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Supporting Information

Dually Switchable Lasing Emission in Photonic Crystal Cavity with Temperature and Solvent-Responsiveness

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Materials and Methods

Materials. Acrylic acid (AA), Tetrahydrofuran (THF), N-Isopropyl acrylamide (NIPAM), Benzil and 2-benzyl–2-(dimethylamino)-4-morpholinobutyrophenone were purchased from J&K Chemical Co., Ltd. Dipentaerythritol hexacrylate (DPE-6A) was purchased from Kyoeisha Chemical Co. Ltd., Japan. Ethanol, acetaldehyde solution (40 % solution in water), toluene, sodium hydroxide (NaOH) and polyvinyl alcohol (PVA) were purchased from Sinopharm Chemical Reagent Beijing Co., Ltd. 3-(trimethoxysilyl)propyl methacrylate (TMSPMA) was purchased from Nanjing Chuangshi Chemical Co., Ltd. Rhodamine B was purchased from Tianjin Hengxing Chemical Reagent Co., Ltd. Polystyrene monodisperse nanoparticle emulsion was home-made in the laboratory. The glass slides were purchased from Starmicro Co. Ltd. All of the chemicals are used without further purification.

Preparation of PS colloidal crystals. PS colloidal crystals were self-assembled on the surface of glass slides by the vertical deposition method. Firstly, the glass slides were cleaned by alkali tank, rinsed with deionized water, and dried. Then, the glass slides were vertically immersed in monodisperse PS emulsion (0.18 wt%) in vacuum oven at 65 ℃ for 72 hours. Finally, PS colloidal crystals were deposited on the surface of the glass slides. PS colloidal crystal templates with different stopbands were obtained by using PS emulsion with different nanoparticle sizes (408, 380 and 280 nm).

Preparation of responsive photonic crystals (RPCs). Responsive photonic crystals were constructed by the template method using PS colloidal crystals. Firstly, we prepared the responsive photoresist by mixing 12 mg benzil, 12 mg Irgacure 369, 362 mg AA, 354 mg NIPAm, and 260 mg DPE-6A in dark room for 8h. Secondly, the TMSPMA-treated glass slide was covered on PS colloidal crystal template, and photoresist was infiltrated in the PS colloidal crystal template by capillary force. The photoresist was photopolymerized by UV irradiation (32.5 $mW \cdot cm^{-2}$, 3 minutes). Thirdly, the cured photoresist with PS colloidal crystal template is transferred to the TMSPMA-treated glass slide after careful separation of the two glass slides. Finally, responsive photonic crystals were obtained by the removal of PS colloidal crystal templates through immersion in THF for 12h.

Preparation of RhB-doped polymer film. 48 mg RhB was mixed with 11 mg benzil, 11 mg Irgacure 369, 249 mg AA, 243 mg NIPAm, and 438 mg DPE-6A in dark room for 8h. Then, RhB-doped photoresist was spin-coated on the glass slide, and cured by UV irradiation (32.5 $mW \cdot cm^{-2}$, 3 minutes) to obtain the RhB-doped polymer film.

Preparation of responsive photonic crystal cavity. RPC cavity was constructed by sandwiching a pair of RPCs with RhB-doped polymer film. RPC_{408nm} was selected to prepare

the RPC cavity for the temperature-responsive lasing emission. For the reversibly switchable lasing emission under different solvents, $RPC_{380\ nm}$ was employed to construct the RPC cavity.

Characterization and measurements.

UV-Vis absorption and photoluminescence spectra were measured by using Varian Cary-5000 and Hitachi F-4500 fluorescence spectrometer, respectively. The morphology of the RPCs was characterized by scanning electron microscopy (SEM, S-4800, Hitachi, Japan). The reflection spectra were measured by using an Ocean Optics spectrometer (Shanghai Ideaoptics Corp., Ltd.) with standard aluminum mirror as a reference mirror. Solvent response of the RPCs was evaluated by measuring the reflection spectra after exposure to the 40 % acetaldehyde and THF. Temperature response of the RPC was evaluated by measuring the reflection spectra before and after thermal treatment on the hotplate. Emission spectra of the RPC cavity were excited by using a 532 nm pulsed laser (Nd: YAG, 8 ns, 10 Hz, Spectrum Physics, USA), and recorded by a home-made experimental setup with a fiber optic spectrometer (SD 2000, Ocean optics, USA). All the measurements are carried out at room temperature.

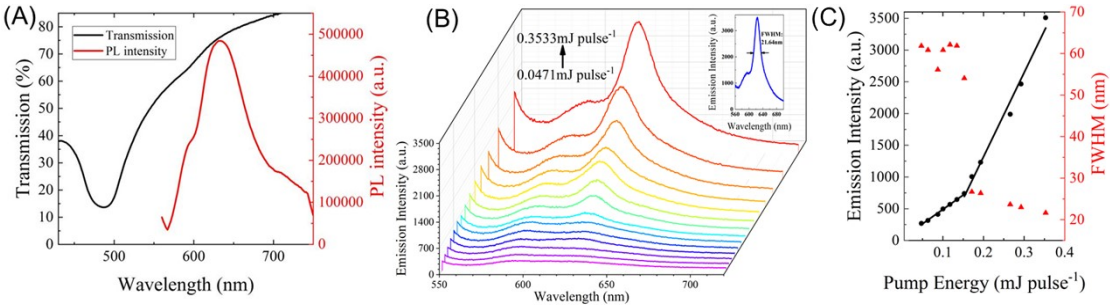

Figure S1. (A) Transmission spectrum of $RPC_{280\ nm}$ and PL spectrum of RhB-doped polymer film. (B) Emission spectra of the $RPC_{280\ nm}$ cavity under 532 nm laser excitation. (C) The relationship of emission intensity and FWHM as a function of pump energy.