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Supporting information

A bifacial colour-tunable system via combination of cholesteric liquid crystal network and hydrogel

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Contents

A. Sample Fabrication:

1. Silanization: Glass substrates were first sonicated with acetone and isopropyl alcohol for 10 min each. This was followed by treatment under UV-ozone cleaner for 20 min to activate the glass surface towards functionalization. Then 3-(trimethoxysilyl)propyl methacrylate (Silane A174, Sigma Aldrich) solution (1 vol % solution in a 1:1 water−isopropanol mixture) was spin coated on the activated surface (3000 rpm, 60 s) of the glass substrate and finally cured at 100 ^{o}C for 10 min to get methacrylate functionalized surface.

2. Preparation of PVA coating: Glass substrates (15mm x 15 mm) were first sonicated with acetone and isopropyl alcohol for 10 min each. Then, 1 wt% polyvinyl alcohol (PVA, Sigma Aldrich) solution (in water) was spin coated on the glass substrate (3000 rpm, 60 s), followed by baking at 100 ^{o}C for 10 min.

3. Preparation of ChLCN coating: Preparation of ChLCN was done according to previous report.[1] 1 gm of ChLCN mixture containing 18 wt% each of 4-Methoxybenzoic acid 4-(6-acryloyloxyhexyloxy)phenyl ester (Synthon Chemicals), 4-(6-Acryloyloxy-n-hex-1-yloxy)benzoic acid (Synthon Chemicals), 4-(6-Acryloyloxy-n-hex-1-yloxy)-2-methylbenzoic acid (Synthon Chemicals), 4-Cyano-4'-pentylbiphenyl (Sigma Aldrich), 22.5 wt% of 1,4-Bis-[4-(3-acryloyloxypropyloxy)benzoyloxy]-2-methylbenzene (Synthon Chemicals), 4.5 wt% of (3R,3aS,6aS)-Hexahydrofuro[3,2-b]furan-3,6-diyl bis(4-(4-((4-(acryloyloxy)butoxy)carbonyloxy)benzoyloxy)benzoate) (LC756, Synthon Chemicals) and 1 wt% of photoinitiator Phenylbis(2,4,6-trimethylbenzoyl)phosphine oxide (Sigma Aldrich), was dissolved in 2 mL of dichloromethane. Then, 15 µL of this solution was cast on methacrylate functionalized glass substrate, followed by solvent evaporation by heating to 70 ^{o}C on a hot plate. Next, the sample was covered by a PVA coated glass substrate (15mm x 15 mm) and cooled to 40 ^{o}C, while continuously shearing in one direction to get the cholesteric alignment. After ensuring the uniform reflection from the sample, polymerization was carried out by irradiating with 375 nm (40 mW cm^{-2}) UV LED (Thorlabs) for 5 minutes. After polymerization, sample was put in water, so that PVA coated glass can be easily removed to obtain ChLCN coating (15mm x 15 mm) attached to silanized glass. Coating was then made humidity responsive by dipping in THF and 1 M NaOH solution for 30 min each. Average thickness of pristine coating was found to be ca. 15 µm.

4. Preparation of PAA hydrogel layer: Hydrogel preparation was done as previously reported.[2] The monomer mixture consisted of 99 vol% acrylic acid (AA, Sigma Aldrich) and 1 vol % poly(ethylene glycol) diacrylate (PEGDA-575, Sigma Aldrich). In addition to this Phenylbis(2,4,6-trimethylbenzoyl)phosphine oxide (Sigma Aldrich) – a photoinitiator - was also added to the mixture (0.1 wt% of total monomer weight). The solution was diluted by adding 75%vol of water. This solution was then infiltrated into a cell gap (15 mm x 15 mm x 0.05 mm) made from silanized and PVA coated glasses and polymerized by irradiating with 375 nm (40 mW cm^{-2}) UV LED (Thorlabs) for 5 minutes to get poly(acrylic acid) hydrogel (PAA). After that PVA coated glass was removed, hydrogel layer remained attached to the silanized glass substrate.

