Electronic Supplementary Information

***In Situ* growth of octa-phenyl polyhedral oligomeric silsesquioxane nanocages over fluorinated graphene nanosheets: super-wetting coatings for oil and organic Sorption**

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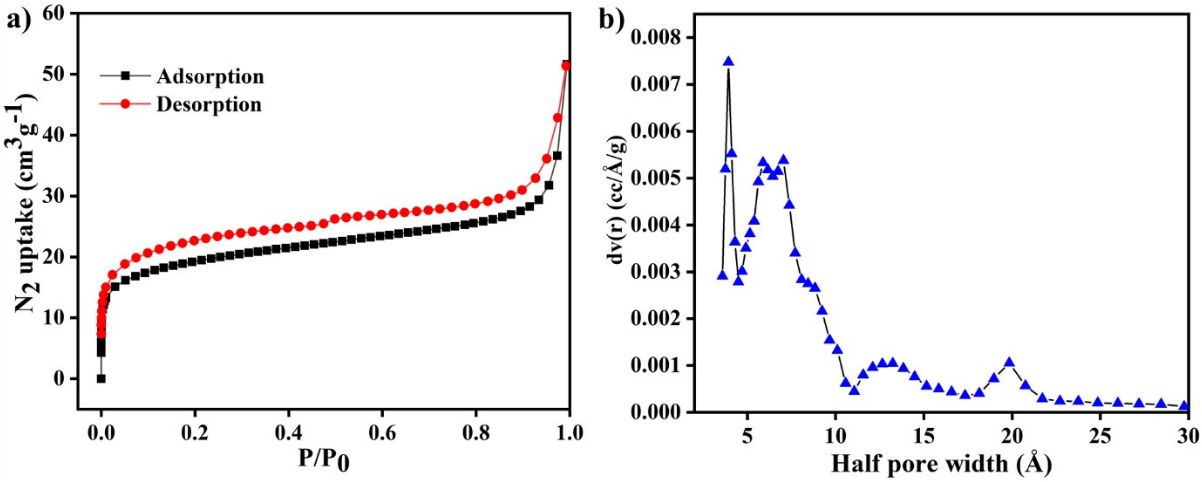

Figure S1. (a) N_2 isotherms at 77 K for O-Ph-POSS-FG and (b) corresponding pore size distribution.

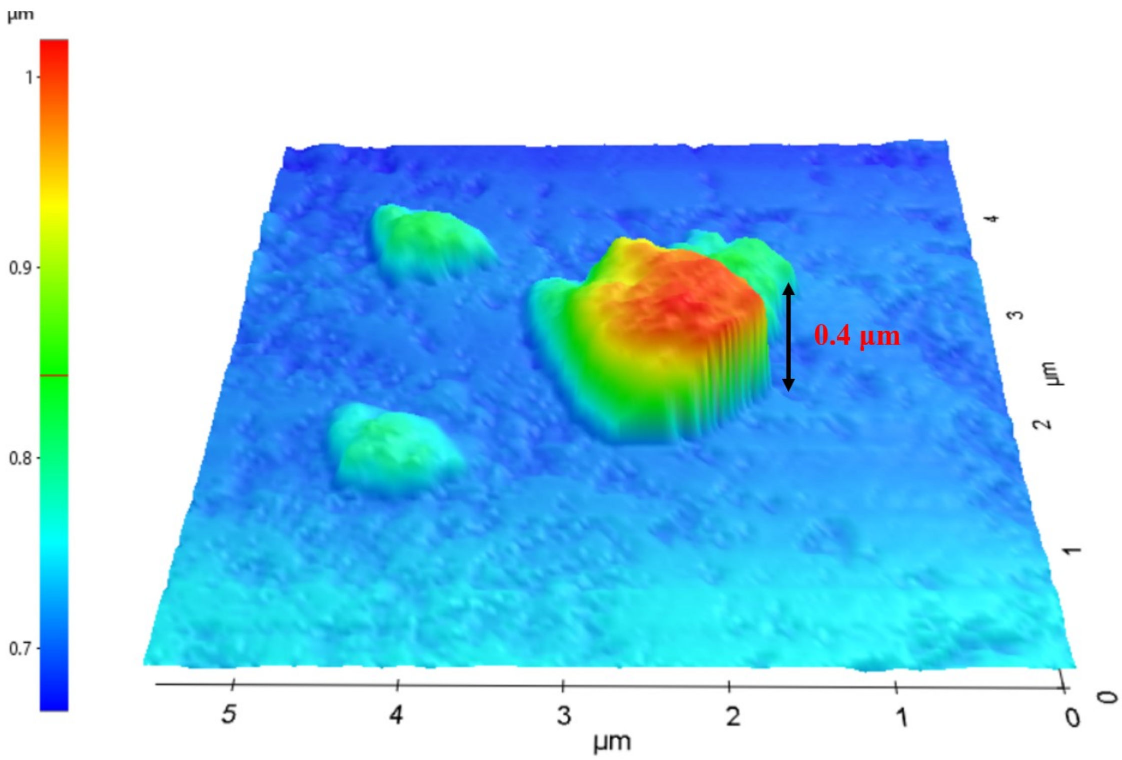

Figure S2. Surface topographies of O-Ph-POSS-FG material determined by AFM.

