Electronic Supporting Information

Replicating novel carbon nanostructures with 3D macroporous silica template

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1. Calculation of the stop band positions of macroporous silicas before and after carbon coating.

Before coating of carbon layer:

For 220 nm porous silica:

$$n_{eff} = 1*0.74 + 1.4*0.26 = 1.104$$

$$\lambda = \sqrt{8/3}\, d n_{eff} = \sqrt{8/3} \times 220 \times 1.104 = 397\, nm$$

For 300 nm porous silica:

$$n_{eff} = 1*0.74 + 1.4*0.26 = 1.104$$

$$\lambda = \sqrt{8/3}\, d n_{eff} = \sqrt{8/3} \times 300 \times 1.104 = 541\, nm$$

After coating of carbon layer:

For 220 nm carbon coated silica (shell thickness: 21 nm):

Volume fraction of air: $V_{air}/V_{pore} = (4/3)\pi r^3 /(4/3)\pi R^3 = (r/R)^3 = 0.530$

$$\varphi_{air} = 0.74 \times 0.530 = 0.392$$

Average refractive index:

$$n_{eff} = n_{air} \times V_{air} + n_{carbon} \times V_{carbon} + n_{silica} \times V_{silica}$$
$$= 1 \times 0.392 + 2.1 \times (0.74 - 0.392) + 1.4 \times 0.26 = 1.487$$

Position of bandgap: $\lambda = \sqrt{8/3}\, d n_{eff} = \sqrt{8/3} \times 220 \times 1.487 = 534 nm$
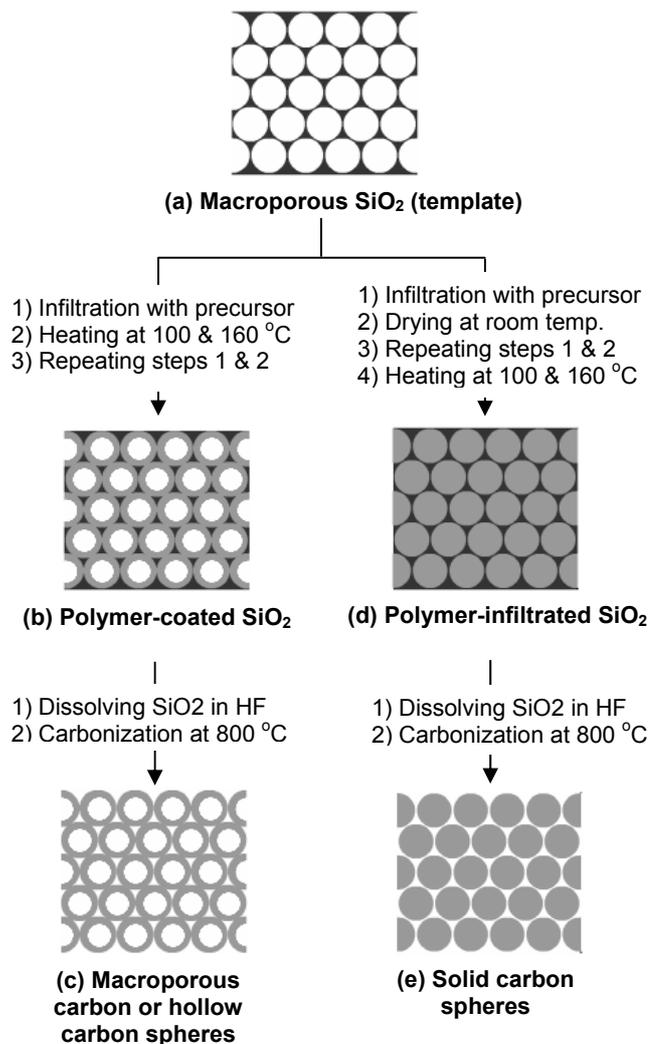
For 300 nm carbon coated silica (shell thickness: 29 nm):

Volume fraction of air: $V_{air}/V_{pore} = (4/3)\pi r^3 /(4/3)\pi R^3 = (r/R)^3 = 0.525$

$$\varphi_{air} = 0.74 \times 0.525 = 0.389$$

$$n_{eff} = n_{air} \times V_{air} + n_{carbon} \times V_{carbon} + n_{silica} \times V_{silica} = 1 \times 0.389 + 2.1 \times (0.74 - 0.389) + 1.4 * 0.26 = 1.490$$

Position of bandgap: $\lambda = \sqrt{8/3}\, d n_{eff} = \sqrt{8/3} \times 300 \times 1.490 = 730 nm$

2. **Fig. S1.** A scheme illustration showing the synthetic steps at which different compositional and structural carbons can be obtained.

