solid-state NMR spectrometer (Bruker, Switzerland) equipped with cross-polarization magic angle spinning (CP-MAS). The spectrometer operated at a static magnetic field of 9.4 T with a 4.0 mm MAS probe. The sample was loaded into a 4.0 mm zirconium oxide rotor and spun at an MAS frequency of 14 kHz. The 13C CP-MAS experiments were conducted using a standard linearly ramped cross-polarization pulse sequence. Adamantane served as an external reference standard for chemical shift calibration. NMR data processing was performed using Mestrenova software.

1.4.6 Thermogravimetric (TG) analysis

Thermal stability of F-COF powder, PAN membrane, PAN/TAPB membrane, PAN/F-COF fibrous membrane, and porous F-COF membrane was evaluated using a synchronous thermal analyzer (STA 449 F5-QMS 403 C, Netzsch, Germany). Measurements were conducted under a N_2 atmosphere with a heating rate of 10°C min^{-1} across a temperature range of 30–900°C.

1.4.7 Contact angle (CA) analysis

Static contact angles of various membrane materials and F-COF powder were measured using a droplet shape analysis system (OSA200, Ningbo New Boundary Scientific Instruments Co., Ltd.) equipped with a high-resolution camera. The operational procedure was as follows: a 5 μL deionized water droplet was deposited onto the sample surface, and contact angles at three random positions were recorded by the system. The average value of these measurements was reported as the static contact angle for each material.

1.4.8 X-ray photoelectron spectroscopy (XPS) analysis

Surface chemical composition and electronic state variations of PAN/F-COF membranes, as well as F-COF membranes before and after OCPs enrichment, were investigated using an ESCALAB QXi X-ray photoelectron spectrometer (ThermoFisher Scientific, USA) with a monochromatic Al Kα X-ray source (hν = 1486.6 eV). All spectra were charge-corrected by referencing the adventitious carbon peak (C-C/C=C) at 284.8 eV binding energy.

1.4.9 Gas chromatography-spectrometry (GCMS) analysis

A gas chromatography-mass spectrometer (GC-MS-QP 2020 NX, Shimadzu Corporation, Japan) equipped with an Rtx-5MS capillary column (30 m × 0.25 mm × 0.25 μm) was employed for OCPs standard solution analysis. The SPME-GC parameters were configured in splitless mode with high-pressure injection (250 kPa), an inlet temperature of 250°C, and high-purity helium as the carrier gas at a column flow rate of 1.2 mL min^{-1} and purge flow rate of 3.0 mL min^{-1}. The temperature program began with an initial hold at 60°C for 1 min, followed by a rapid ramp of 40°C min^{-1} to 172°C (2 min hold), a gradual increase of 1°C min^{-1} to 195°C, and a final ramp of 30°C min^{-1} to 280°C with a 2-min hold, resulting in a total runtime of 33.87 min.

The mass spectrometer was operated in electron ionization (EI) mode. Key parameters included a transfer line temperature of 260°C, ion source temperature of 280°C, detector voltage of 0.95 kV, and solvent delay time of 3 min. Quantitative analysis of ion fragments was performed via selected ion monitoring (SIM) mode, with specific m/z values for OCPs detailed in Table S5.

Table S5 Parameters of the SIM Mode

Analytes	Retention time (min)	Q_1 (m/z)	Q_2 (m/z)	Q_3 (m/z)	Reference ion (m/z)
α-BHC	13.02	181	183	219	183.0~219.0
Hexachlorobenznze	13.19	284	282	251	286.0~282.0
β-BHC	14.1	181	183	219	109.0~183.0

Table S5, continued Parameters of the SIM Mode

Analytes	Retention time (min)	Q1 (m/z)	Q2 (m/z)	Q3 (m/z)	Reference ion (m/z)
γ-BHC	14.505	181	183	217	183.0~219.0
σ-BHC	15.82	219	181	183	219.0~183.0
Heptachlor	18.105	100	272	274	272.0~274.0
Aldrin	19.965	66	263	265	263.0~91.0
Isodrin	21.5	193	195	66	195.0~66.0
Heptachlor epoxide	22.13	353	355	81	355.0~81.0
o, p'-DDE	23.95	246	248	318	248.0~318.0
Endosulfan I	24.36	241	239	197	239.0~195.0
p, p'-DDE	25.855	246	248	316	248.0~318.0
o, p'-DDD	26.125	235	237	165	237.0~165.0
Endrin	26.81	263	317	281	265.0~281.0
Endosulfan II	27.3	195	241	237	241.0~207.0
p, p'-DDD	27.715	235	237	165	237.0~165.0
o, p'-DDT	27.795	235	237	165	237.0~165.0
p, p'-DDT	29.15	235	237	165	237.0~165.0
Methoxychlor	31.035	227	212	274	228.0~274.0
Mirex	32.325	272	274	237	274.0~270.0

