Supporting Information

Amorphous Colloidal Photonic Crystals Assembled by Mesoporous Silica Particles for Thin Layer Chromatography with High Separation Efficiency and Colorimetric Recognition

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Calculation of the volume fraction of micron-cracks/pores, interparticle voids, and mesopores in four photonic crystal plates

According to the SEM images and BET measurements, there are three kinds of pores in the SiO_2 PC, SiO_2 APC, m-SiO_2 PC, and m-SiO_2 APC plates. These pores are 1) micron-scale cracks/pores in PC/APC film, 2) the interparticle voids with several tens of nanometers, and 3) the mesopores inside the particles. It should be noted that the micron-scale cracks and pores are produced by the shrinkage of PC and APC domains during solvent evaporation. The interparticle voids are produced due to the close packing of spherical particles.

Before the calculation of pore ratios, the area (A) of four PC/APC films were measured by a ruler, and the film thickness (d) were measured according to the cross-sectional SEM image so that the total volume (V_{total}) was calculated to be their product. The mass of SiO_2 or m-SiO_2 particles (m_{SiO2}) was measured as the differential weight between the TLC plate and glass sides. The density of SiO_2 particles (ρ_{SiO2}) was considered as 2.04 g/cm^3 according to the bulk densities. The unit-mass mesopore volume of SiO_2 and m-SiO_2 (V_{BET}) was measured to be 0 and 1.056 cm^3/g, respectively, by the N_2 adsorption-desorption tests. Therefore, the density of m-SiO_2 particles ($\rho_{m\text{-}SiO2}$) was calculated to be 0.647 g/cm^3, since 1 g of m-SiO_2 particles have the total volume of silica (1/2.04 cm^3) and mesopores (1.056 cm^3).

First of all, the volume of mesopores (V_{meso}) could be calculated by the product of m_{SiO2} and V_{BET}. Then, the volume fraction of mesopores (f_{meso}) was calculated to be the ratio of V_{meso} and

V_{total}, as shown in Eq (1).

$$f_{meso} = \frac{V_{meso}}{V_{total}} = \frac{m_{SiO2} \times V_{BET}}{A \times d} \qquad (1)$$

Secondly, the volume of particles (V_{sphere}) in these four PC/APC films could be calculated according to their mass and densities. In a colloidal photonic crystal, the volume fractions of particles and interparticle voids are 74% and 26% according to the close-packed fcc structure. While, in an amorphous colloidal crystal, the volume fractions of particles and interparticle voids are approximately 64% and 36%, according to the literature. Therefore, the volume of interparticle voids (V_{voids}) actually could be calculated according to V_{sphere} and crystal structures. Eventually, the volume fraction of interparticle voids (f_{voids}) was calculated to be the ratio of V_{voids} and V_{total}, as shown in Eq (2) for the SiO_2 PC and the m-SiO_2 PC, and Eq (3) for the SiO_2 APC and the m-SiO_2 APC.

$$f_{voids} = \frac{V_{voids}}{V_{total}} = \frac{m_{SiO2}/\rho \div 0.74 \times 0.26}{A \times d} \qquad (2)$$

$$f_{voids} = \frac{V_{voids}}{V_{total}} = \frac{m_{SiO2}/\rho \div 0.64 \times 0.36}{A \times d} \qquad (3)$$

Thirdly, the volume of the micron-scale cracks or pores (V_{micron}) was the subtraction of V_{sphere} and V_{voids} from V_{total}. Then, the volume fraction of micron-scale cracks/pores (f_{micron}) was calculated to be the ratio of V_{micron} and V_{total}, as shown in Eq (4) for the SiO_2 PC and the m-SiO_2 PC, and Eq (5) for the SiO_2 APC and the m-SiO_2 APC.

$$f_{micron} = \frac{V_{total} - V_{sphere} - V_{voids}}{V_{total}} = 1 - \frac{m_{SiO2}/\rho \div 0.74}{A \times d} \qquad (4)$$

$$f_{micron} = \frac{V_{total} - V_{sphere} - V_{voids}}{V_{total}} = 1 - \frac{m_{SiO2}/\rho \div 0.64}{A \times d} \qquad (5)$$

