Electronic Supplementary Information

Patterned One-Dimensional Photonic Crystals with Acidic/alkali Vapor Responsibility

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Experimental

Materials: Synthesis of the TiO_2 Sol: Tetrabutyl titanate (20 g) was dissolved in 20 g of ethyl alcohol with stirring for 1 h. Acetic acid (2.12 g), hydrochloric acid (4.06 g), and ethanol (7 g) were then mixed homogeneously followed by adding dropwise into the above solution and stirred for another 3 h. The obtained yellow transparent solution was allowed to undergo hydrolysis reaction at room temperature overnight. The EB form PANI was dissolved by Dimethyl Formamide (DMF) and adjusted to suitable concentrations.

Preparation of the 1DPCs: The 1DPCs were fabricated by spin-coating the TiO_2 sol and the EB form PANI alternately; both the TiO_2 sol and the polymer precursor were spin-coated at 3000 rpm for 60s onto a silicon wafer. PANI was dissolved by Dimethyl Formamide (DMF) and adjusted to suitable concentrations. In order to get different film thicknesses, compositions can be diluted into different concentrations or spin-coated in different rotate speeds. The TiO_2 layer was baked at 60 °C for 10 min and the polymer layer was baked at 135 °C for 10 min. The first layer was the polymer layer and the last layer was the TiO_2 layer in all our experiments. The number of total layers of the film materials was 2 N.

Preparation of HCl and NH_3: The acid-base vapors were performed under saturated pressure of concentrated HCl (37 wt. %) and NH_3 (28 wt. %).

Characterization: Scanning electron microscopy (SEM) images were obtained from a field emission scanning electron microscope (FE-SEM, HitachiS-3000N, Japan). In situ reflectance spectra were collected by a fiber optic spectrophotometer (Ocean Optics, Inc., HR 2000 256 UV-Vis-NIR).Ultraviolet (UV)-light (handheld UV-lamp, 0.3 mW cm^{-2}, 365 nm). Angle dependence intensity spectra were obtained by Spectroscopic Ellipsometry (Semilab GES5E).Color photos were taken on a digital camera (Canon 5D Mark II, Japan).

Formula:

$$m\lambda_{Bragg}=2D(n^2_{eff}-sin^2\theta)^{1/2} \qquad (1)$$

$$n^2_{eff}=n_1^2f_1+n_2^2f_2 \qquad (2)$$

Where m is the diffraction order, D is the period, λ_{Bragg} is the position of Bragg peak, θ is the incident angle, n_{eff} is the effective refractive index, *and* n_1, f_1, n_2 and f_2 are refractive indexes and volume fractions of the two different layers respectively.

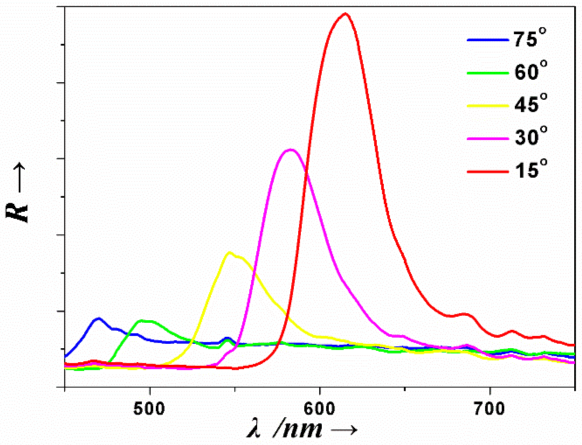

Figure S1. Optical angle dependence properties of the 1DPCs with different incident angles.

Theoretical value of the stop bands

According to the formula (1) and (2) above, we can calculate the theoretical value of the photonic stop bands. The effective refractive index of the TiO_2 layer was determined by spectroscopic ellipsometry to be 1.83. The effective refractive indexes of the EB form PANI layer was about 1.45 and ES form PANI was up to 1.51-1.56 which were also determined by spectroscopic ellipsometry. As the EB form PANI layer's thickness was about 193 nm and TiO_2 layer was 38 nm which were determined by SEM.

The original stop band of the EB form PANI/TiO_2 1DPC was at 531 nm. The theoretical stop band of the ES form PANI/TiO_2 1DPC was at about 560 nm ~ 584 nm. Nevertheless, the actually stop band was at 591 nm which was larger than the theoretical value. We attribute the increase to the swelling of the porous PANI structural. In conclusion, the main reason of the stop band shift was caused by the change of the refractive index.

Analysis of FT-IR

The interface interaction between PANI and TiO_2 was cause by UV radiation. In FT-IR, it can be clearly seen that the main characteristic peaks of PANI all appear in the FT-IR spectra. And compared with the main bands of EB form PANI at 1560 cm^{-1}(C=N and C=C stretching mode), 1296 and 1240 cm^{-1}(C=N stretching mode), all bands made a red shift after being doped with HCl. However, after irradiated with UV light, all bands of the doped ES form PANI showed another red shift.