5. Fabrication of HumiCell: PAA containing glass substrate was dipped in water for 2 minutes, flushed with compressed air and allowed to dry on a weighing balance. The weight of water inside the hydrogel was observed to decrease continuously with time, till it reached equilibrium condition. Hence, several samples with distinct wt% of water could be prepared by keeping the sample on weighing balance (for drying) and monitoring the weight loss with time. When the sample reaches a required wt% of water, it was immediately sealed in a HumiCell design assembly. This was achieved by sealing a hydrogel coated glass together with a humidity responsive ChLCN coated glass (both described above) in a cell geometry, such that the two coatings face each other. Sealing was done using a 1mm thick double-sided adhesive tape (3M®), which gives a cell gap of 1mm.

References:

1 M. Moirangthem and A. P. H. J. H. J. Schenning, *ACS Appl. Mater. Interfaces*, 2018, **10**, 4168–4172.

2 J. E. Elliott, M. MacDonald, J. Nie and C. N. Bowman, *Polymer (Guildf).*, 2004, **45**, 1503–1510.

B. Supplementary Figures:

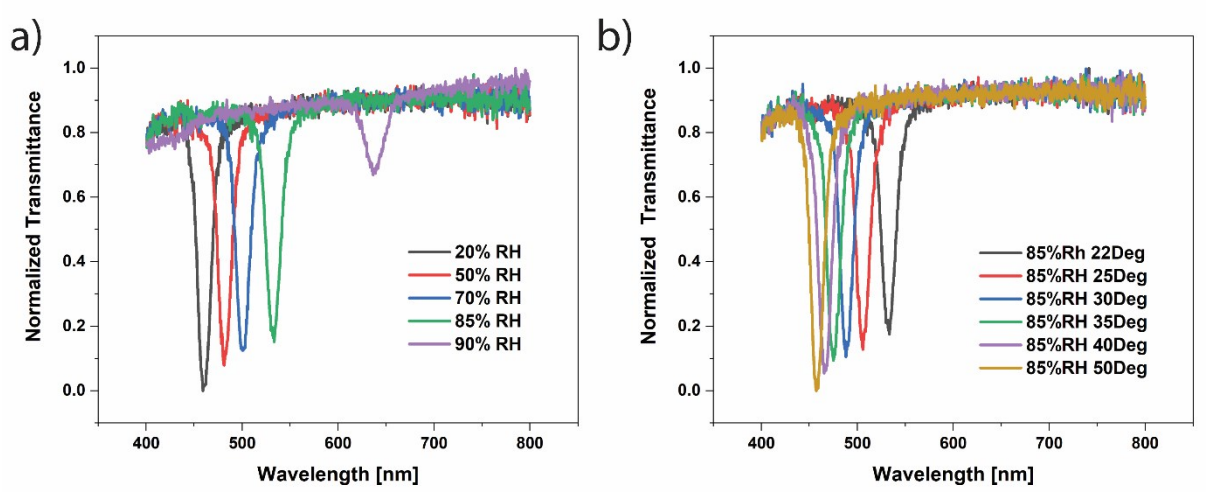


Fig. S1. Normalized transmission spectra of ChLCN coating at **a)** different RH% and at **b)** constant RH of 85% with sample being heated to different temperatures.