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2 Supplemental figures

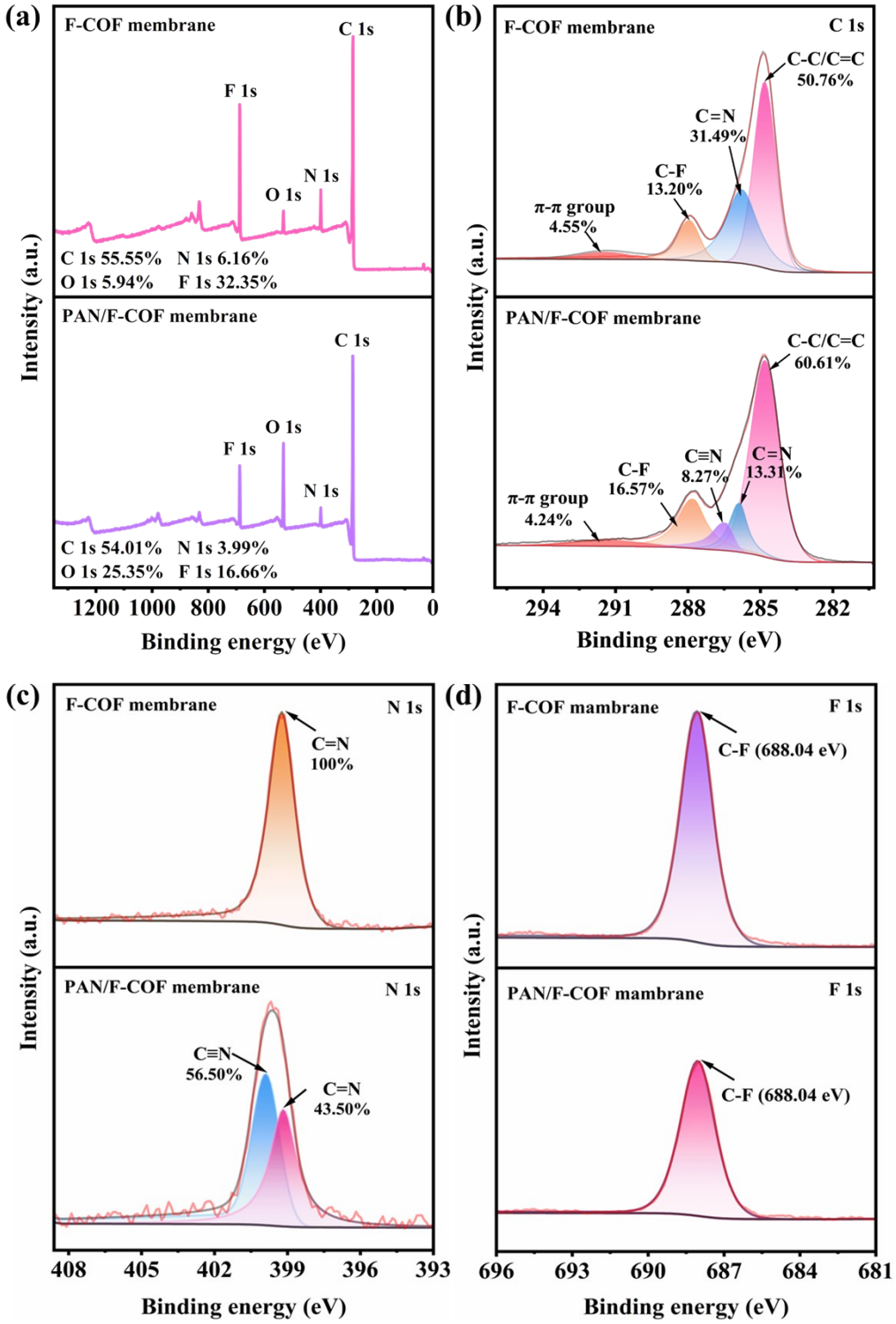

Figure S2 XPS survey spectra of PAN/F-COF membrane and F-COF membrane (a), high-resolution C 1s spectra (b), high-resolution N 1s spectra (c) and high-resolution F 1s spectra (d)