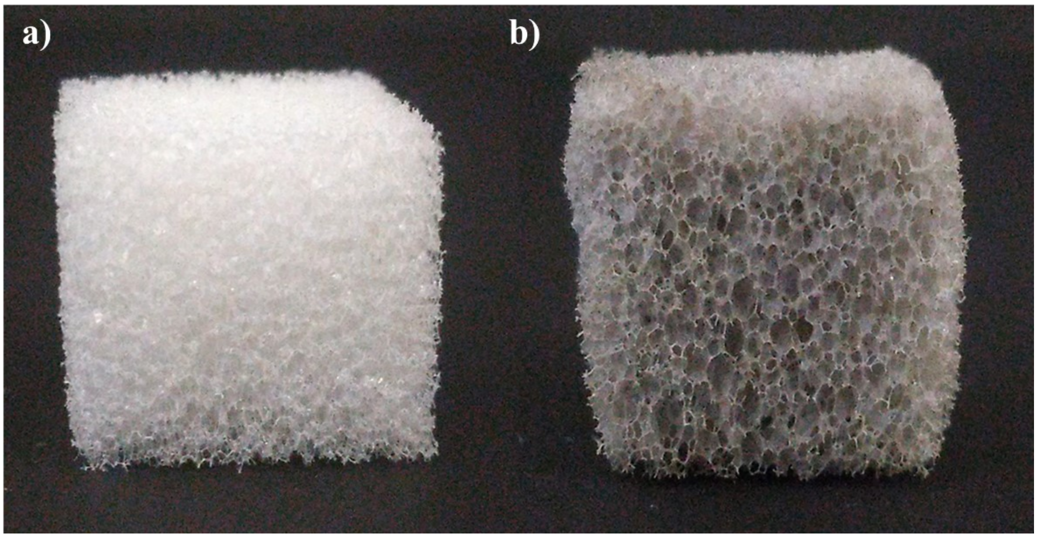

Figure S3. Photograph of (a) Commercial PU sponge and (b) O-Ph-POSS-FG@Sponge.

Table S1. Density and porosities of both pristine sponge as well as O-Ph-POSS-FG@sponges (4 units)

	Density	**Porosity**
Uncoated Sponge	0.0601 g/cm^3	99%
O-Ph-POSS-FG@Sponge-1	0.08 g/cm^3	98.67%
O-Ph-POSS-FG@Sponge-2	0.078 g/cm^3	98.70%
O-Ph-POSS-FG@Sponge-3	0.079 g/cm^3	98.69%
O-Ph-POSS-FG@Sponge-4	0.076 g/cm^3	98.74%

Apparent densities were calculated by measuring their masses and dimensions. The porosity was calculated using the following equations.[1]

$Porosity = (1 - \rho/\rho_s) \times 100\%$

where ρ is the bulk density of the sponges and ρ_s is the density of raw material sponge.

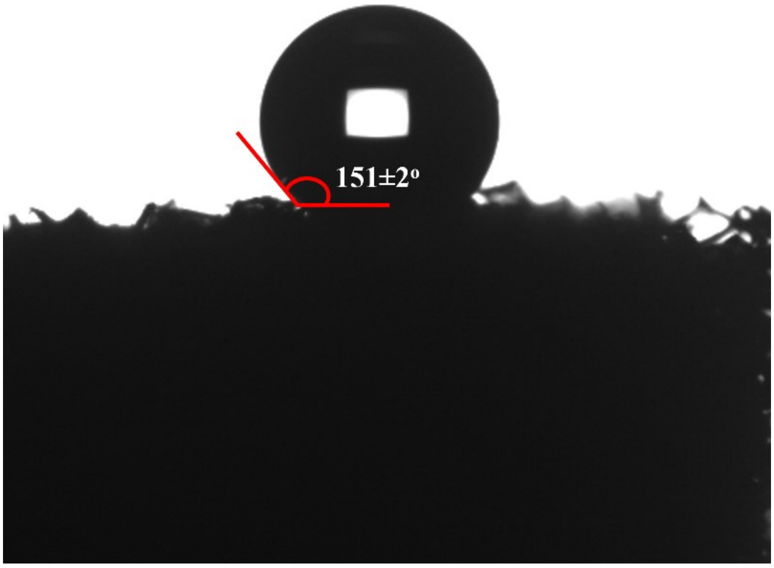

Figure S4. Water contact angle of O-Ph-POSS-FG@Sponge.

