Electronic Supplementary Information

Enhanced linear thermosensitivity of gel-immobilized colloidal photonic crystal film bound on glass substrate

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Experimental procedure

Materials

A suspension of monodisperse polystyrene particles (Thermo Scientific, 5014B; particle diameter: 140 nm) was deionized in a vial using mixed-bed ion-exchange resin (Bio-Rad, AG501-X8) until it showed iridescence, which was indicative of a crystal phase. The colloidal crystal was mixed with an aqueous solution that consisted of *N*-isopropylacrylamide (NIPAM, Wako Pure Chemical Industries, Ltd.) and *N*-methylolacrylamide (NMAM, Wako Pure Chemical Industries, Ltd.) as monomers, *N*,*N*′-methylene-bis-acrylamide (BIS, Wako Pure Chemical Industries, Ltd.) as a cross-linker, and 2,2′-azobis[2-methyl-*N*-(2-hydroxyethyl)propionamide] (VA, Wako Pure Chemical Industries, Ltd.) as a photo-induced polymerization initiator for ultraviolet (UV) light. The colloidal crystal containing the gelation reagent (particle concentration: 11.3 vol%; NIPAM: 440 mM; NMAM: 360 mM; BIS: 40 mM; VA: 0.5 mM) was bubbled with Ar gas for 5 min to remove the dissolved O_2 and CO_2.

Fabrication of flat capillary cell

3-(trimethoxysilyl)propyl methacrylate (TMSPMA, GE Healthcare Life Sciences, Bind-Silane) was diluted in toluene (Wako Pure Chemical Industries, Ltd.) to a concentration of 10 vol%. A slide glass (Muto Pure Chemicals, Co., Ltd.) was coated with the solution and then dried for 1 day. The slide glass was washed with ethanol and used as a bottom substrate for a flat capillary cell. A quartz substrate with a flow channel (0.1 mm thick, 9 mm wide, 50 mm long) was used as a top substrate for the cell. The top and bottom substrates were put between two metallic frames and fixed with screws. The flat capillary cell with the bottom substrate uncoated with the TMSPMA was used to prepare the gel-immobilized colloidal crystal film that was unbound on the substrate.

Preparation of gel-immobilized colloidal photonic crystal film bound on glass substrate

The colloidal crystal containing the gelation reagent was injected into the flat capillary cell and processed with a momentarily strong shear flow to obtain a single domain crystal extending throughout the cell. The NIPAM, NMAM, and BIS dissolved in the suspension and TMSPMA bound on the substrate were polymerized by the uniform UV light irradiation with two sets of LED arrays (Moritex Corp., MBRL-CUV7530) from both sides of the cell surface through light diffusers at 25 °C for 2 h. When the screws were loosened, and the top substrate was removed, the gel-immobilized colloidal crystal film bound on the bottom substrate was obtained. The thickness of the gel film was ~100 μm, and approximately 480 FCC (111) crystalline layers were aligned perpendicular to the thickness direction.

Characterization

The gel-immobilized colloidal crystal films unbound and bound on the substrates were put in a water bath and the temperature was controlled using a temperature controller (AS ONE Corp., TR-3A or SCP-125). Photographs and reflection spectra of the gel films at normal incidence were obtained at various temperatures using a charge-coupled device (CCD) camera (Sony, XCD-V60CR) and a multichannel spectrometer (Soma Optics, Fastevert S-2630) connected to a Y-branch optical fiber, respectively. For the spectral measurement, light from a halogen lamp was illuminated onto the film through one branch of the fiber. Backscattered light from the film was collected by the same fiber head through the other branch and detected using the spectrometer. The thickness of the gel film bound on the substrate was measured by observation made through an optical microscope (Olympus, GX-71) at various temperatures.

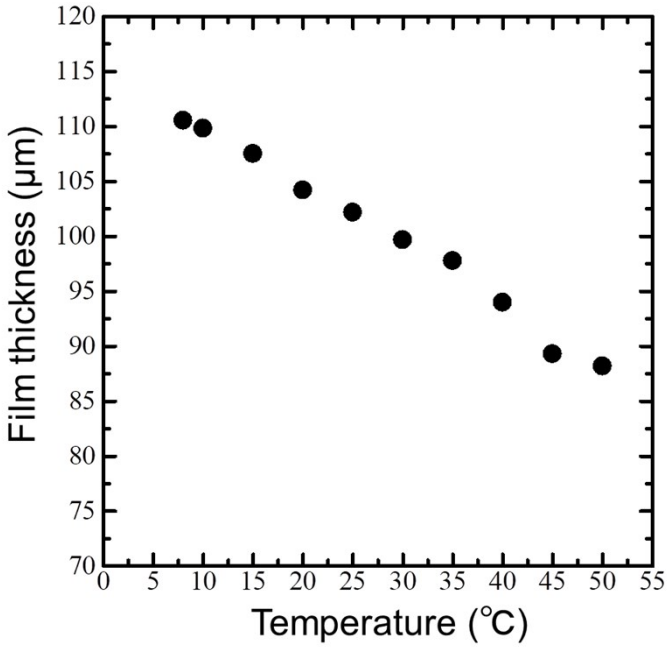

Fig. S1 Thickness of the gel-immobilized colloidal crystal film bound on a substrate at various temperatures.