Electronic Supplementary Information


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Fig. S5 Photographic images of (a) water wetting behaviour of (i) HKUST-1 (ii) Ph-POSS@HKUST-1; (b) water wetting behaviour of (i) PU sponge (ii) PDA@sponge and (iii) Ph-POSS@HKUST-1@PDA@Sponge; (c) (i) water droplet on the surface of Ph-POSS@HKUST-1, (ii) oil droplet on the surface of Ph-POSS@HKUST-1; (d) (i) water droplets on the surface of Ph-POSS@HKUST-1@PDA@Sponge, (ii) oil droplets on the surface of Ph-POSS@HKUST-1@PDA@Sponge.

Fig. S6 Photographic images of (a) Stability checkup for Ph-POSS@HKUST-1 under acid and alkaline medium; (b) Stability checkup for Ph-POSS@HKUST-1 under acidic condition with stirring at different times (500 rpm); (c) Stability checkup for Ph-POSS@HKUST-1 under alkaline condition with stirring at different times (500 rpm)

Fig. S7 (a) The photographs of Ph-POSS@HKUST-1@PDA@Sponge exposed to acid, salt, and alkaline conditions; (b) HR-SEM images of Ph-POSS@HKUST-1@PDA@Sponge after being treated with (i) acid, (ii) alkaline and (iii) salt medium.

References
**Synthesis of Octaphenyl POSS**

Octaphenyl POSS was synthesized according to the previously reported literature.\(^1,^2\) Initially, 0.3 grams of KOH were suspended in 40 ml of toluene in a dried 100 ml double-neck round-bottom flask under a nitrogen atmosphere. To the above reaction mixture, 3.6 ml of phenyltriethoxy silane was added, and the solution was refluxed at 110 °C. Subsequently, 0.5 ml of water was methodically introduced at three-hour intervals, repeating the process three times. A white precipitate formed overnight, and the reaction solution was continuously refluxed for three days. Finally, the resulting product was filtered, washed with water and methanol, and subsequently dried overnight. Yield: 2.762 grams (86 %). FT-IR (KBr, cm\(^{-1}\)): 3079(m), 3026(m), 1596(m), 1436(m), 1138(s), 1116(s), 1028(m), 994(m), 743(s), 698(s), 623(w), 606(m), 497(m). Solid state \(^{29}\)Si NMR CP-MAS (8 kHz, TMS, PPM): -77.7. TGA: temperature range (weight loss): 100–180 °C (7.7%), 360–850 °C (45.6%).

Octaphenyl POSS is insoluble in most the solvents but very slightly soluble in dichloromethane under hot condition.

**Synthesis of HKUST-1**

HKUST-1 was synthesized according to previously reported literature.\(^3\) Briefly, 1.22 grams of Cu(NO\(_3\))\(_2\)·3H\(_2\)O and 0.58 grams of 1,3,5-benzene tricarboxylic acid were dissolved in 5 grams of DMSO. This reaction solution was slowly added into the methanol solution and stirred continuously for 24 hours; the resulting product was obtained by centrifugation and washed with the excess amount of methanol three times, dried at 60 °C for overnight. Yield: 0.140 grams (45%). FT-IR (KBr, cm\(^{-1}\)): 3490(b), 1647(s), 1588(w), 1452(m), 1375(s), 1112(m), 936(w), 758(m), 729(s), 490(m). TGA: temperature range (weight loss): 30–250 °C (35.1%), 265–420 °C (30.1%) and 420–830 °C (22.8 %).
Fig. S1 (a) FT-IR spectrum of Ph-POSS@HKUST-1 (from 400 to 2100 cm\(^{-1}\)); (b) Overlapped PXRD patterns of Octaphenyl POSS, HKUST-1, and Ph-POSS@HKUST-1.

Fig. S2 \(N_2\) isotherm for HKUST-1, inset shows pore size distribution measured at 77 K (Black and red circles represent adsorption and desorption respectively).
**Fig. S3** Chemical stability PXRD spectra of Ph-POSS@HKUST-1 with different solvents (THF, Hexane and Ethanol).

**Estimation of octaphenyl POSS compositied with HKUST-1**

The residual weight % of Ph-POSS@HKUST-1 (the cage structural of POSS)

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<thead>
<tr>
<th>Quantity of Octaphenyl POSS</th>
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<td>15.2</td>
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= 37.81 wt % composited with HKUST-1

40.2

The molecular weight fraction of the cage structural POSS in Octaphenyl POSS

Ph-POSS@HKUST-1:

Octaphenyl POSS = 37.81 wt%, ratio: 2

HKUST-1 = 62.19 wt%, ratio: 3
Compared with the thermal decomposition behaviors of Ph-POSS and HKUST-1, Ph-POSS@HKUST-1 exhibited a significantly higher weight loss of 85 wt%. Furthermore, the amount of Ph-POSS on the HKUST-1 was estimated to be around 37.81 wt%. This estimation was performed based on the residual 15.2 wt% of the POSS cage and the molecular weight fraction of the POSS cage (40.2 wt%) in Ph-POSS, which closely matched the content of Ph-POSS in Ph-POSS@HKUST-1 during the synthesis process. The results demonstrated that incorporation of Ph-POSS to HKUST-1 in 2:3 ratio successfully leads to the formation of the Ph-POSS@HKUST-1 composite material.

**Fig. S4** Photographs show the water-wetting behavior at different (a) 0.25, (b) 0.5, (c) 0.75, (d) 1.0 (e) 1.5 and (f) 2.0 equivalents Ph-POSS loading in HKUST-1 for the synthesis of Ph-POSS@HKUST-1.
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References