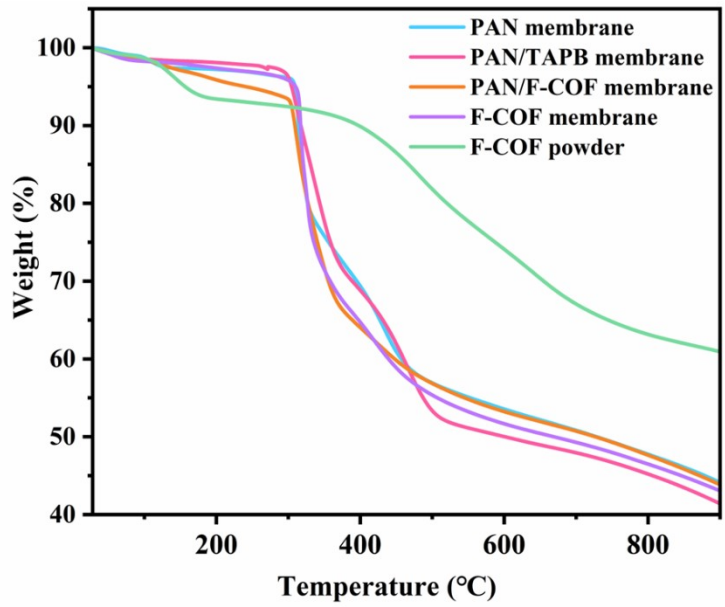

Figure S3 Thermogravimetric analysis of PAN, PAN/TAPB, PAN/F-COF, F-COF nanofiber membrane and F-COF powder

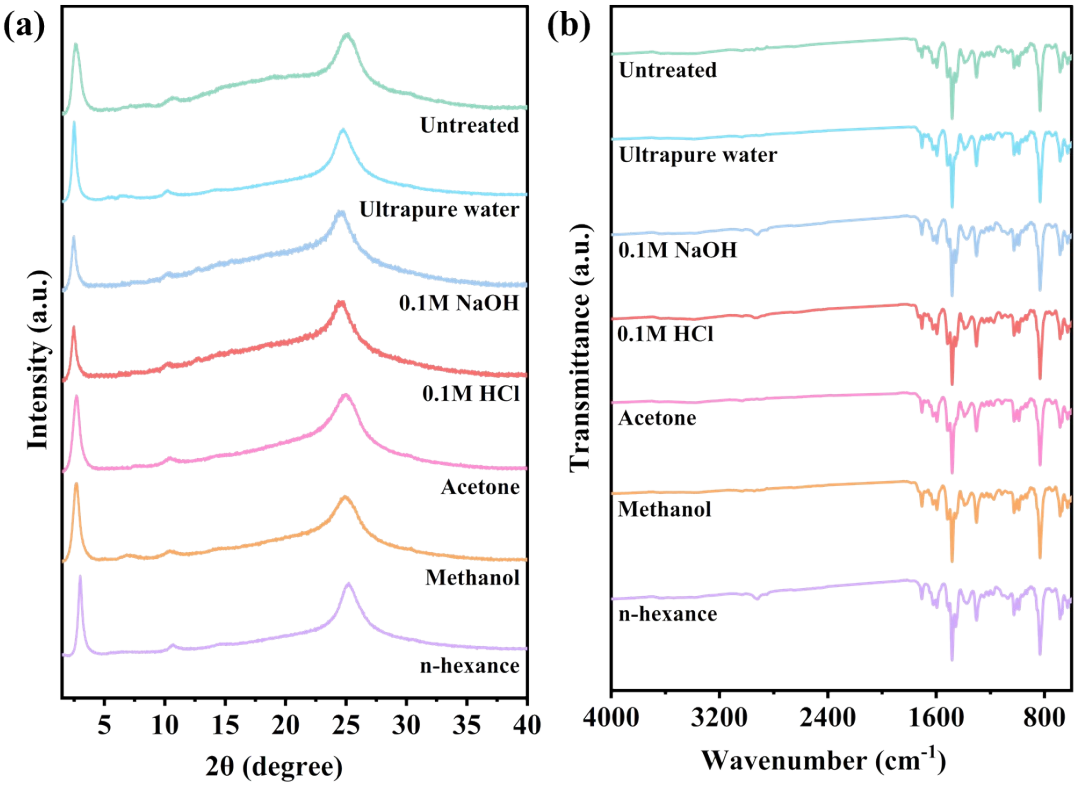

Figure S4 XRD patterns (a) and FT-TR spectra (b) of F-COF nanofiber membrane after treatment For 72 h in different chemical reagents