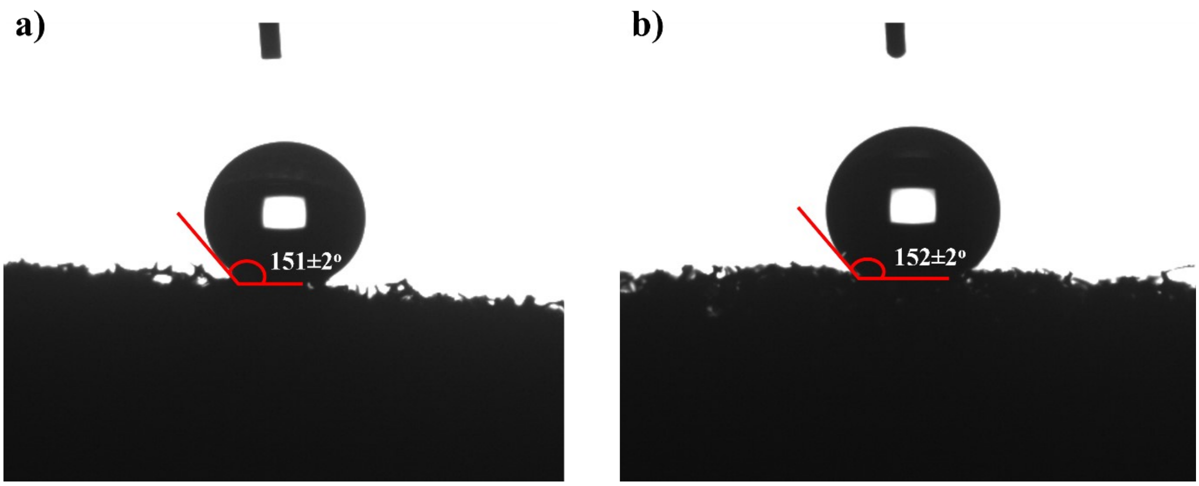

Figure S5. WCA measurements of (a) 1 year old O-Ph-POSS-FG@Sponge and (b) 1 week old O-Ph-POSS-FG@Sponge.

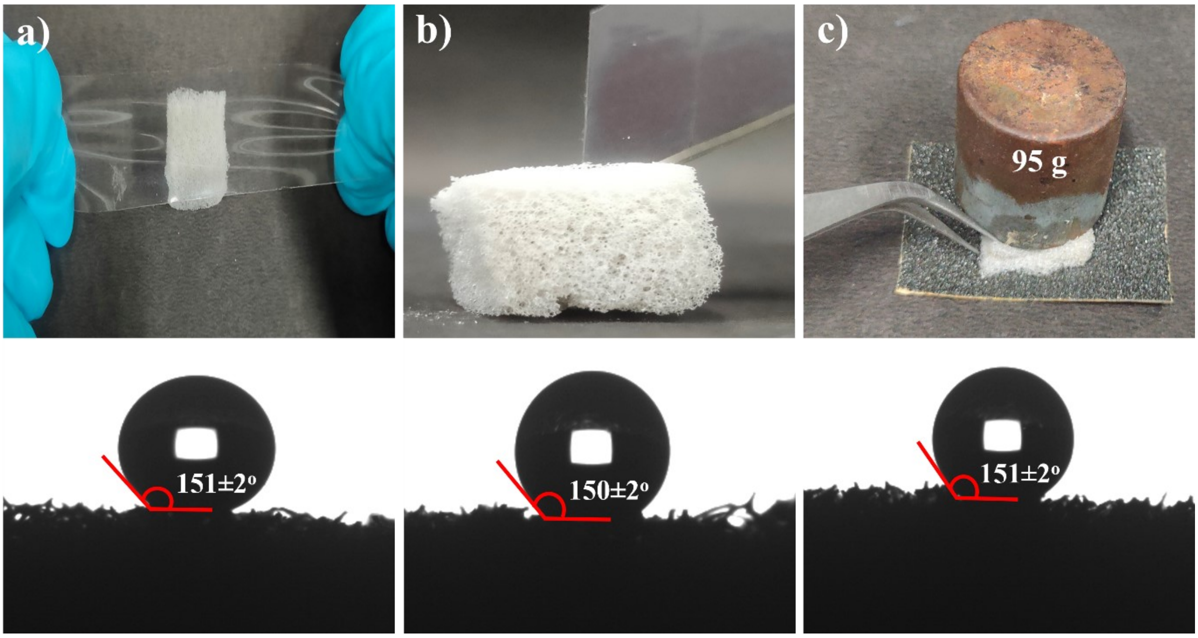

Figure S6. Mechanical properties of O-Ph-POSS-FG@Sponge in different conditions followed by the evaluation of WCA.