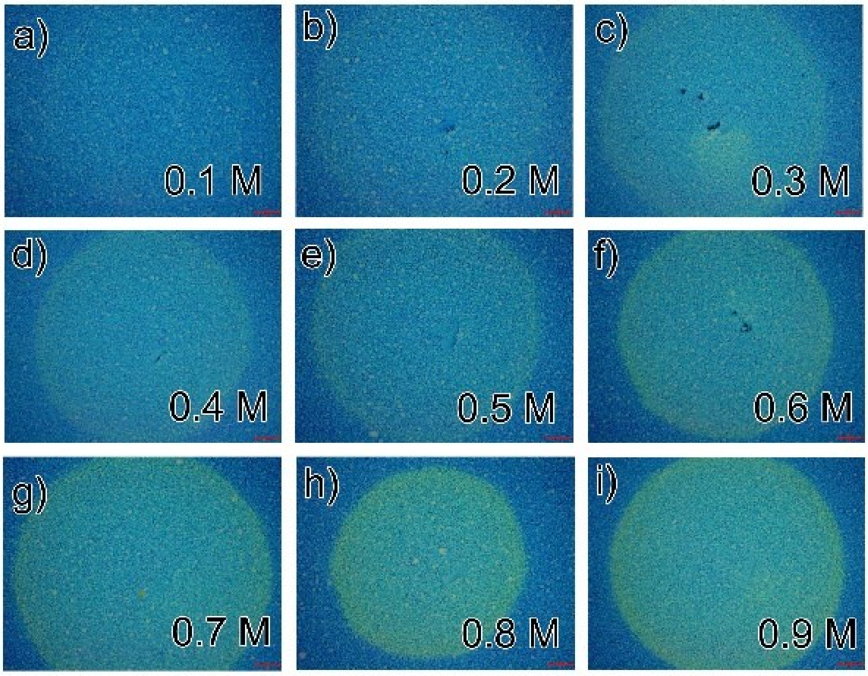

Figure S1. OM images of 4-NP sample spots with different loading concentration

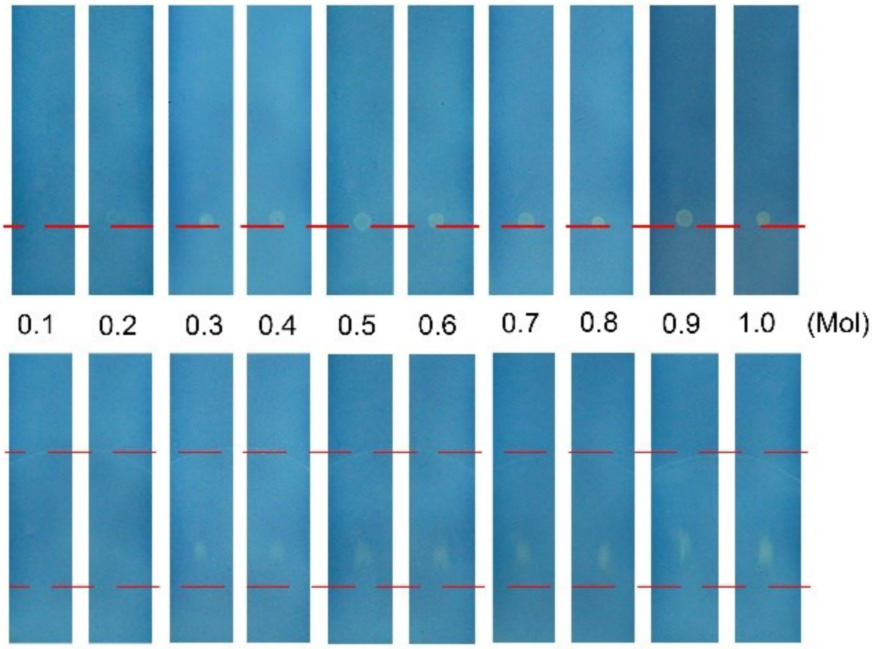

Figure S2. 4-NP sample spots with different loading concentration, developed by eluent