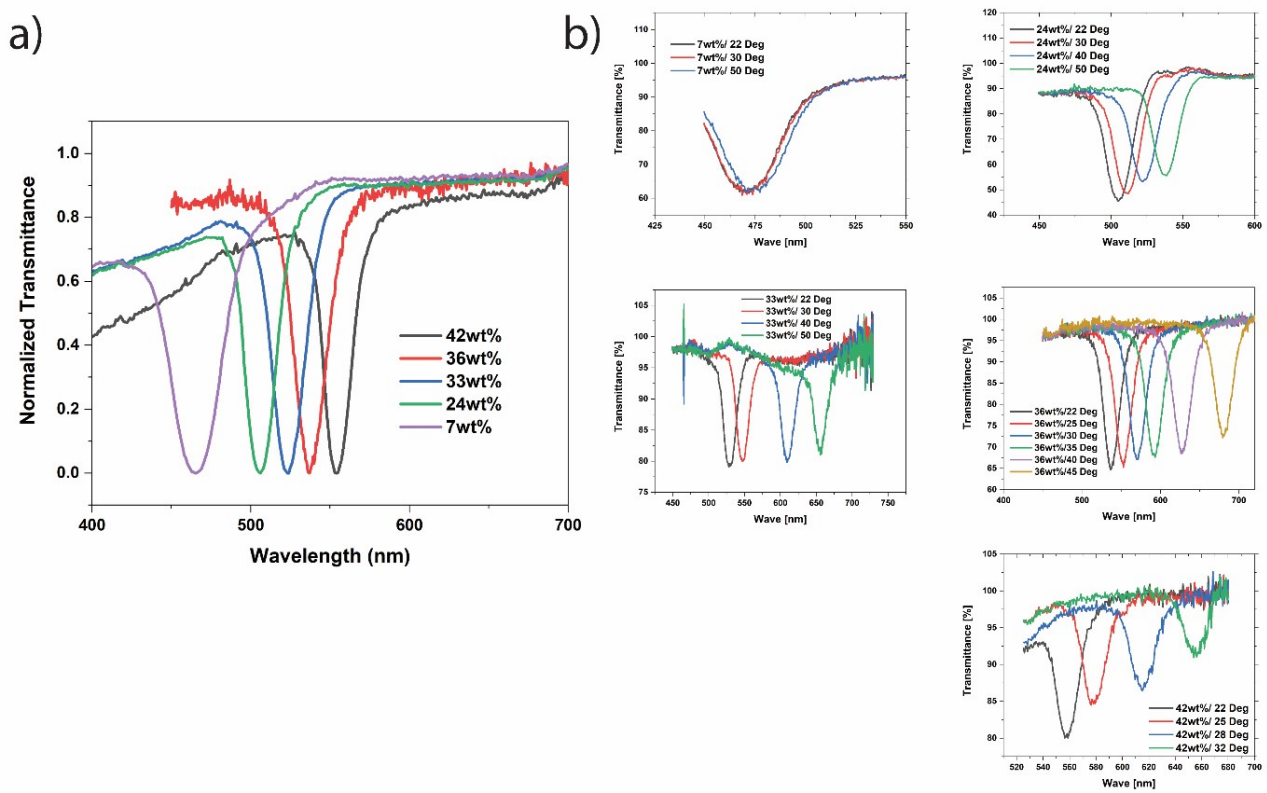


Fig. S2. a) Normalized transmission spectra of HumiCells containing different hydrogel water content, at room temperature and **b)** Shifts in transmission spectra of samples in a), when heated from hydrogel side.