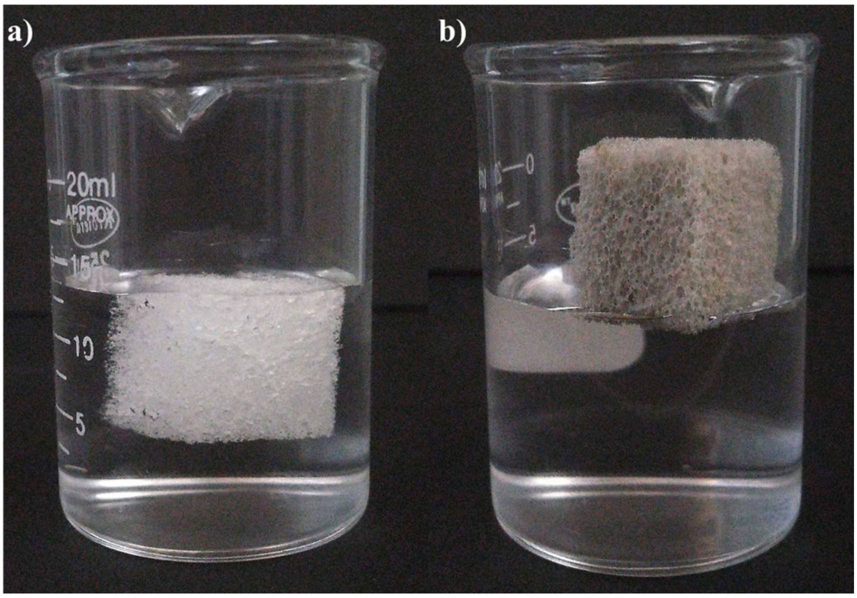

Figure S7. Photograph of (a) PU sponge in water and (b) O-Ph-POSS-FG@Sponge on water.

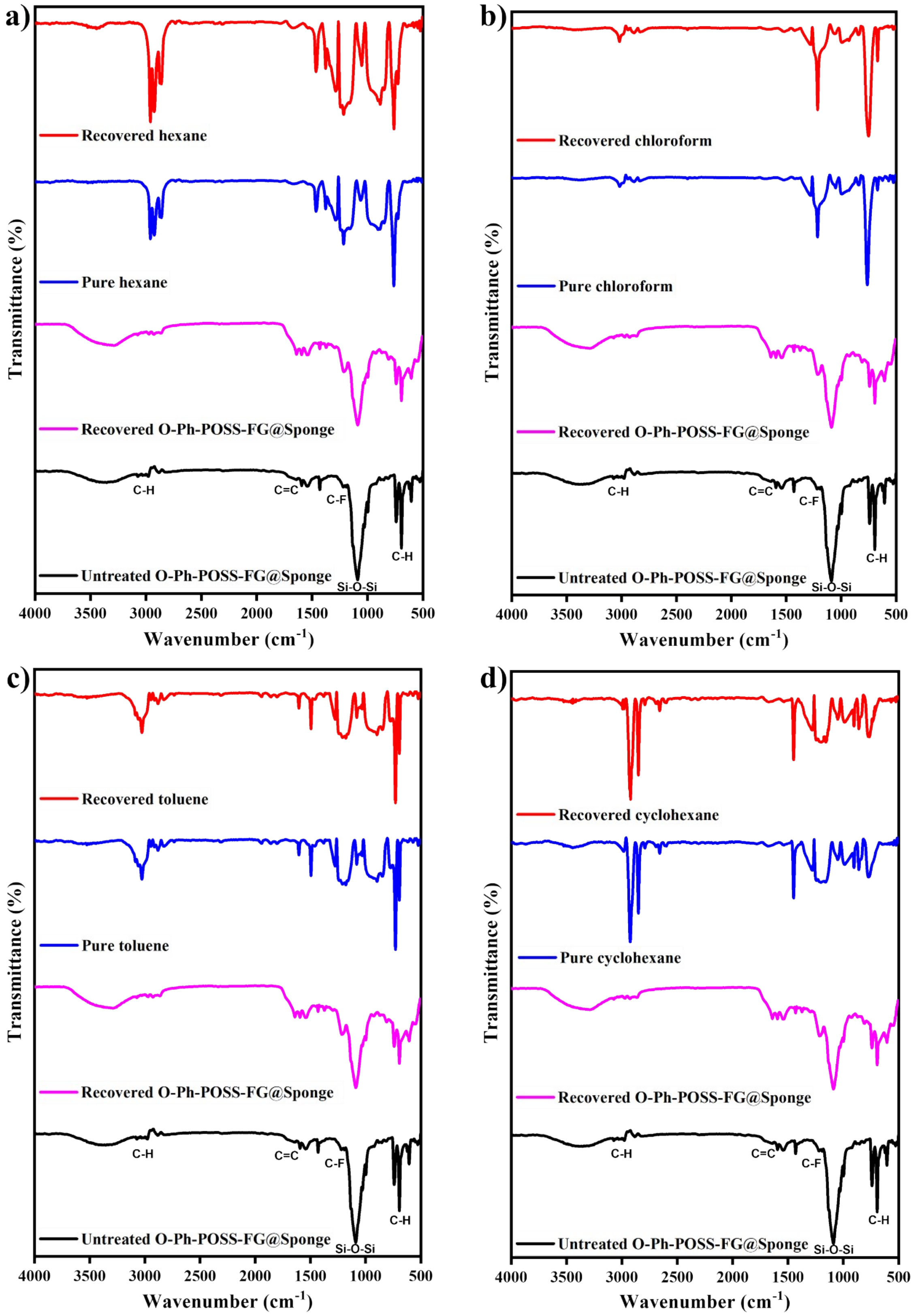

Figure S8. FT-IR spectra of untreated O-Ph-POSS-FG@Sponge and recycled O-Ph-POSS-FG@Sponge after (a) Hexane, (b) Chloroform (c) Toluene and (d) cyclohexane sorption respectively.