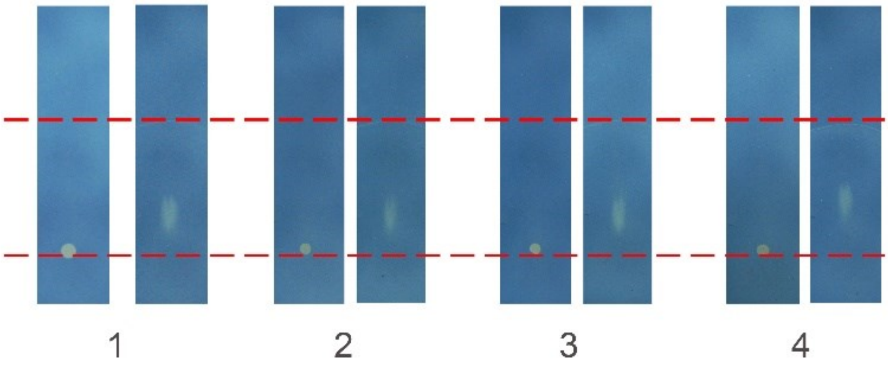

Figure S3. Development of 4-NP on the same APC plate for 4 times.

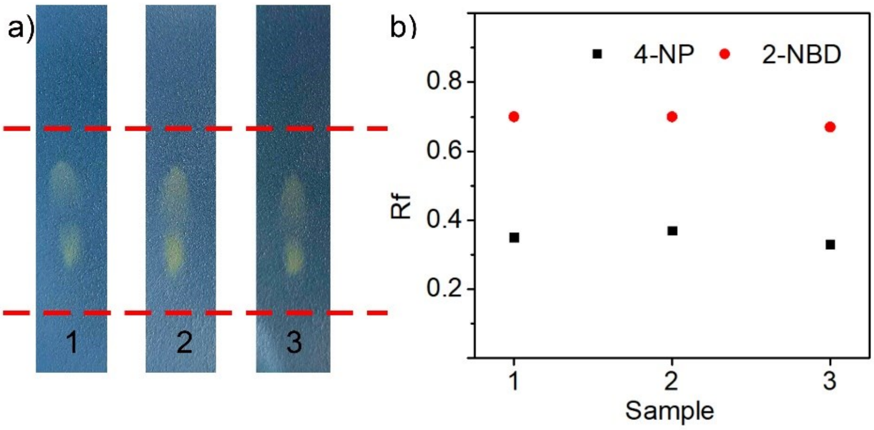

Figure S4. Three different APC-TLC plate used for the separation of 4-NP and 4-TBP

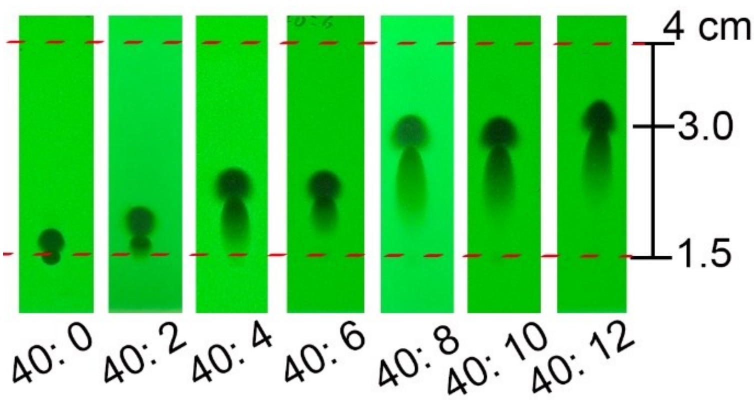

Figure S5. Digital photo of SiO_2 gel TLC plate for the separation of 4-NP, 2-NBD in different developing solvent

Figure S6. Digital photo of SiO_2 gel TLC plate for the separation of 2-NBD, 4-TBP in different developing solvent