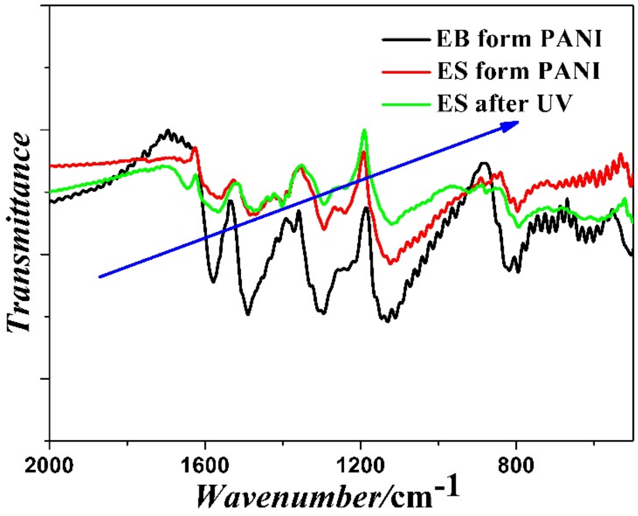

Figure S2. FT-IR spectra of PANI under EB form (black line), ES form (red line) and after UV irradiation process (green line).

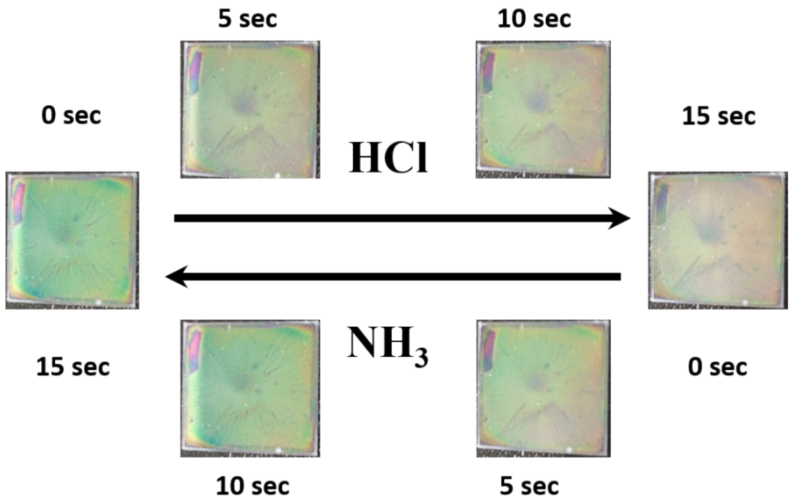

Figure S3. Photographs of the as-prepared 1DPCs without artificial pattern corresponding to different exposure times to HCl and NH_3 vapors.

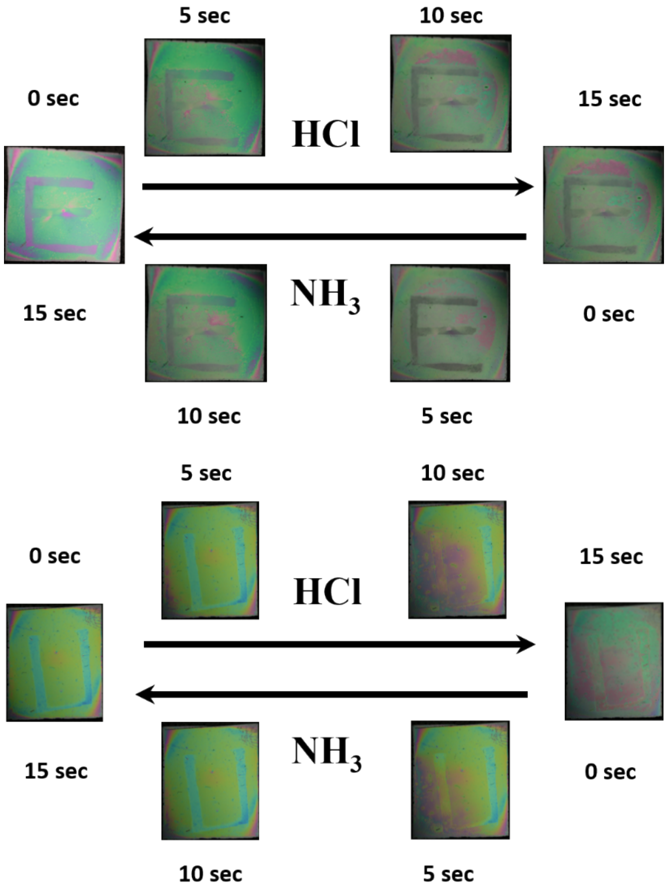

Figure S4.Photographs of the as-prepared 1DPCs with artificial pattern "E" and "U" corresponding to different exposure times to HCl and NH_3 vapors.