Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Morphological study of bicontinuous concentric lamellar silica synthesized at atmospheric pressure and its application as an internal micro-reflector in dye-sensitized solar cells

Nadiatus Silmi[a,b], *Rafiq Arsyad*[a], *Didi Prasetyo Benu*[a,b,c], *Fairuz Gianirfan Nugroho*[d,e], *Wiji Lestari Khasannah*[a], *Muhammad Iqbal*[f], *Brian Yuliarto*[e,f], *Rino Rakhmata Mukti*[a,e,g], *Veinardi Suendo*[a,e*]

[a] Division of Inorganic and Physical Chemistry, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung 40132, Indonesia.

[b] Doctoral Program of Chemistry, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung 40132, Indonesia.

[c] Department of Chemistry, Universitas Timor, Kefamenanu 85613, Indonesia.

[d] Master's Program in Nanotechnology, Graduate School, Institut Teknologi Bandung, Bandung 40132, Indonesia.

[e] Research Center for Nanosciences and Nanotechnology, Institut Teknologi Bandung, Bandung 40132, Indonesia.

[f] Advanced Functional Materials (AFM) Laboratory, Department of Engineering Physics, Institut Teknologi Bandung, Bandung 40132, Indonesia.

[g] Center for Catalysis and Reaction Engineering, Institut Teknologi Bandung, Bandung 40132, Indonesia.