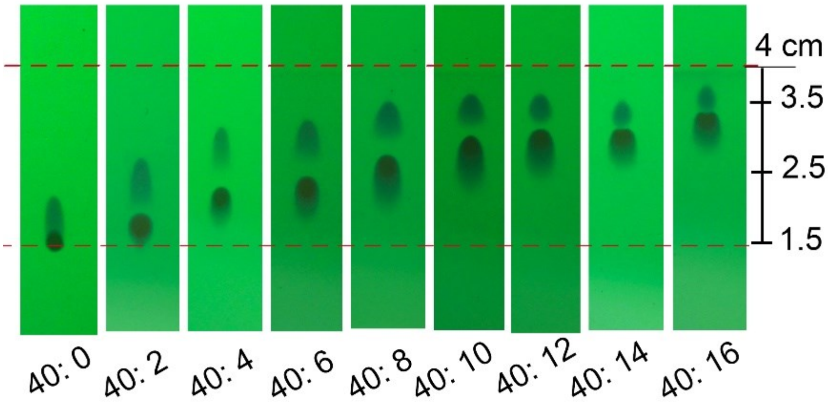

Figure S7. Digital photo of SiO_2 gel TLC plate for the separation of 4-NP, 4-TBP in different developing solvent

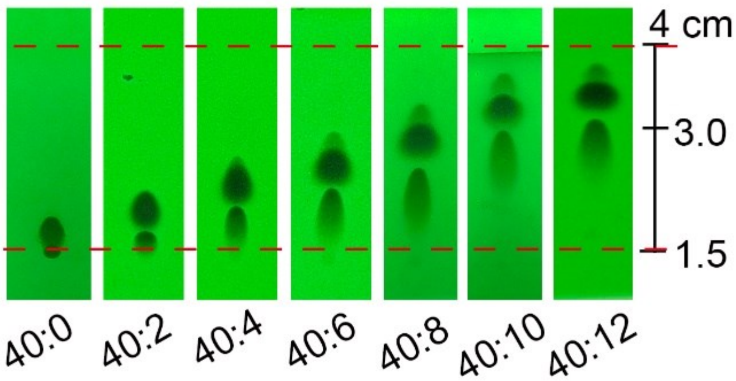

Figure S8. Digital photo of SiO_2 gel TLC plate for the separation of 4-NP, 2-NBD, 4-TBP in different developing solvent

Table S1.1 Calculation of volume fraction of "mesopores" inside TLC plate

TLC plate	m_{SiO2} (mg)	V_{BET} (cm^3/g)	V_{meso} (mm^3)	A (cm^2)	d (μm)	V_{total} (mm^3)	f_{meso} (%)
SiO_2 PC	8.30	0	0	5.025	11.43	5.743	0.00
SiO_2 APC	40.0	0	0	18.125	22.19	40.22	0.00
m-SiO_2 PC	2.83	1.056	2.988	4.650	13.66	6.352	47.0
m-SiO_2 APC	14.0	1.056	14.78	18.125	23.47	42.54	34.8

Table S1.2 Calculation of volume fraction of "interparticle voids" inside TLC plate

TLC plate	m_{SiO2} (mg)	ρ_{sphere} (g/cm^3)	V_{sphere} (mm^3)	V_{voids} (mm^3)	A (cm^2)	d (μm)	V_{total} (mm^3)	f_{voids} (%)
SiO_2 PC	8.30	2.040	4.069	1.430	5.025	11.43	5.743	24.9
SiO_2 APC	40.0	2.040	19.61	11.03	18.125	22.19	40.22	27.4
m-SiO_2 PC	2.83	0.647	4.374	1.537	4.650	13.66	6.352	24.2
m-SiO_2 APC	14.0	0.647	21.64	12.17	18.125	23.47	42.54	28.6

Table S1.3 Calculation of volume fraction of "micron-cracks/pores" inside TLC plate

TLC plate	m_{SiO2} (mg)	ρ_{sphere} (g/cm^3)	V_{sphere} (mm^3)	V_{micron} (mm^3)	A (cm^2)	d (μm)	V_{total} (mm^3)	f_{micron} (%)
SiO_2 PC	8.30	2.040	4.069	0.245	5.025	11.43	5.743	4.3
SiO_2 APC	40.0	2.040	19.61	9.582	18.125	22.19	40.22	23.8
m-SiO_2 PC	2.83	0.647	4.374	0.441	4.650	13.66	6.352	6.9
m-SiO_2 APC	14.0	0.647	21.64	8.729	18.125	23.47	42.54	20.5

Table S2. TLC parameters for the separation of 4-NP and 2-NBD by traditional SiO_2 gel TLC (Entry 1-7) and m-SiO_2 APC-TLC (Entry 8).

