Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Multifunctional sensors based on liquid crystals scaffolded in nematic polymer networks

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Figure S1 shows DSC thermograms of the PEGDA/5CB mixture before and after polymerization. Before the polymerization, the phase transition temperature of the blended polymer with 6% PEGDA was 29.7 °C. With 12% PEGDA, the transition temperature only changed slightly to 28.7 °C. It suggests that the addition of PEGDA to 5CB lowered the clearing point of the mixture. Once the mixture was polymerized, the 5CB phase-separated from the polymer matrix and its clearing temperature went back to 32.9 °C. The presence of polymerized PEGDA did not influence the phase transition of 5CB.

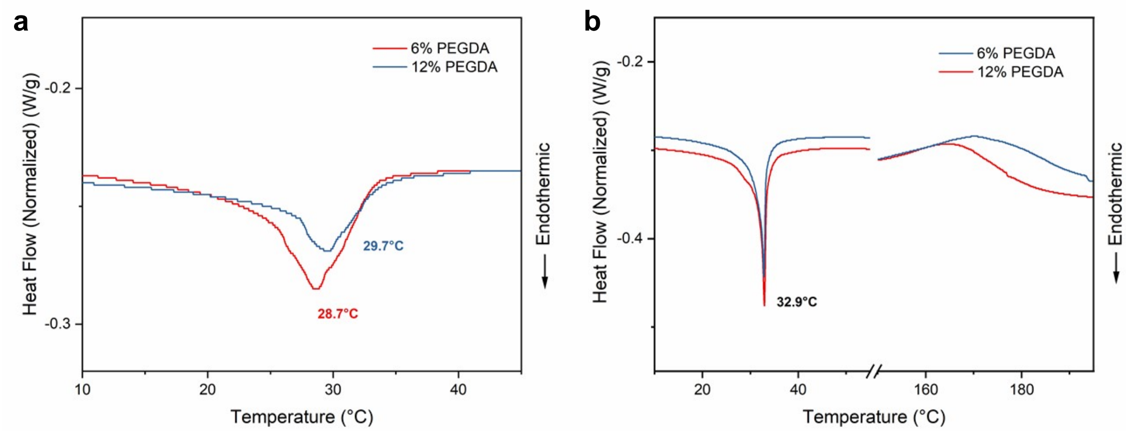

Figure S1. Differential scanning calorimetry (DSC) of the PEGDA/LC mixtures (a) prior to polymerization and (b) after polymerization.

Figure S2 shows the fabrication process of toluene vapor sensor. The microchannels encapsulated with LC mixtures with different concentrations of RM257 were prepared by infusing the LC mixtures at a constant flow rate to obtain a planar alignment. Subsequently, the LC mixture was polymerized under UV and used as a toluene vapor sensor.

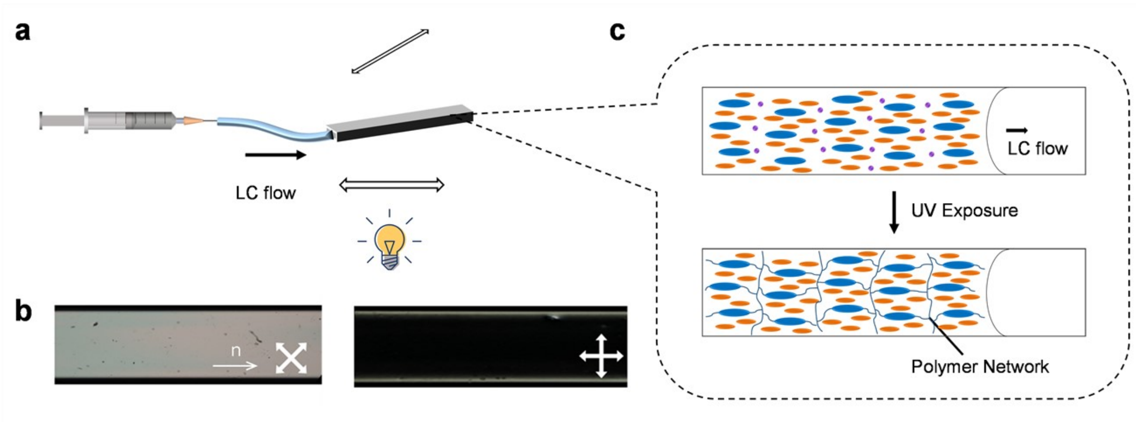

Figure S2. (a) Experimental set-up of the LC mixture flow into the DMOAP-coated microchannel. (b) Schematic illustration of the LC orientation driven by the flow inside the microchannel. The LCN is formed after UV exposure. (c) Polarized optical images of the PNLC in the microchannel, where the alignment direction is 45° to the polarizer in the bright mode and 90° in the dark mode.

