Synthesis and formation mechanism of 1D hollow SiO_2 nanomaterials using *in-situ* formed 1D NaCl crystal templates

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Experimental Section

***Materials*:** TEOS, ammonia, glycerinum, isopropanol, isobutanol, sodium chloride and ethanol were of analytical grade and used as received and supplied by Aldrich. The water used was deionized.

***Synthesis of SiO_2 hollow nanobelts*:** The synthesis of SiO_2 hollow nanobelts were achieved by using the NaCl nanobelts as the templates in basic solution at room temperature. Typiclly, a certain amount of NaCl/glycerinum (1.7M) solution (0.1ml) was added into the isopropanol (20ml), and agitated for 5min. To this suspension, TEOS (0.21ml), $NH_3{\cdot}H_2O$ (0.14ml) and H_2O (0.14ml) were added step by step, which was reacted at 25°C for 2h and the NaCl@SiO_2 composites were formed. And then, TEOS (0.24ml), $NH_3{\cdot}H_2O$ (0.1ml), and H_2O (0.45ml) were added step by step and reacted at room temprature for another 4h. Then the products were collected by centrifugation, washed with deionized water several times, dried at 200°C under air atmosphere overnight.

***Synthesis of SiO_2 hollow nanotubes*:** For the synthesis of NaCl@SiO_2 nanotubes with size of about 150nm, a certain amount of NaCl/glycerinum (0.1ml) was added into the isobutanol (20ml). To this suspension, TEOS (0.30ml), $NH_3{\cdot}H_2O$ (0.2ml) and H_2O (0.2ml) were added step by step, which was reacted at 25°C for 2h. And then, TEOS (0.4ml), $NH_3{\cdot}H_2O$ (0.1ml), and H_2O (0.45ml) were added step by step and reacted at room temprature for another 4h. Then the products were collected by centrifugation, washed with deionized water several times, dried at 200°C under air atmosphere overnight.

***Characterization*:** The microscopic morphology was obtained using a field-emission

scanning electron microscope (FE-SEM, HITACHI S-3400, Japan) at an acceleration voltage of 15kv. The microstructure and composition of the samples were further analyzed using a transmission electron microscope (TEM, JEOL 2010) with an energy –dispersive spectrometer (EDS) attachment. The powder X-ray diffraction (XRD) patterns were recorded using a Rigaku UItima IV diffractometer with Cu Ka X-ray radiation (r=1.5405 A), using a voltage and current of 40 kV and 40mA, respectively, with a scanning rate of 5^{o} min^{-1}. N_2 adsorption/desorption measurements were performed using Micromeritics ASAP 2010. The pore size distribution was calculated from the adsorption branch of the sorption isotherms using the Brunauer-Joyner-Halenda (BJH) method.

Figure S1. Nitrogen adsorption-desorption isotherms and pore size distributions of mesoporous SiO_2 hollow nanobelts (a) and SiO_2 hollow nanotubes (b). The inset shows the pore size distribution calculated from the desorption branch.

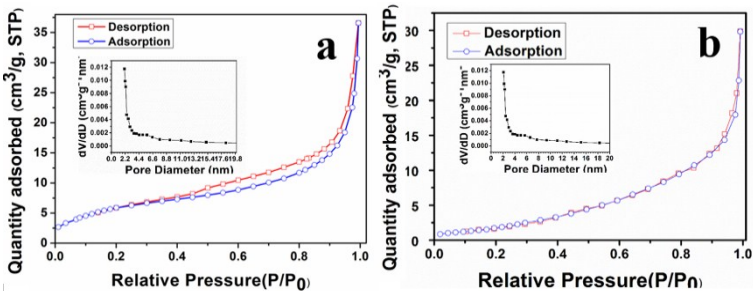

Figure S2. Typical SEM image of the RD-NaCl@SiO_2 composites with size of about 2um (a), NaCl@SiO_2 nanobelts (before filtration) prepared at different adding amount of water of 0.05ml (b), 0.25ml (c), 0.45ml (d), 0.65ml (e), while the adding amount of the TEOS and ammonia was fixed at 0.15ml and 0.1ml. When the adding amount of water was 0.05ml, NaCl crystals in NaCl@SiO_2 composites were partly dissolved and released (f), the red arrows shown the NaCl@SiO_2 yolk-shell composites. The inset in image e shows a TEM image of the SiO_2 hollow particles.