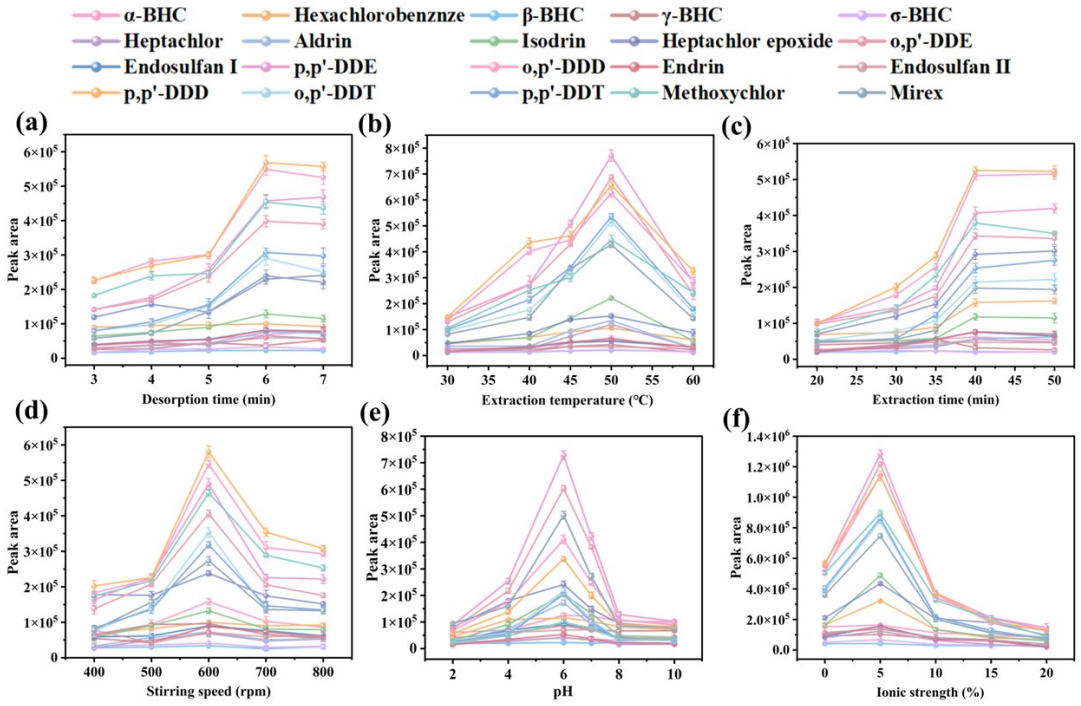

Figure S5 Parameters affecting the enrichment performance of the F-COF membrane coated fiber including desorption time (a), extraction temperature (b), extraction time (c), stirring speed (d), solution pH (e) and ionic strength (f)