Entry	PE / EA	$L_{4\text{-NP}}$/cm	$W_{4\text{-NP}}$/cm	$L_{2\text{-NBD}}$/cm	$W_{2\text{-NBD}}$/cm	R
1	40 : 0	0.02	0.05	0.18	0.25	1.00
2	40 : 2	0.13	0.25	0.43	0.35	1.00
3	40 : 4	0.43	0.55	0.90	0.40	1.00
4	40 : 6	0.50	0.40	0.88	0.35	1.00
5	40 : 8	0.90	0.80	1.50	0.40	1.00
6	40 : 10	0.98	0.65	1.50	0.40	1.00
7	40 : 12	1.13	0.75	1.70	0.40	1.00
8	40 : 1	0.88	0.35	1.55	0.3	2.08

Table S3. TLC parameters for the separation of 2-NBD and 4-TBP by traditional SiO_2 gel TLC (Entry 1-7) and m-SiO_2 APC-TLC (Entry 8).

Entry	PE / EA	$L_{2\text{-NBD}}$/cm	$W_{2\text{-NBD}}$/cm	$L_{4\text{-TBP}}$/cm	$W_{4\text{-TBP}}$/cm	R
1	40 : 0	0.15	0.30	0.15	0.30	0.00
2	40 : 2	0.63	0.45	0.63	0.45	0.00
3	40 : 4	0.70	0.40	1.00	0.20	1.00
4	40 : 6	1.23	0.55	1.63	0.25	1.00
5	40 : 8	1.43	0.55	1.83	0.25	1.00
6	40 : 10	1.53	0.45	1.88	0.25	1.00
7	40 : 12	1.63	0.45	2.00	0.30	1.00
8	40 : 1	1.40	0.40	2.10	0.40	1.75

Table S4. TLC parameters for the separation of 4-NP and 4-TBP by traditional SiO_2 gel TLC (Entry 1-9) and m-SiO_2 APC-TLC (Entry 10).

Entry	PE / EA	$L_{4\text{-}NP}$/cm	$W_{4\text{-}NP}$/cm	$L_{4\text{-}TBP}$/cm	$W_{4\text{-}TBP}$/cm	R
1	40 : 0	0.08	0.15	0.39	0.47	1.00
2	40 : 2	0.20	0.40	0.91	0.58	1.45
3	40 : 4	0.50	0.60	1.35	0.60	1.42
4	40 : 6	0.63	0.65	1.53	0.55	1.50
5	40 : 8	0.83	0.85	1.76	0.52	1.36
6	40 : 10	1.13	0.85	1.93	0.45	1.23
7	40 : 12	1.29	0.62	1.93	0.45	1.19
8	40: 14	1.36	0.52	1.88	0.35	1.18
9	40: 16	1.60	0.60	2.10	0.40	1.00
10	40: 1	0.65	0.5	1.55	0.30	2.25

Table S5. TLC parameters for the separation of 4-NP, 2-NBD and 4-TBP by traditional SiO_2 gel TLC (Entry 1-7) and m-SiO_2 APC-TLC (Entry 8).

Entry	PE / EA	$L_{4\text{-}NP}$/cm	$W_{4\text{-}NP}$/cm	$L_{2\text{-}NBD}$/cm	$W_{2\text{-}NBD}$/cm	$L_{4\text{-}TBP}$/cm	$W_{4\text{-}TBP}$/cm	$R_{NP\text{-}NBD}$	$R_{NBD\text{-}TBP}$
1	40 : 0	0.02	0.05	0.23	0.35	0.23	0.35	1.00	0.00
2	40 : 2	0.13	0.25	0.50	0.40	0.50	0.40	1.15	0.00
3	40 : 4	0.33	0.45	0.80	0.40	1.05	0.10	1.12	1.00
4	40 : 6	0.48	0.55	1.03	0.35	1.30	0.20	1.22	1.00
5	40 : 8	0.66	0.68	1.33	0.35	1.63	0.25	1.29	1.00
6	40 : 10	1.10	0.70	1.75	0.30	2.00	0.20	1.30	1.00
7	40 : 12	1.30	0.60	1.85	0.30	2.13	0.25	1.22	1.00
8	40 : 1	0.85	0.30	1.53	0.35	2.10	0.40	2.08	1.53