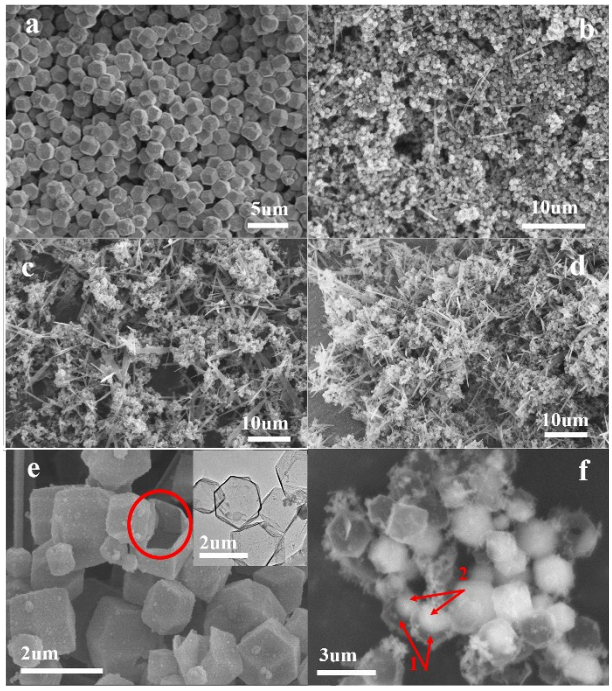

Figure S3. SEM (a), TEM (b) images of NaCl@SiO_2 nanobelts and SiO_2 hollow nanobelts (c), the inset show the SEM image of the SiO_2 hollow nanobelts.

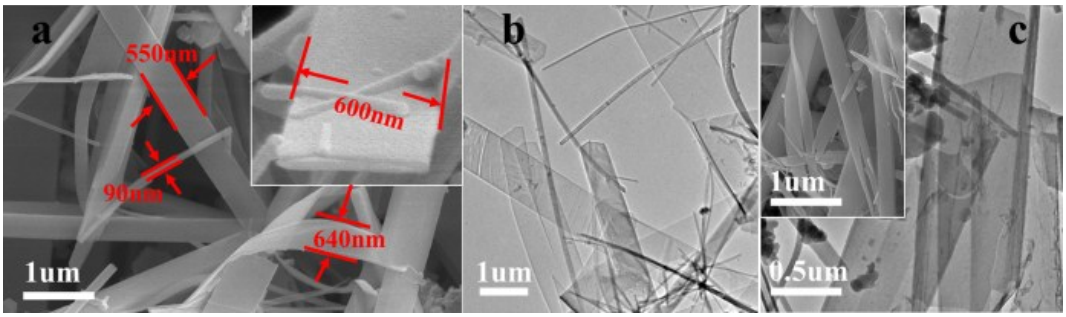

Figure S4. Typical SEM images of NaCl@SiO_2 nanobelts prepared at different adding amount of TEOS of 0.21ml (a), 0.24ml (b), 0.27ml (c), while the adding amount of the water and ammonia, was fixed at 0.45ml and 0.1ml.

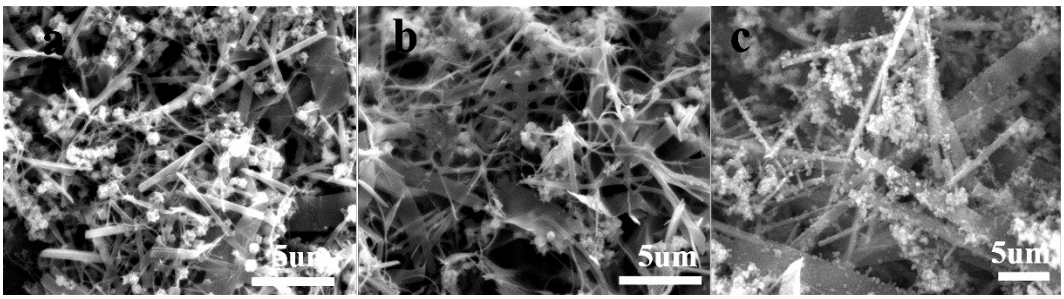

Figure S5. SEM image of ultrafine NaCl@SiO_2 nanowires that had just outflowed of the SiO_2 mesoporous shells.