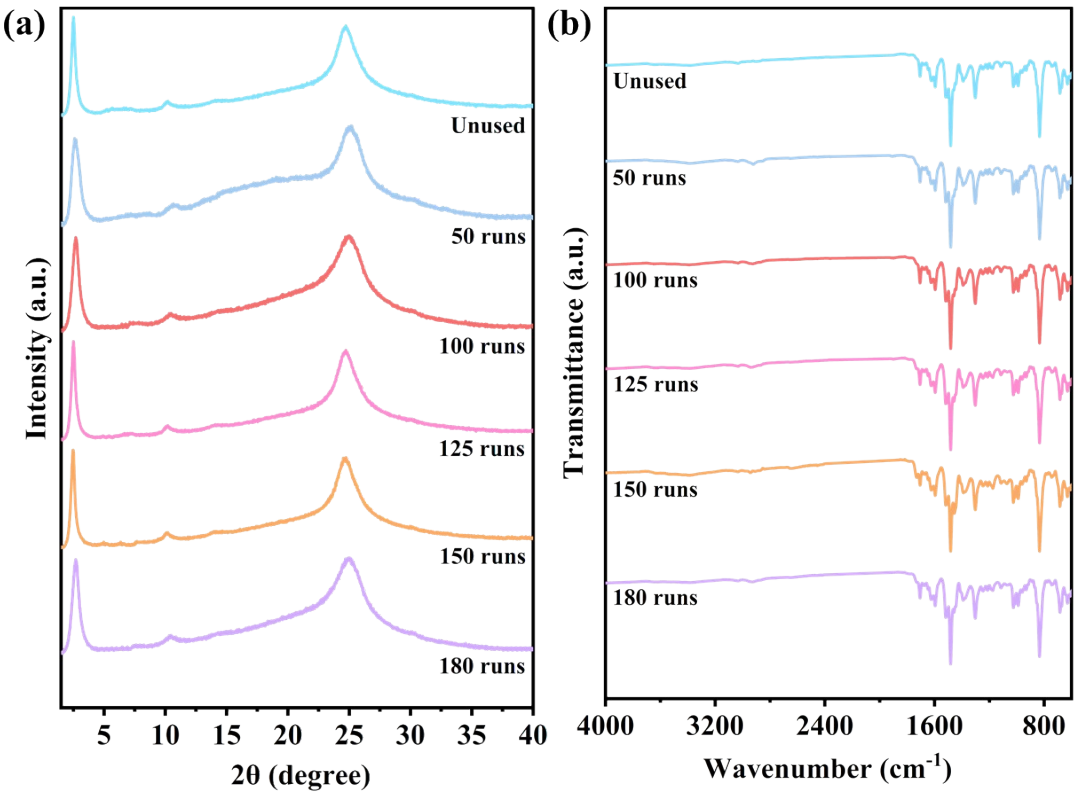

Figure S6 XRD patterns (a) and FT-IR spectra (b) of the fresh and used F-COF membrane