***Corresponding author:** vsuendo@itb.ac.id

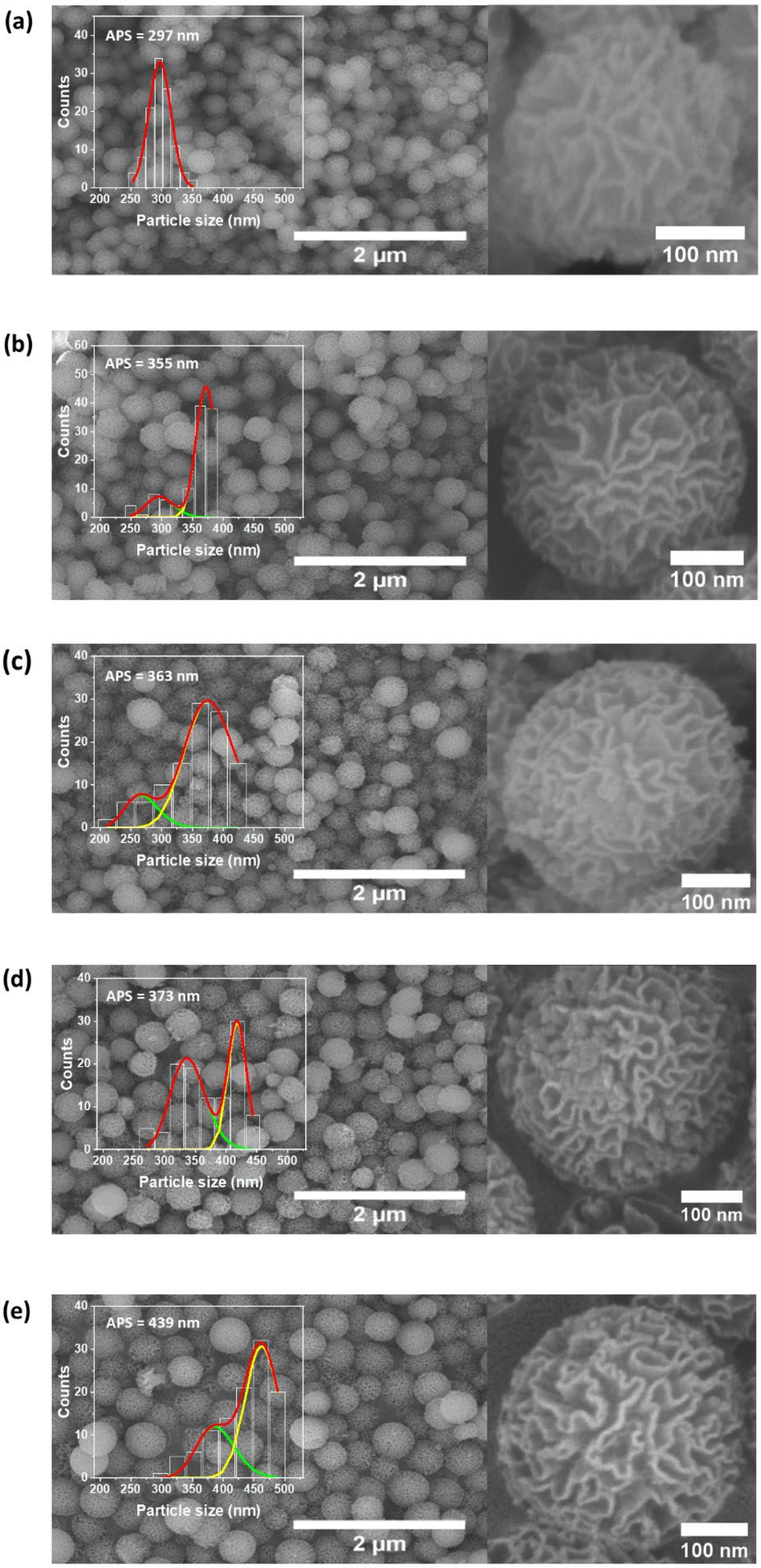


Figure S1. FESEM images and particle-size distributions of *bcl* silica that were synthesized at different times: (a) 6 h, (b) 8 h, (c) 12 h, (d) 18 h, and (e) 72 h.