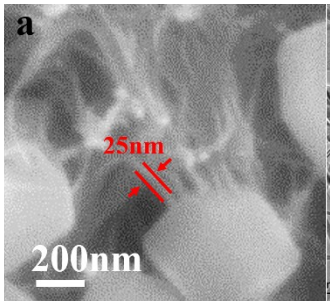

Figure S6. Typical SEM image of the rhombic dodecahedron NaCl cubic crytals (a) with size of about 150nm and TEM image of the NaCl@SiO_2 cubic compsites (b). SEM image (c) of SiO_2 hollow cubic materials and NaCl@SiO_2 nanowires. TEM image (d) shows the SiO_2 hollow cubic after centrifugation. The pure NaCl@SiO_2 nanowires (e) were collected after centrifugation, and the inset in figure e shows the TEM image of the NaCl@SiO_2 nanowires. After washing with water several times, SiO_2 hollow nanotubes (e) are obtained, the insert confirms the hollow structure of the SiO_2 hollow nanobelts.

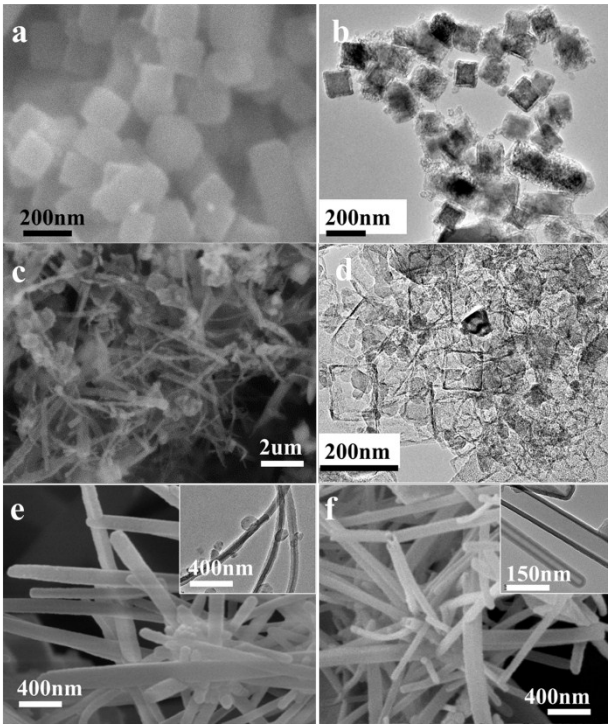

Figure S7: XRD pattern of the NaCl@SiO_2 nanowires and SiO_2 nanotubes after washing the NaCl template.

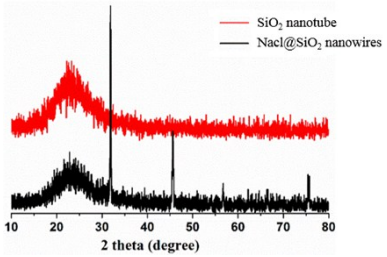

Table S1

Table S1. The influence of coating ratio of TEOS: NH_3H_2O: H_2O and NaCl on the SiO_2 hollow nanobelts.

(1) After the RD-NaCl@SiO_2 composites with size of about 2um formed (0.1ml NaCl/Glycerinum solution, 0.21 ml TEOS, 0.14ml $NH_3{\cdot}H_2O$ and 0.14 ml H_2O were added to the solution for the fromation of RD-NaCl@SiO_2 composites), the second coating ratio of TEOS: NH_3H_2O: H_2O are taken from 0.15: 0.1: 0.05 to 0.27: 0.1: 0.65.

	NaCl/Glycerinum solution (ml)	TEOS (ml)	$NH_3{\cdot}H_2O$ (ml)	H_2O (ml)	Yields of SiO_2 1D hollow materials(mg)	Mophologies
1	0.1	0.15	0.1	0.05	2	Hollow Nanobelts (>90%) and nanotubes
2	0.1	0.15	0.1	0.25	6	Hollow Nanobelts (>90%) and nanotubes
3	0.1	0.15	0.1	0.45	10	Hollow Nanobelts (>90%) and nanotubes
4	0.1	0.15	0.1	0.65	0	No
5	0.1	0.21	0.1	0.45	14	Hollow Nanobelts (>90%) and nanotubes
6	0.1	0.24	0.1	0.45	19	Hollow Nanobelts (>90%) and nanotubes
7	0.1	0.27	0.1	0.45	21	Hollow Nanobelts (>90%) and nanotubes