Figure S3 shows color profiles of PNLCs with different concentrations of RM257, after they were exposed to 11,500 ppm of toluene vapor for 7 h to reach equilibrium. The color at the open end of sample containing 4%-10% of RM257 showed white, light yellow, magenta, and purple color, respectively. But for the sample containing only 2% RM257, we only observed a strip pattern. The black part inside the strip suggests that the LC transfers into isotropic phase directly. For the sample containing 12% of RM257, the interference color through the channel had little variation even at high toluene vapor concentration.

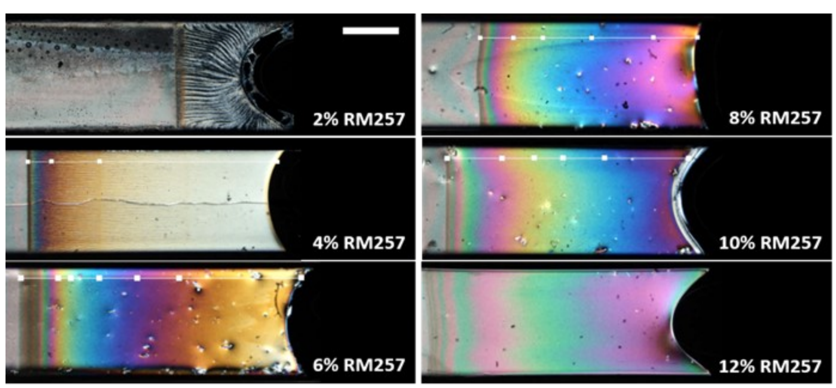

Figure S3. Optical responses of microchannel encapsulated PNLC with 2%-12% of RM257 exposing to 11,500 ppm of toluene vapor for 7 h. (Scale bar: 500 µm)

We exposed the samples with 4% to 10% RM257 to different toluene vapor concentration from 2,300 to 11,500 ppm for 15 h to reach an equilibrium state. Since the color at the open end of the microchannel represents the toluene vapor concentration in the environment, it can be used to detect the toluene vapor effectively. The relationship between the estimated birefringence and toluene vapor concentration of each sample was obtained in Figure S4. The birefringence decreases with the increase of toluene vapor concentration.

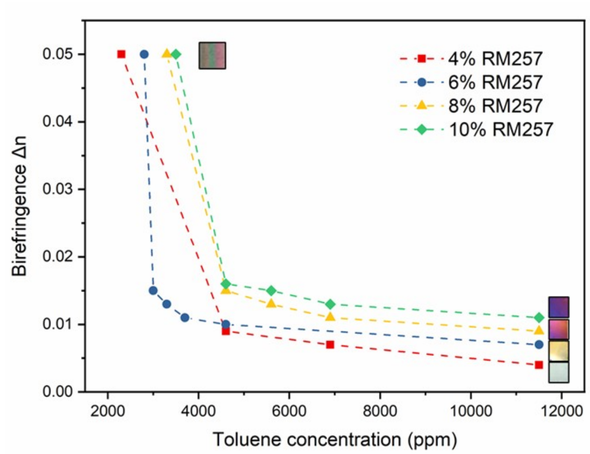

Figure S4. Birefringence (*Δn*) of the microchannel encapsulated PNLCs with 4% - 10% RM257 at different toluene vapor concentrations. The *Δn* decreased with the increase of toluene vapor concentration. The estimated birefringence was obtained from the interference color according to the Michel-Levy chart.

We measured the transmission spectra of the PNLC films of 4%, 8% and 10% RM257 at different temperatures. As shown in Figure S5, all the transmittance curve shifted towards a shorter wavelength with the increase of temperature.

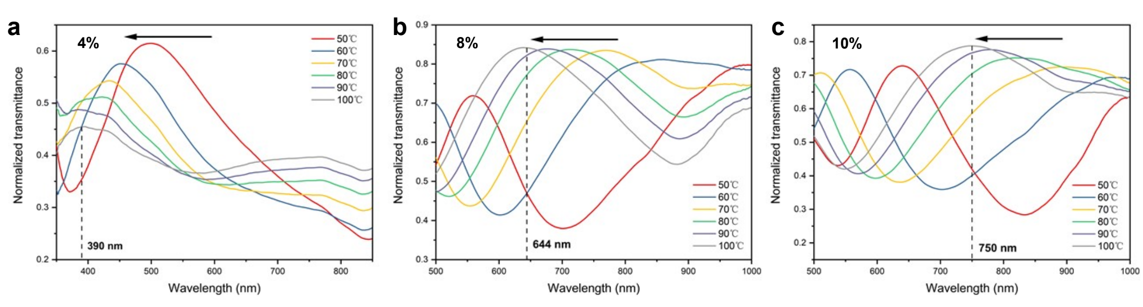

Figure S5. Normalized transmittance spectrum of the PNLC with (a) 4%, (b) 8%, and (c) 10% RM257 from 50 ℃ to 100 ℃.