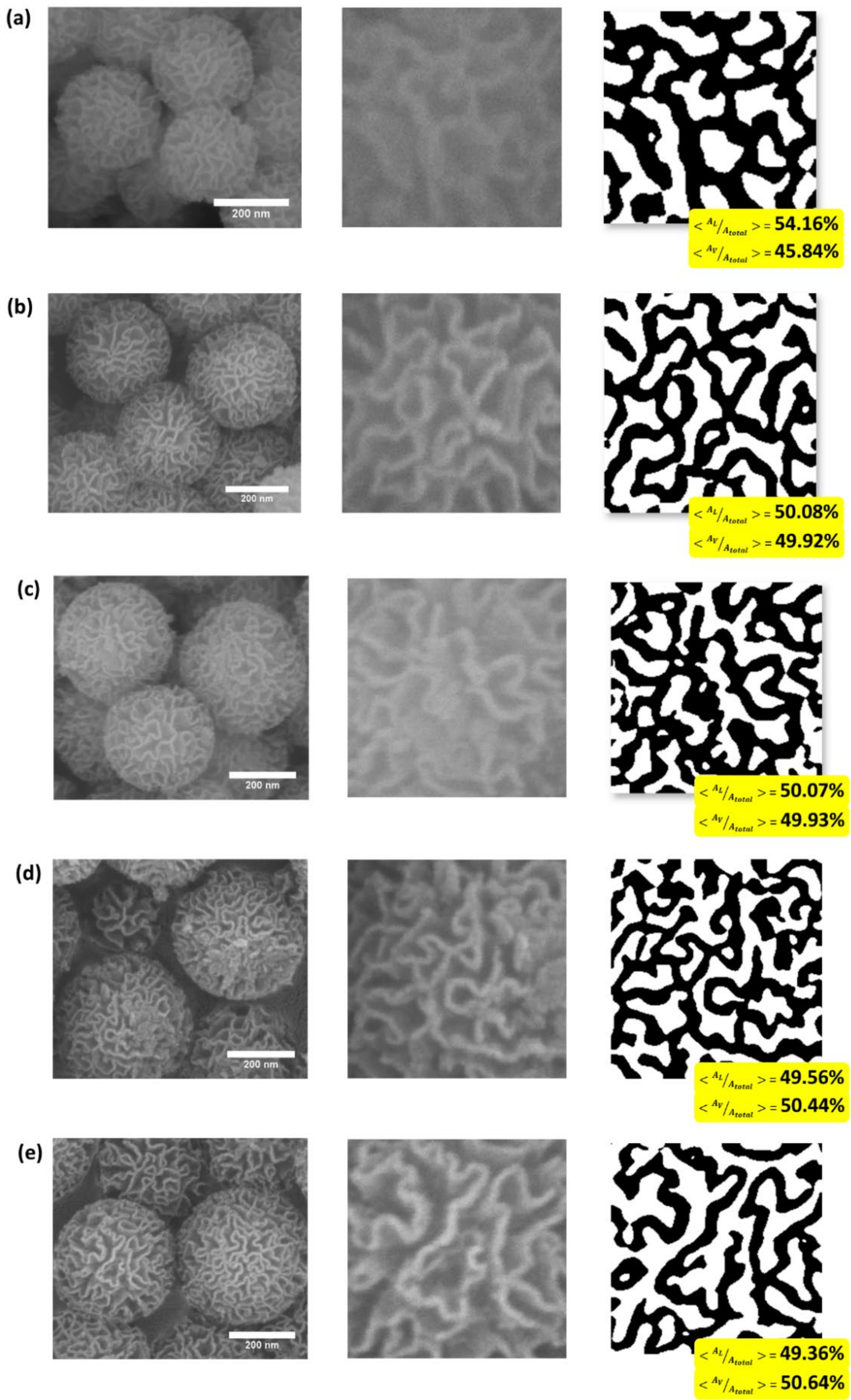


Figure S2. FESEM and binary images of *bcl* silica samples that were synthesized at different times: (a) 6 h, (b) 8 h, (c) 12 h, (d) 18 h, and (e) 72 h.

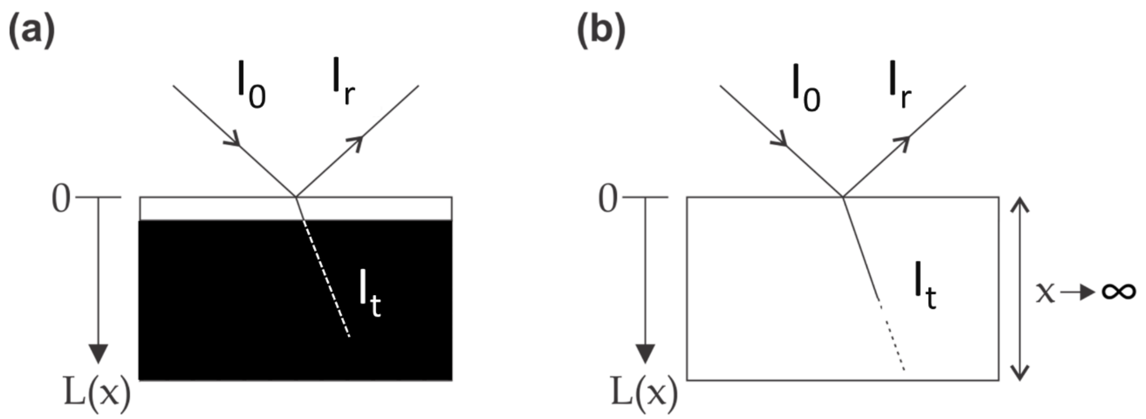


Figure S3. Kubelka-Munk model's light path. (a) The reflectance factor for a single sheet over a black background, R_0 and (b) the reflectance when the specimen is infinitely thick, R_∞.