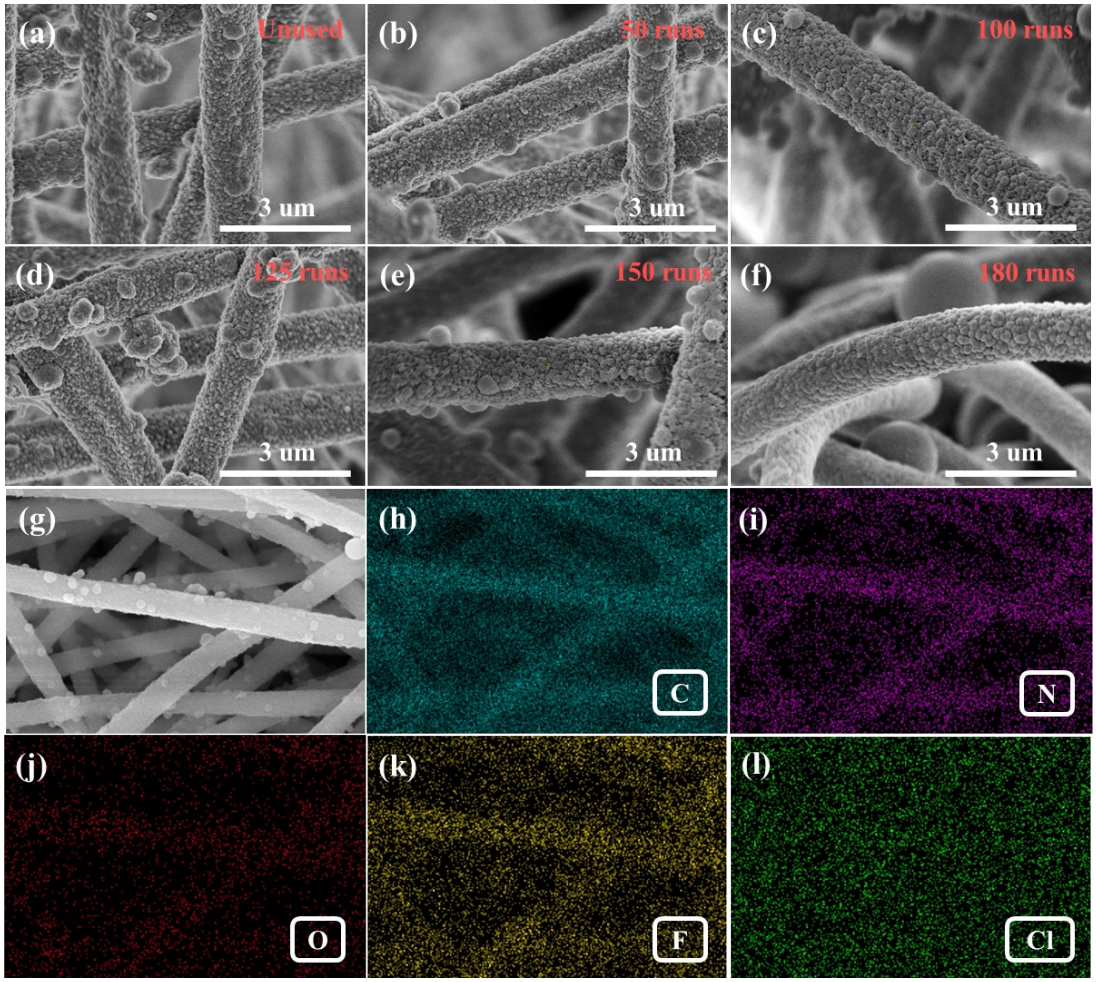

Figure S7 FESEM and mapping image of the fresh and used F-COF membrane

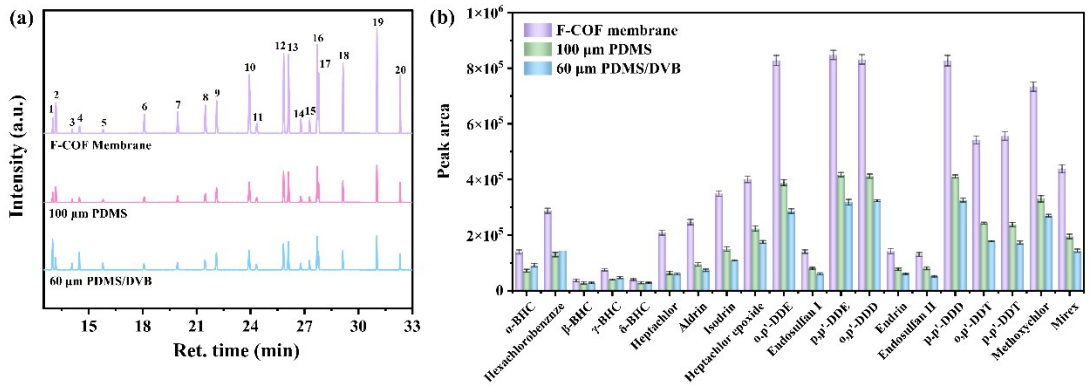

Figure S8 The GC-MS chromatograms of F-COF membrane and two commercial fibers after extracting 0.0005 mg L-1 OCPs (a), Comparison of peak area of F-COF membrane (purple) for OCPs with 100μm PDMS (green) and 60μm PDMS/DVB (blue) (b)

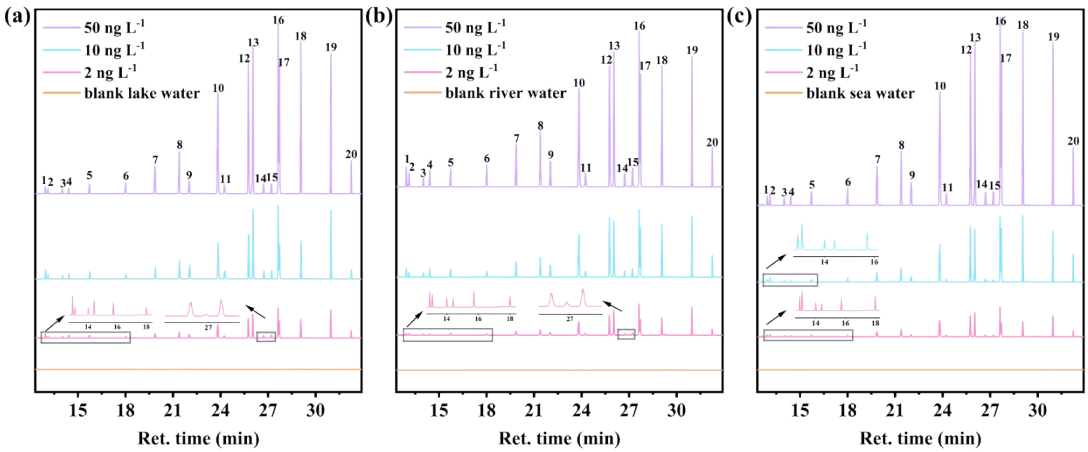

Figure S9 The GC-MS chromatograms of OCPs enriched from environmental water samples utilizing the F-COF coated SPME fiber spiked with 2 ng L^{-1}, 10 ng L^{-1} and 50 ng L^{-1}: lake water (a), river water (b) and sea water (c)