(a) Macroporous SiO$_2$ (template)

1) Infiltration with precursor
2) Heating at 100 & 160 ^{o}C
3) Repeating steps 1 & 2

1) Infiltration with precursor
2) Drying at room temp.
3) Repeating steps 1 & 2
4) Heating at 100 & 160 ^{o}C

(b) Polymer-coated SiO$_2$

(d) Polymer-infiltrated SiO$_2$

1) Dissolving SiO2 in HF
2) Carbonization at 800 ^{o}C

1) Dissolving SiO2 in HF
2) Carbonization at 800 ^{o}C

(c) Macroporous carbon or hollow carbon spheres

(e) Solid carbon spheres

3. **Fig. S2.** N_2 adsorption/desorption isotherms and pore size distribution curve of hollow carbon spheres with pores of 190 nm in diameter and massive micropores.
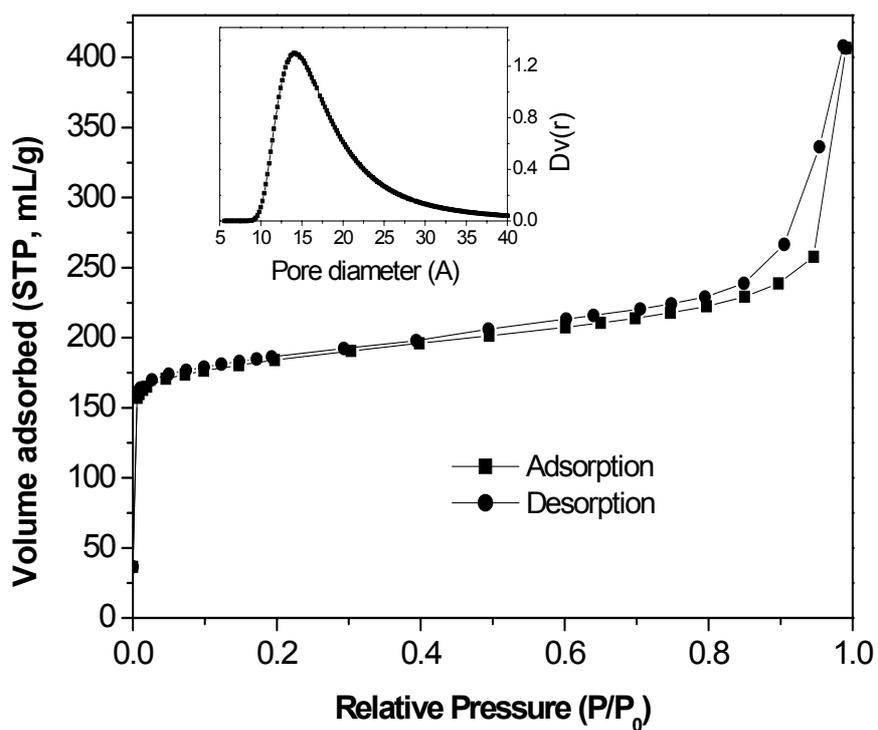
4. **Figure S3.** Reflectance microscope photographs of pure macroporous silicas and carbon-silica composites. (a) and (c): macroporous silica with pore diameters of 220 and 300 nm respectively; (b) and (d): one-time coating of carbon of (a) and (c).
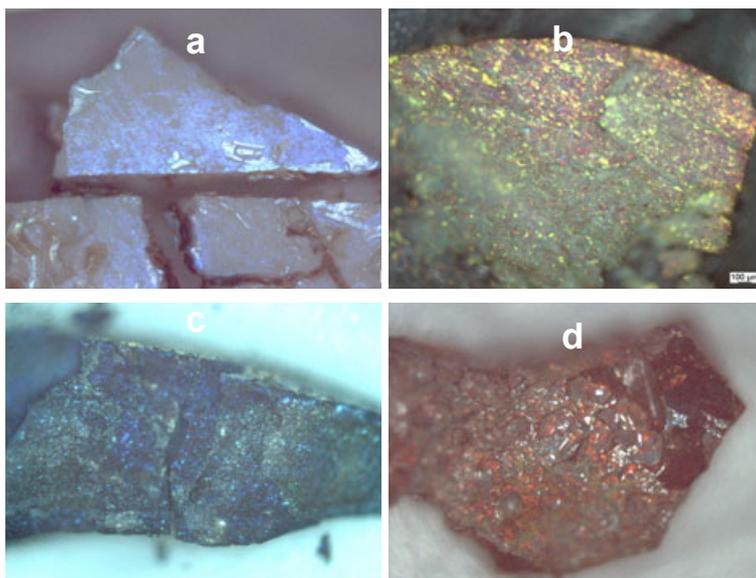
5. **Figure S4.** Photonic band structures of (a) a porous silica template, (b) a carbon-silica composite with a carbon layer thickness of 30% of the pore size of the porous silica template, and (c) a carbon-silica composite with a carbon layer thickness of 50% of the pore size of the porous silica template. Here we assume that the structures is a close-packed fcc lattice and the refractive indexes of carbon, silica and air are 2.1, 1.4, and 1, respectively.