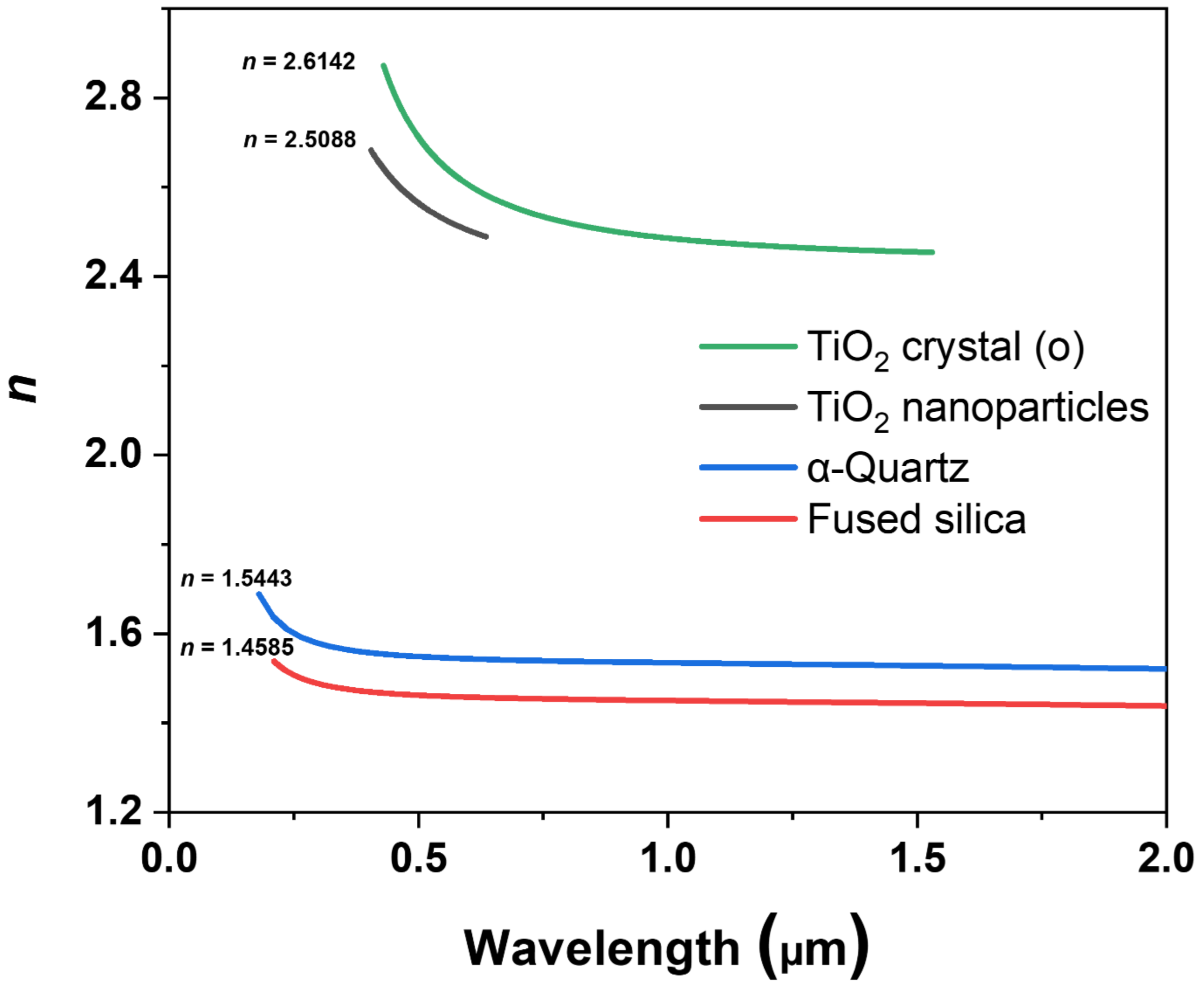


Figure S4. Refractive index (*n*) as a function of wavelength for TiO_2 crystals (ordinary ray),[1] TiO_2 nanoparticles,[2] α-Quartz,[3,4] and fused silica.[5,6]