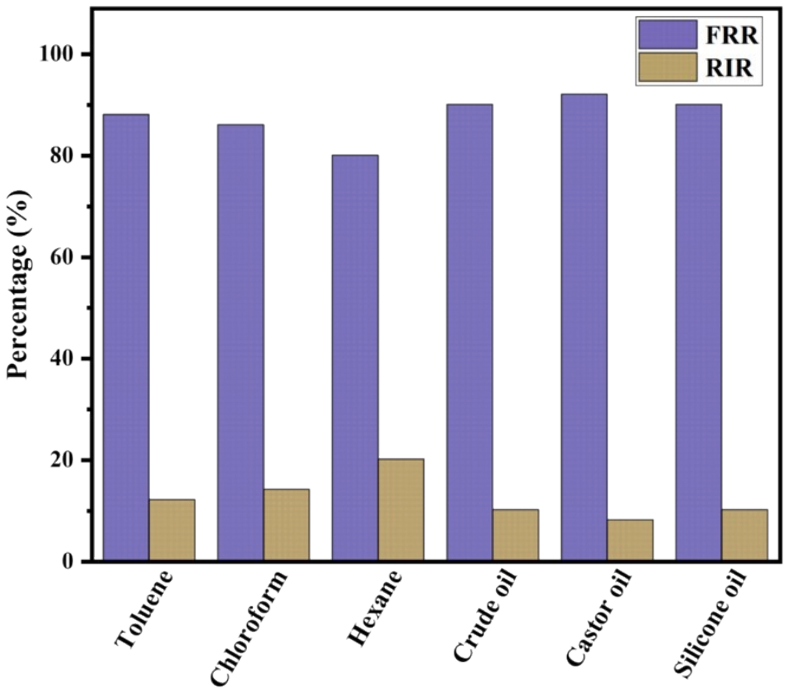

Figure S9. Flux recovery ratio (FRR) and irreversible fouling ratio (RIR) of O-Ph-POSS-FG@Sponge for oil absorption.

The anti-oil fouling property of the O-Ph-POSS-FG@Sponge was evaluated by two indexes of the flux recovery ratio (FRR) and irreversible fouling ratio (RIR). In general, FRR means that the variation of absorption capacity of sponges before and after use. The RIR indicate the changing rate of absorption capacity of sponges.[1]

which were calculated by the formula

$$FRR = (J_{w2}/J_{w1}) \text{ X } 100\%$$

$$RIR = [\ J_{w1} - J_{w2})/\ J_{w1}] \text{ X } 100\%$$

where J_{w1} is original absorption capacity and J_{w2} is last absorption capacity after desorption.

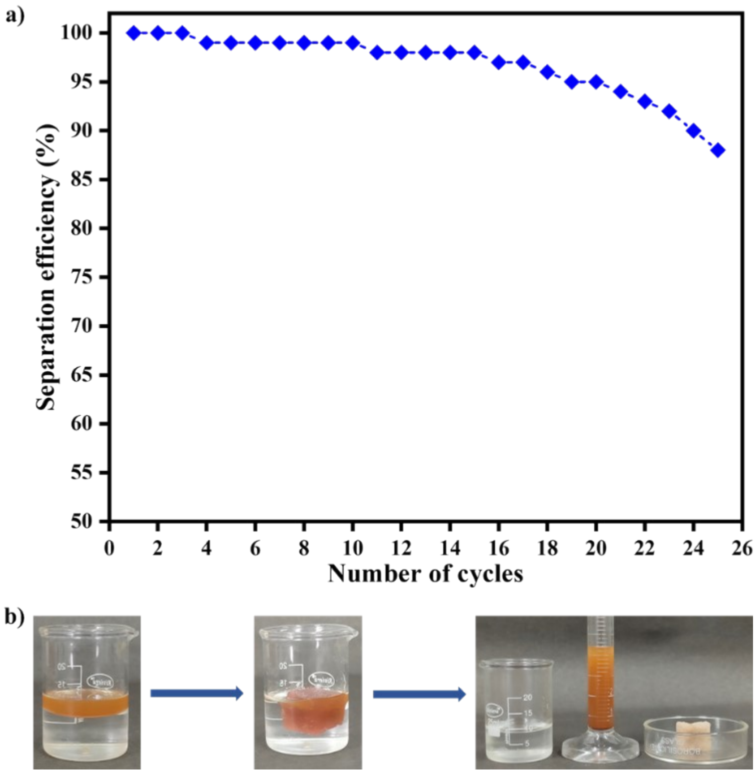

Figure S10. (a) Pump oil reusability test using O-Ph-POSS-FG@Sponge; (b) Oil separation from water mixture using O-Ph-POSS-FG@Sponge.