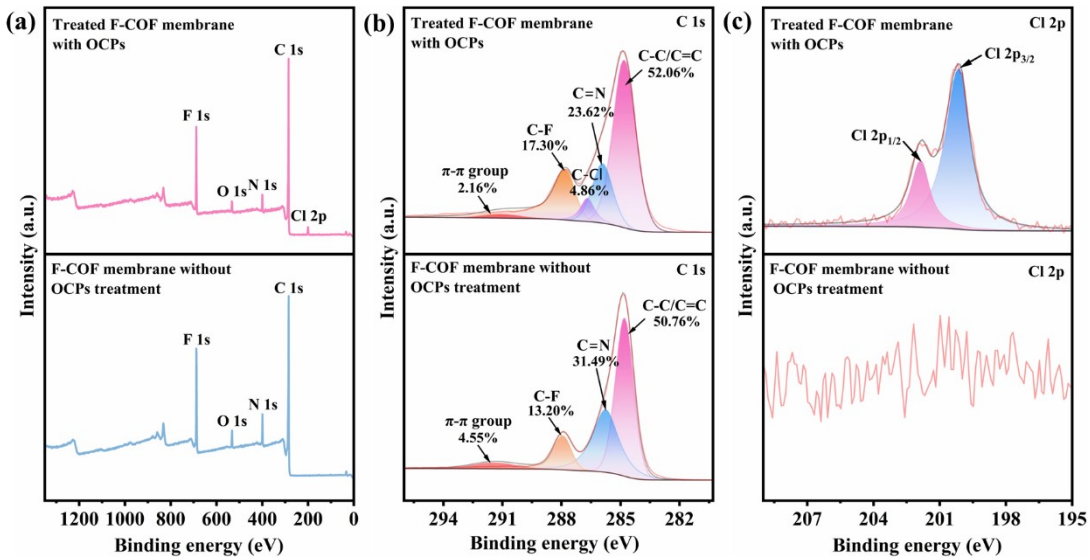

Figure S10 XPS survey spectrum (a), high-resolution C 1s spectra (b) and high-resolution Cl 2p spectra (c) of XPS before and after enrichment of OCPs utilizing F-COF membrane