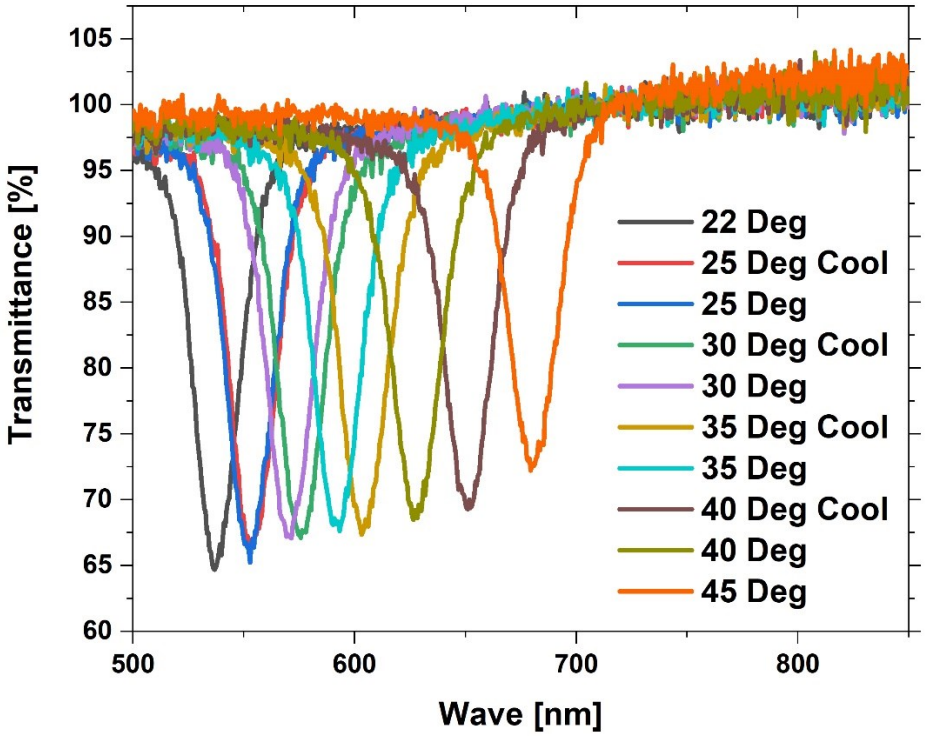
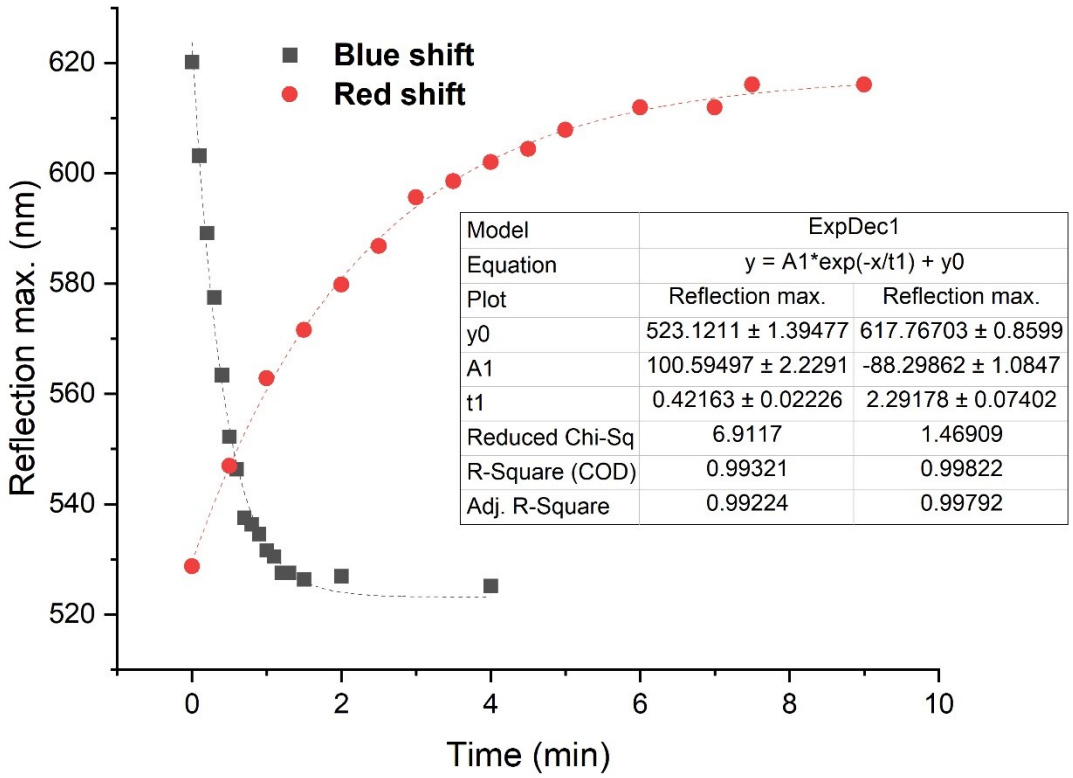


Fig. S3. Shifts in transmission spectra of HumiCell with 36wt% water upon heating and cooling from hydrogel side.



Model	ExpDec1	
Equation	y = A1*exp(-x/t1) + y0	
Plot	Reflection max.	Reflection max.
y0	523.1211 ± 1.39477	617.76703 ± 0.8599
A1	100.59497 ± 2.2291	-88.29862 ± 1.0847
t1	0.42163 ± 0.02226	2.29178 ± 0.07402
Reduced Chi-Sq	6.9117	1.46909
R-Square (COD)	0.99321	0.99822
Adj. R-Square	0.99224	0.99792

Fig. S4. Kinetics of blue and red-shifts, when HumiCell is placed on 40 ^{o}C hot plate along ChLCN and hydrogel sides, respectively.

Supplementary Videos:

Video S1: Video shows the change in reflected colour of HumiCell (containing 42wt% water in hydrogel), when heated from hydrogel side at a rate of 5 ^{o}C/min.

Video S2: Video shows the change in reflected colour of HumiCell (containing 36wt% water in hydrogel), when heated and cooled from hydrogel side at a rate of 5 ^{o}C/min.