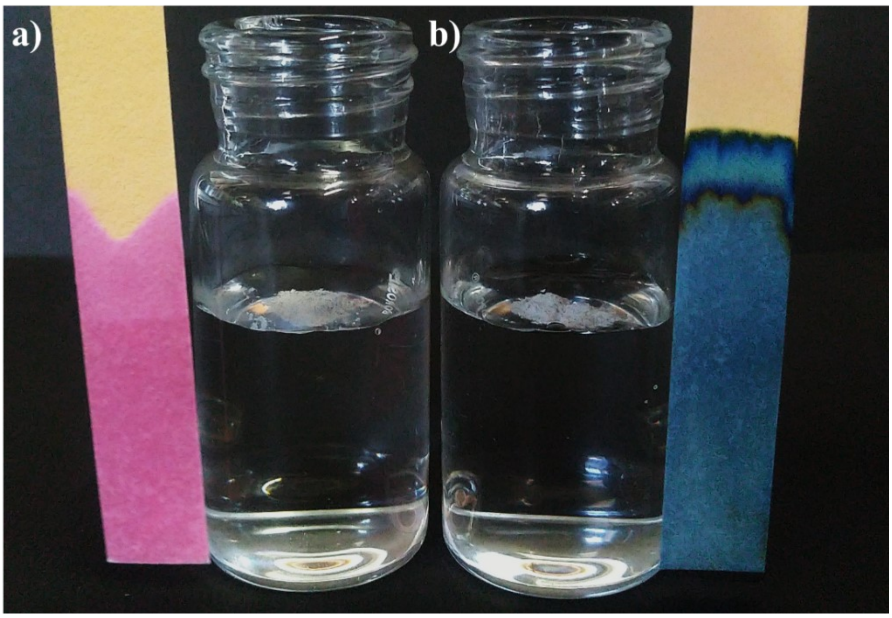

Figure S11. O-Ph-POSS-FG in (a) Acidic (2 M) and (b) Alkaline media (2 M).

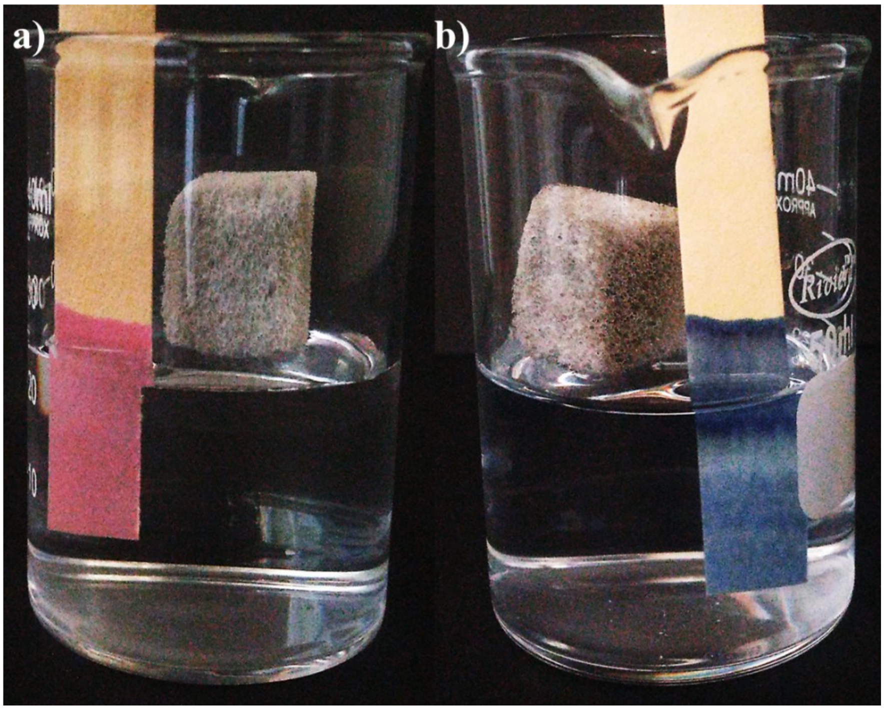

Figure S12. O-Ph-POSS-FG@Sponge (a) Acidic (2 M) and (b) Alkaline media (2 M).

