

Supporting Information

Background Color Dependent Photonic Multilayer Films for Anti-counterfeiting Labeling

Jeong Min Kim, ‡^a Jae Min Bak, ‡^b Bogyu Lim,^a Yu Jin Jung,^a Byong Chon Park,^c Min Ji Park,^a Jong Mok Park,^{*a} Hyung-il Lee^{*b} and Seo-Hyun Jung^{*a}

^aCenter for Advanced Specialty Chemicals, Korea Research Institute of Chemical Technology (KRICT), Ulsan 44429, Republic of Korea

^bDepartment of Chemistry, University of Ulsan, Ulsan 680-749, Republic of Korea

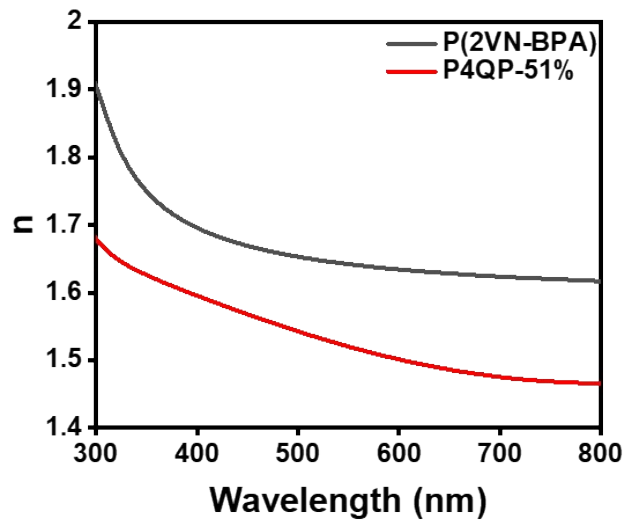
^cKorea Research Institute of Standards and Science, Daejeon 305-340, Republic of Korea

1. Experimental Section

Materials: 2,2-Azobisisobutyronitrile (AIBN; 98%, JUNSEI) was purified by recrystallization with methanol before use, while 4-Vinylpyridine (95%, Alfar Aesar) and acryloyl chloride (96%, Merck KGaA) were utilized after purification through a basic alumina-filled column to remove inhibitors. 2-Vinylnaphthalene (95%, Sigma-Aldrich), 4-hydroxybenzophenone (98%, Alfar Aesar), triethylamine (TEA, 99%, Tokyo Chemical Industry Co., Ltd.; TCI), 1,4-dioxane (99%, Sigma-Aldrich), N,N-dimethylformamide (DMF, 99.9%, SAMCHUN), and 1-chloropropane (98%, Sigma-Aldrich) were used as received. P(2VN-co-BPA) and P4QP-51% were prepared as reported previously.

Instrumentation: ¹H NMR spectroscopy was conducted with an Avance III HD 300 MHz (Bruker). Apparent molecular weights were measured by gel permeation chromatography (GPC) (1260 Infinity, Agilent) using a polystyrene standard with DMF eluent at 30 °C and a 1 mL/min flow rate. The refractive index of each polymer was measured by ellipsometry (HORIBA Scientific., UVISEL). Lamellae were viewed using transmission electron microscopy (TEM) prepared from the polymer-laminated sample using a focused ion beam (FIB) method. To reduce the FIB damage, the outermost layer of the polymer laminate was pre-coated with successive layers of sputtered-platinum, carbon (permanent marker deposition), and ion-beam deposited platinum before FIB milling. The ion-beam deposition and milling were performed with an FEI Helios Nanolab FIB system (Thermo Scientific). Cross-sectional images of the polymer laminates were then acquired from the lamellae via scanning-TEM (STEM) (bright field, four-channel-STEM; GEMINISEM 500, ZEISS) at a 30 kV acceleration voltage (200 kV failed to produce enough contrast difference between the two alternating polymer films in the laminate). Spectral reflectance was observed using a UV-vis spectrometer (USB4000, OceanOptics Inc.). Digital photographs of the 1D PC films were acquired using a Canon EOS RP.

Fabrication of the 1D PC film (F1): F1 film samples were prepared as follows: 1.5 wt% (P4QP-51%) was dissolved in 1-propanol, and 2.5 wt% P(2VN-co-BPA) in chlorobenzene, and passed through a 0.45 μm PTFE syringe filter before spin-coating. Next, the two polymer solutions were alternatively spin-coated onto a PET film at 2300 rpm for 12 s. The film was then dried for 2 min to eliminate the solvent, followed by exposure to a UVA lamp (652 mJ/cm^2) after each spin-coated layer was applied. This process was repeated to generate overall 10 layers.



Polymers	Refractive index
P(2VN-BPA)	1.630
P4QP-51%	1.491

Figure S1. The refractive indices of single layers of each polymer analyzed by ellipsometer.