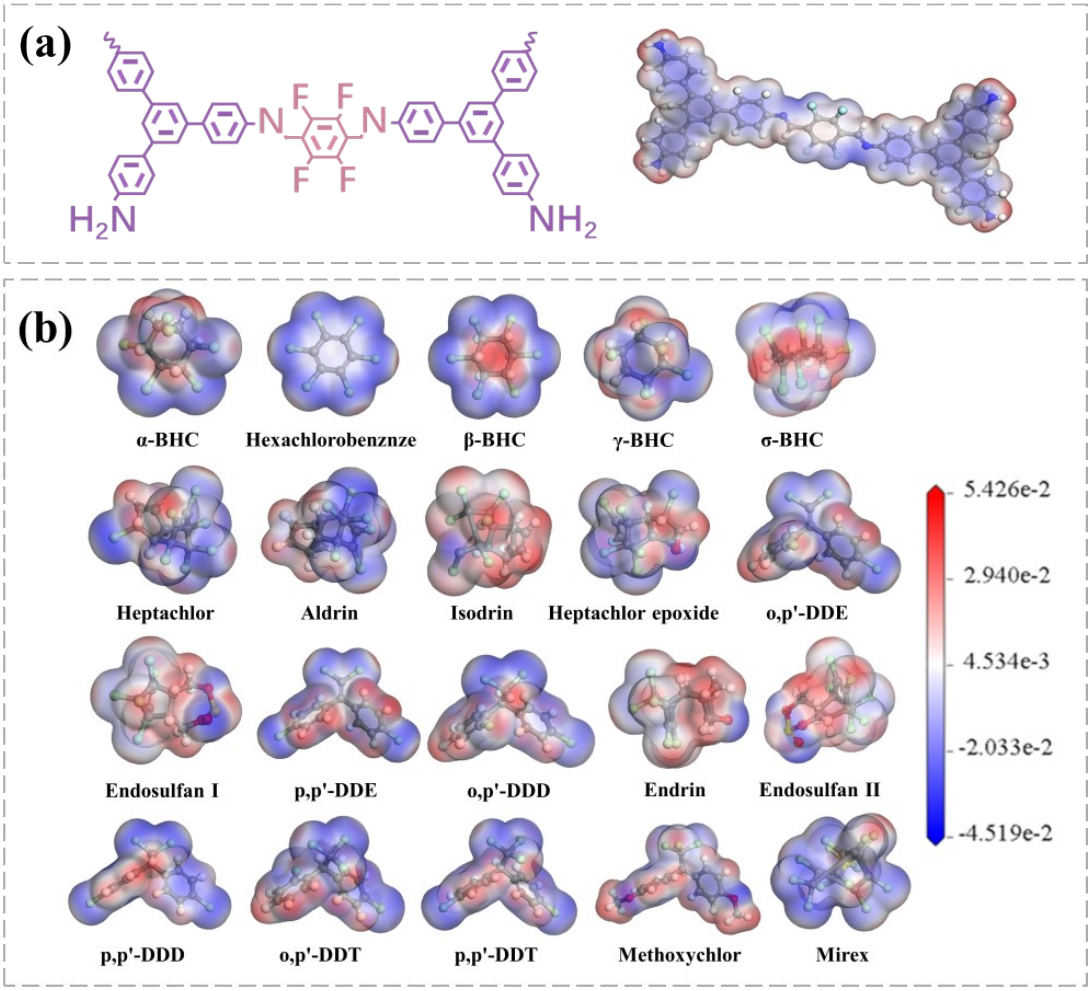

Figure S11 The surface electrostatic potential of F-COF and 20 OCPs

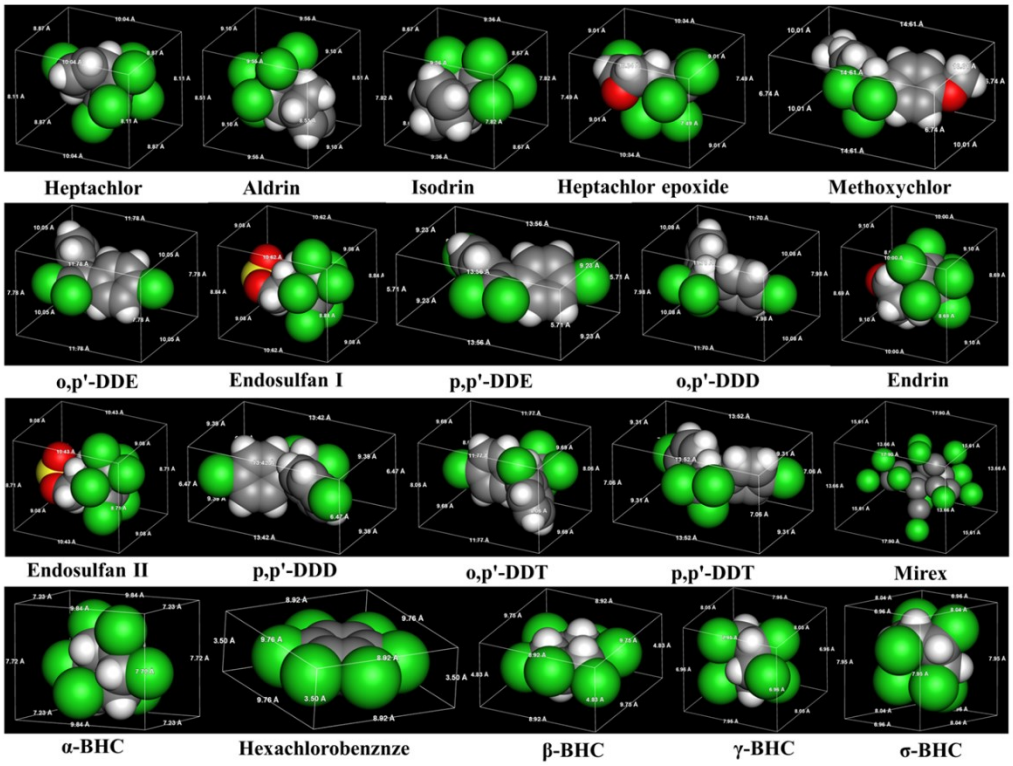

Figure S12 Molecular dimensions of the 20 target OCPs

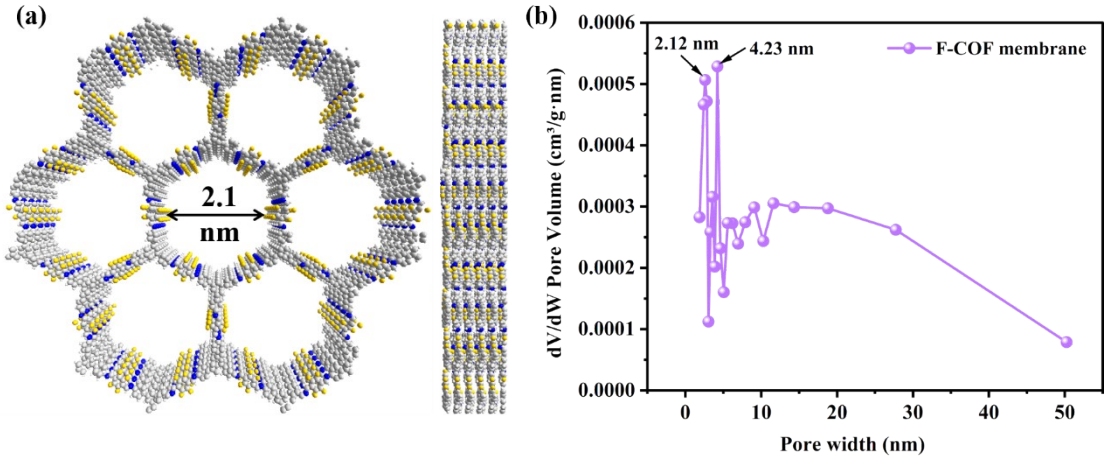

Figure S13 Space-filled model of F-COF (a) and pore size distribution of F-COF nanofiber membrane (b)