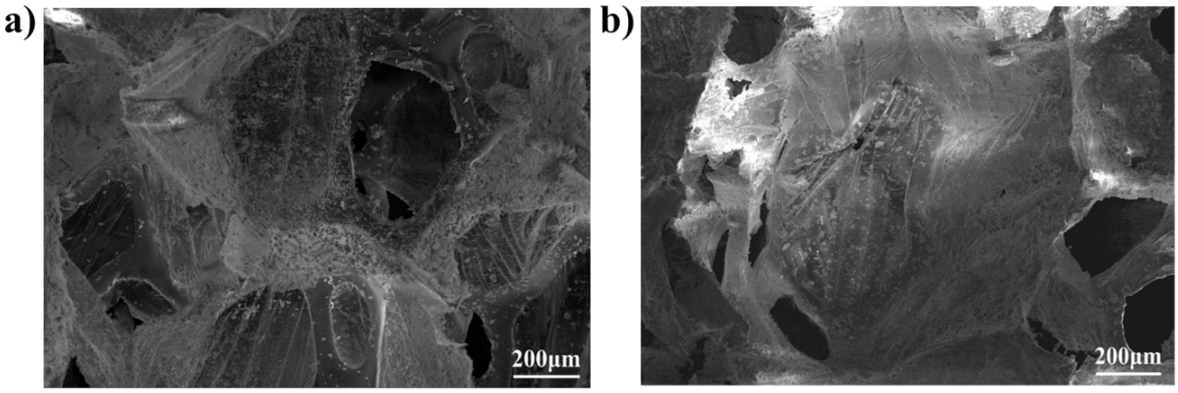

Figure S13. FE-SEM images of (a) Acid treated O-Ph-POSS-FG@Sponge and (b) Alkaline treated O-Ph-POSS-FG@Sponge.

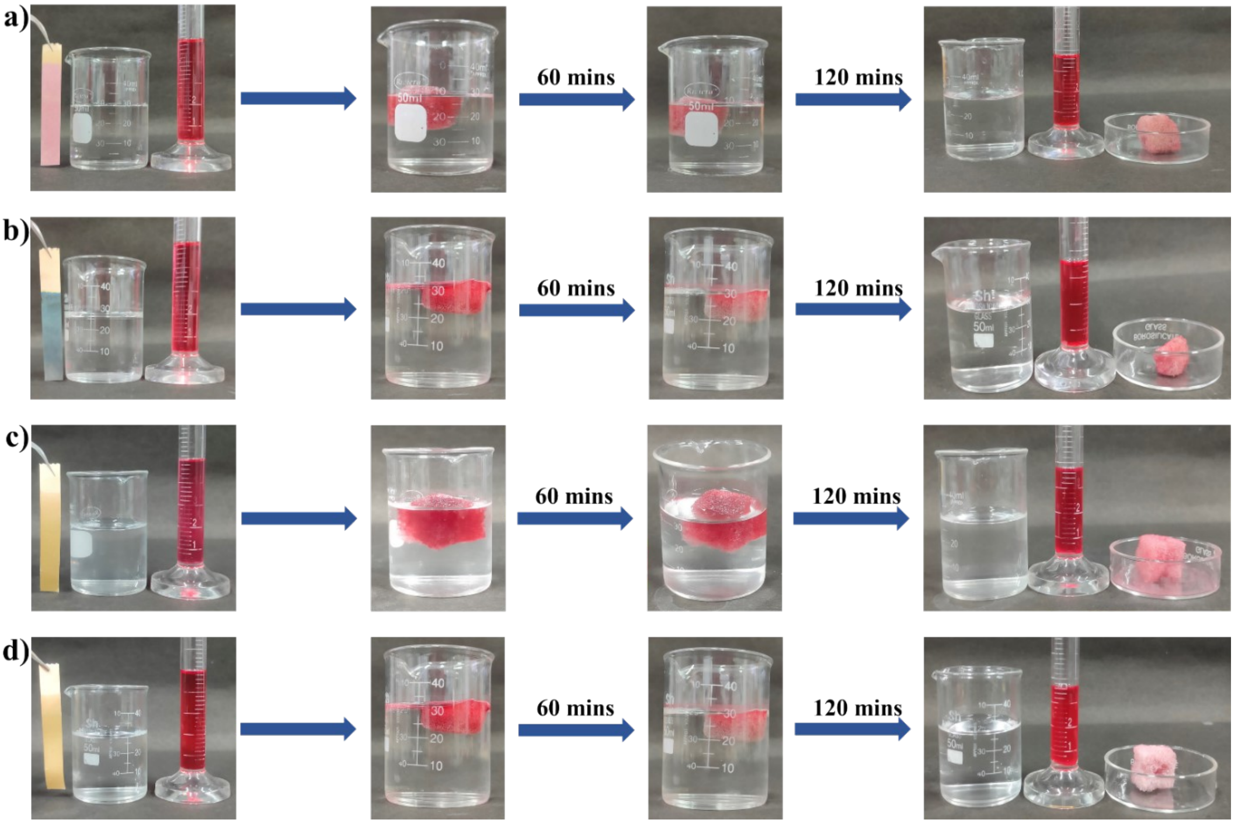

Figure S14. Photographs showing the floatability behaviour of O-Ph-POSS-FG@Sponge (a) acidic, (b) alkaline, (c) sea water and (d) normal water.