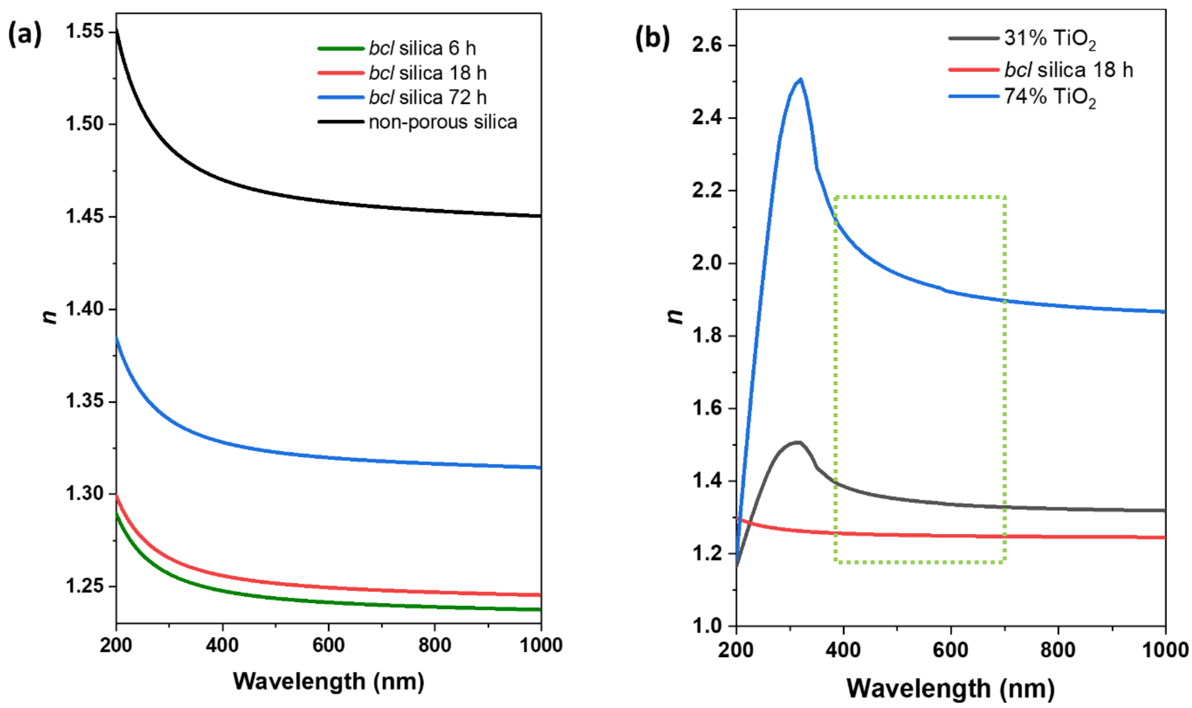


Figure S5. (a) The effective refractive index for *bcl* silica synthesized for different times compared with non-porous silica. (b) Comparison of the effective refractive indexes between the nano-spherical titania and *bcl* silica systems. The effective refractive index of nano-spherical titania film varied from the closed-packed system of hcp lattice with a filling factor of 0.74 (74% TiO_2) to a 3D random contact network of packed spheres with the threshold of 0.31 (31% TiO_2).[7,8] The green dotted line shows the visible light range. The effective refractive indexes are calculated using Bruggeman effective medium approximation by mixing the refractive index of pure silica/SiO_2[9] or titania/TiO_2 with the void in different volume fractions. The optical constants/refractive index of TiO_2 was obtained from the J.A. Woollam Co. materials database.

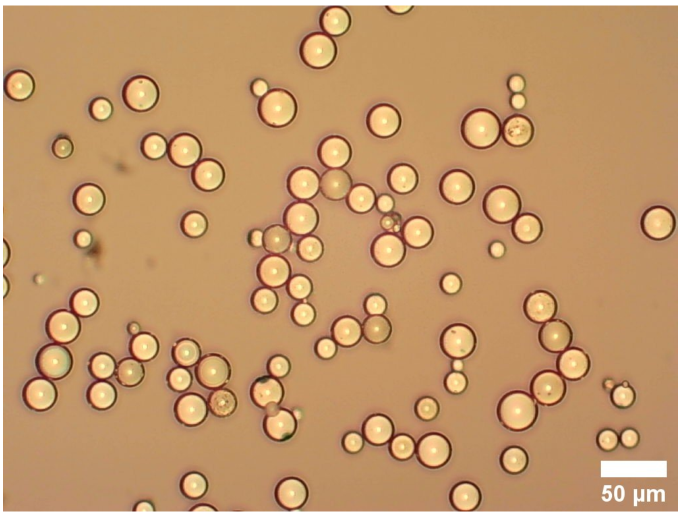


Figure S6. Microscope images of SiO_2 microbeads.

Table S1. The quantization results of the Cahn-Hilliard spinodal decomposition model (variation in D values)

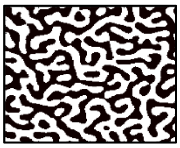
D	Gamma	Iterations	Simulation results	A_L/A_{total} (%)
5	5	10000		49.256
10	5	10000		49.654
15	5	10000		49.388
20	5	10000		49.654
25	5	10000		49.633

Table S2. The quantization results of the Cahn-Hilliard spinodal decomposition model (variation in gamma values)

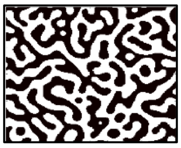
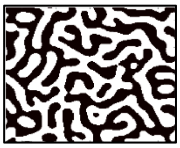
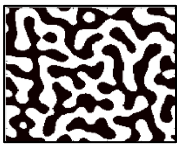
D	Gamma	Iterations	Simulation results	A_L/A_{total} (%)
10	3	10000		49.170
10	6	10000		49.348
10	9	10000		50.251
10	12	10000		48.939
10	14	10000		49.591

