

Supporting information

Experimental

The preparation of SBA-15. SBA-15 was synthesized by the report method.¹ 4.0 g of Pluronic P123 was dissolved in 30 g of deionized water and 120 g of 2M hydrochloric acid aqueous solution under magnetic stirring at 35°C. Then, 8.5 g of tetraethyl orthosilicate was added into the solution under magnetic stirring at 35°C and the stirring was continued for 20 hours. Then, the mixture was aged at 100°C for 1 day without stirring. The solid product was collected by centrifugation at 4,000 rpm for 15 minutes, washed with the deionized water, and air-dried at 25°C. The sample was calcined in air by slow heating from 25 to 500°C for 8 hours and kept at 500°C for 6 hours to remove P123 completely.

Characterization

The low-angle and the wide-angle powder X-ray diffraction patterns (XRD) of the products were recorded using Bruker New D8 Advance equipped with monochromatic Cu K α radiation. UV-vis absorption spectra were recorded on a Hitachi U2900 spectrophotometer (Hitachi, Japan). The photoluminescence spectra were recorded on a fluorescence spectrophotometer (FLS980, Edinburgh Instruments, England) with the excitation at 370 nm. N₂ adsorption/desorption isotherms were obtained at -196°C on a Belsorp Mini instrument (MicrotracBEL Corp). Prior to the measurement, the samples were dehydrated at 120°C under vacuum for 2 hours. The surface area was calculated by the Brunauer–Emmett–Teller (BET) method using a linear plot in the range of P/P0=0.05–0.20.² Pore size distributions were derived from the N₂ adsorption isotherm by the Barrett–Joyner–Halenda (BJH) method.³ The composition was derived on a wavelength-dispersive X-ray fluorescence spectrometer (XRF, Bruker S8 Tiger). SEM images were obtained on a JEOL JSM-7610F SEM. Prior to the measurements, the samples were coated with a platinum layer (4 nm). TEM images were obtained on a JEOL JEM 2100 FEG TEM/STEM operated at 200 kV. Elemental mapping was obtained by TEM equipped with EDS (Oxford) and EELS/GIF (Gatan) systems. FIB/SEM (Tescan, GAIA) and ultramicrotome (Reichert Ultracut E) with a DiATOME diamond knife were used to prepare the TEM specimen by cutting the hybrids particles parallelly and vertically to the pore channel of SBA-15.

Results:

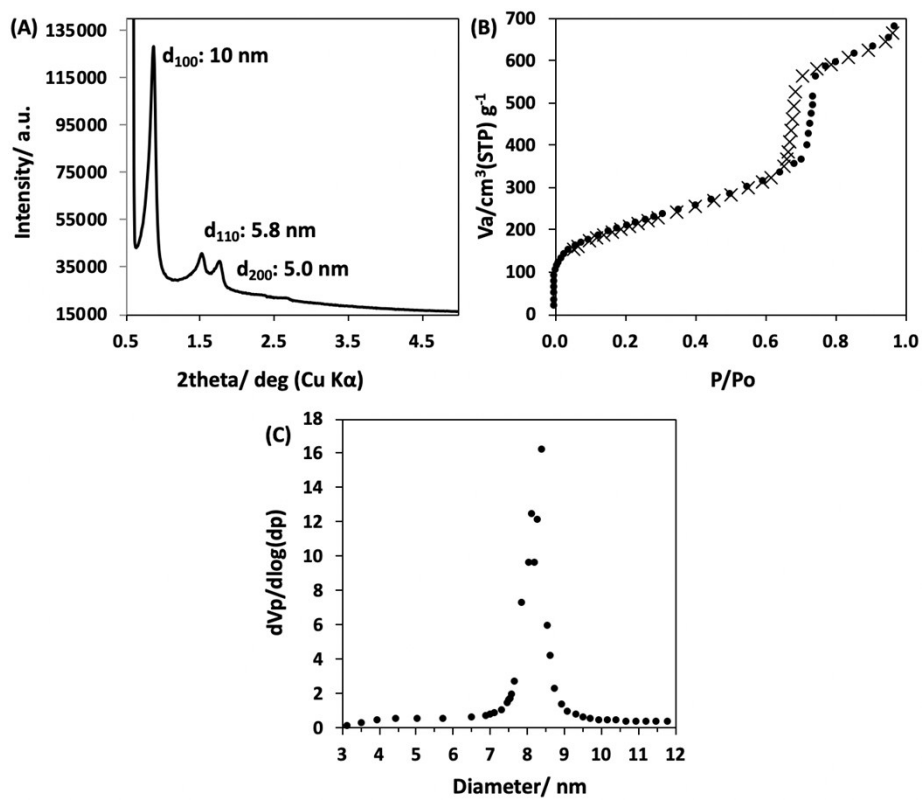


Figure S1. (A) Low angle X-ray powder diffraction of SBA-15. (B) N₂ adsorption (•) /desorption (×) isotherms and (C) BJH pore size distribution, derived from the N₂ adsorption isotherm, of SBA-15.

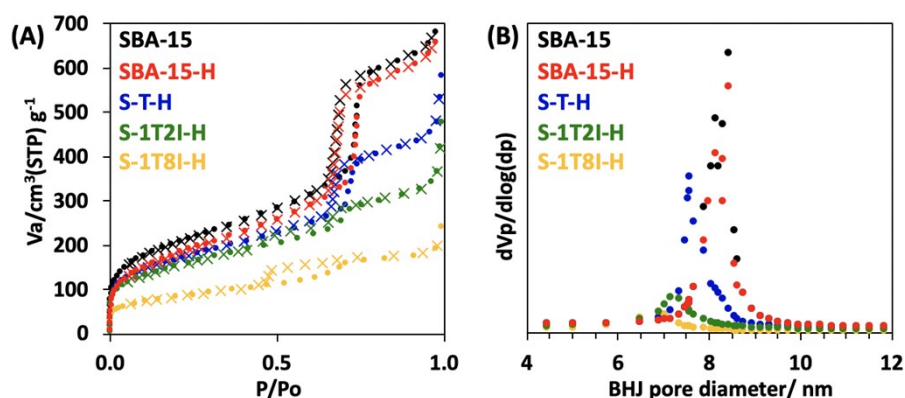


Figure S2. (A) N_2 adsorption (\bullet) /desorption (\times) isotherms (B) and BJH pore size distribution (C), derived from the N_2 adsorption isotherms, of SBA-15, SBA-15-H (SBA-15 was exposed in HCl vapor for 1 day and calcined at 300°C in air), S-T-H, S-1T2I-H and S-1T8I-H.

Table S1. The summary of the porosities and the TiO_2 content of SBA-15, SBA-15-H, S-T-H, S-1T2I-H and S-1T8I-H.

| Samples | S_{BET} (m^2/g) | V_{PORE} (cm^3/g) | D_{BJH} (nm) | TiO_2 content* (mass%) |
|----------|--|--|-----------------------|---------------------------------|
| SBA-15 | 644 | 1.35 | 8.0 | - |
| SBA-15-H | 634 | 1.33 | 8.0 | - |
| S-T-H | 290 | 0.36 (0.95)** | Broad | 64 |
| S-1T2I-H | 508 | 0.63 (1.09)** | 7.0 | 42 |
| S-1T8I-H | 575 | 0.88 (1.12)** | 7.5 | 26 |

* TiO_2 contents were determined by XRF. **The value in the parentheses is the pore volume of SBA-15–anatase (cm^3/g of silica), which was calculated from the pore volume of SBA-15–anatase ($0.36 \text{ cm}^3/\text{g}$ of hybrid) and the SiO_2 content (38 mass %) of the hybrid.

References

- (1) D. Zhao, Q. Huo, J. Feng, B. F. Chmelka, G. D. Stucky, *J. Am. Chem. Soc.*, 1998, **120**, 6024.
- (2) S. Brunauer, P. H. Emmett, E. Teller, *J. Am. Chem. Soc.*, 1938, **60**, 309.
- (3) E. P. Barrett, L. G. Joyner, P. P. Halenda, *J. Am. Chem. Soc.*, 1951, **73**, 373.