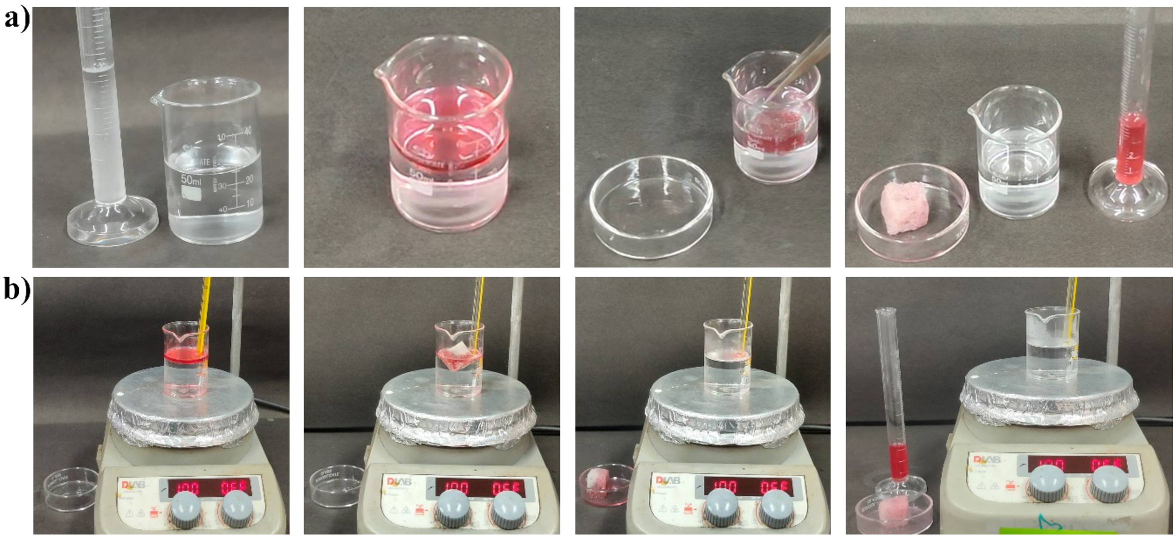

Figure S15. Toluene/water separation (a) supercool condition at -40 °C and (b) superheat condition at 100 °C.

Table S2. Hydrophobicity, absorption capacities, and separation efficiency of various POSS and 2D-based hydrophobic materials comparison with present work.

S. No	Material	Water Contact Angle [°]	Absorption capacity	Separation efficiency	Application	Ref
1	ODT-POSS-CT fabric membrane	144	1600-4800 wt%	-	Hydrophobic cotton fabric ODT-POSS-CT membrane for oil-water separation	2
2	P(MMA-SMA-MAPOSS)	153	-	99 %	Oil-water separation	3
3	OV-POSS@MF	141	-	-	Oil-water separation performance	4
4	TiO_2-SH-POSS@CT	157.6	-	99 %	Self-cleaning and Oil-water separation	5
5	POSS/PDMS modified polyacrylate	161	-	>97%	Oil-water separation, Self-cleaning and antifouling	6
6	POSS-modified Luffa sponge	155	-	-	Oil absorption from water	7
7	Ph-POSS@HKUST-1	137±4	130-480 wt%	>96	Oil-water separation	8
8	PIM-1/POSS	155	-	99 %	Oil-water separation and cleanup of oil soluble contaminants	9
9	POSS-MPTMS	142	280 wt%	96%	Oil-water separation and self-cleaning process	10
10	ZIF-POSS	157	540–860 wt%	>99%	Reusable sorbent material for separation of organic liquids separation from water	11
11	GO-ePOSS	145	-	-	Oil-water separation	12
12	F-SQs-ECA-PU sponges (Fluoro silsesquioxanes	>150	-	-	Oil-water separation and metal anticorrosion	13

	with Ethyl Cyano Acrylate)					
13	*f*-FG@ZIF-67 functionalized fluorinated graphene	140±1	540–860 wt%.	>99%	Oil and organic solvent sorption	14
14	HFGO@ZIF-8 composite Sponge@HFGO@ZIF-8	162	150–600 wt%	-	Oil-water separation	15
15	FGO@Al-MOG	125			Oil and organic solvent absorption and separation	16
16	FG-HKUST-1 composite sponge	130±3	-	-	Oil-water separation	17
17	FG supported ZIF-7 and ZIF-11 over stainless steel mesh & cotton cloth	160±2 145±1 155±2	-	94-98%	Percolation networks for selective permeation of oils and chlorinated solvents	18
18	O-Ph-POSS-FG@Sponge	151±2	1500-5500 wt%	90-99%	Oil and organic water separation Toluene-water Emulsion separation	Present work

Supplementary Movies.

The videos of continuous separation for toluene (Video S1) and chloroform (Video S2) from solvent/water mixture by O-Ph-POSS-FG@Sponge were played at 2x speed.

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