Table S3. The quantization results of the Cahn-Hilliard spinodal decomposition model (variation in the number of iterations)

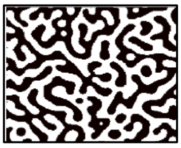
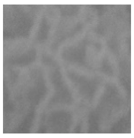
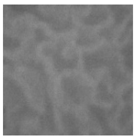
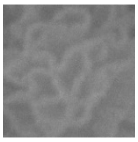
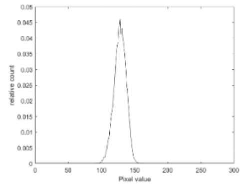
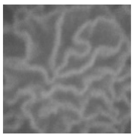
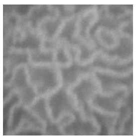
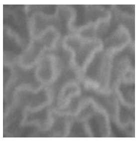
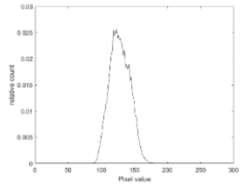
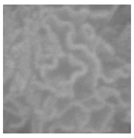
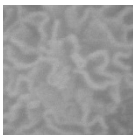
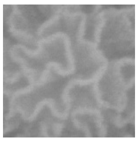
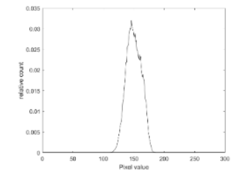
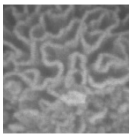
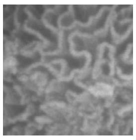
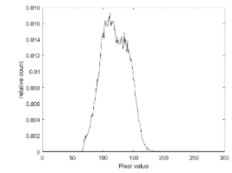
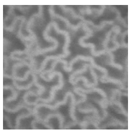
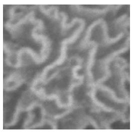
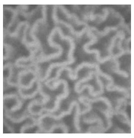
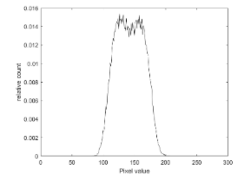
D	Gamma	Iterations	Simulation results	A_L/A_{total} (%)
10	3	10000		49.170
10	3	20000		49.594
10	3	30000		49.010
10	3	40000		49.832
10	3	50000		49.559
10	3	60000		49.331

Table S4. The average calculation of Shannon entropy of the FESEM image before thresholding

Synthesis time (h)	FESEM images before thresholding			Graph	<H>
	1	2	3		
6					5.213
8					5.963
12					5.575
18					6.486
72					6.440

Additional References:

1 J. R. DeVore, Refractive indices of rutile and sphalerite, *Journal of the Optical Society of Amerika*, 1951, **41**, 416–419.

2 I. Bodurov, I. Vlaeva, A. Viraneva, T. Yovcheva and S. Sainov, Modified design of a laser refractometer, *Nanoscience & Nanotechnology*, 2016, **16**, 31–33.

3 T. Radhakrishnan, in *Proceedings of the Indian Academy of Sciences-Section A*, Springer India, 1947, vol. 25, p. 260.

4 T. Radhakrishnan, in *Proceedings of the Indian Academy of Sciences-section A*, Springer India, 1951, vol. 33, p. 22.

5 I. H. Malitson, Interspecimen comparison of the refractive index of fused silica, *Journal of the Optical Society of Amerika*, 1965, **55**, 1205–1209.

6 C. Z. Tan, Determination of refractive index of silica glass for infrared wavelengths by IR spectroscopy, *Journal of Non-Crystalline Solids*, 1998, **223**, 158–163.

7 M. J. Powell, Site percolation in randomly packed spheres, *Phys. Rev. B*, 1979, **20**, 4194–4198.

8 R. M. Ziff and S. Torquato, Percolation of disordered jammed sphere packings, *J. Phys. A: Math. Theor.*, 2017, **50**, 085001.
9 E. D. Palik, *Handbook of Optical Constants of Solids*, Academic Press, 1st edn., 1991, vol. 2.