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A New Twist on Cholesteric Films by using Reactive Mesogen Particles

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Contents:

PHASE TRANSITION BEHAVIOR

Polarized optical microscopy (POM) studies were carried out by using an Olympus BH-2microscope equipped with two polarizers that were operated crossed with the sample in between. A Metler Toledo FP82HT hot-stage with a Metler Toledo FP90 controller and an Infinity2 camera.

Differential scanning calorimetry (DSC) was carried out by using a DSC-Q1000 from TA instruments was used with 10 °C / min temperature ramp ranging from -20 °C till 180 °C and equilibrating at -20°C after each cycle.

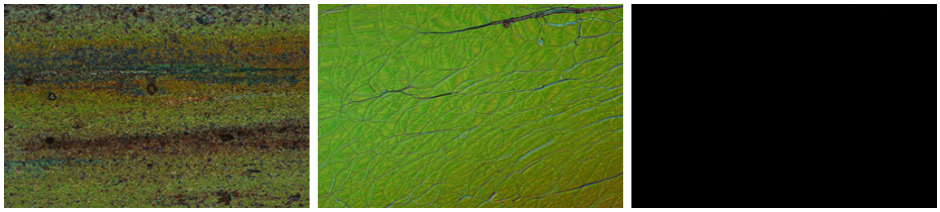


Figure S1. Representative POM pictures of the monomeric mixture in transmission mode. From left to right: cholesteric (r.t.), cholesteric (90°C) and isotropic liquid (134°C) for the red monomer mixture.

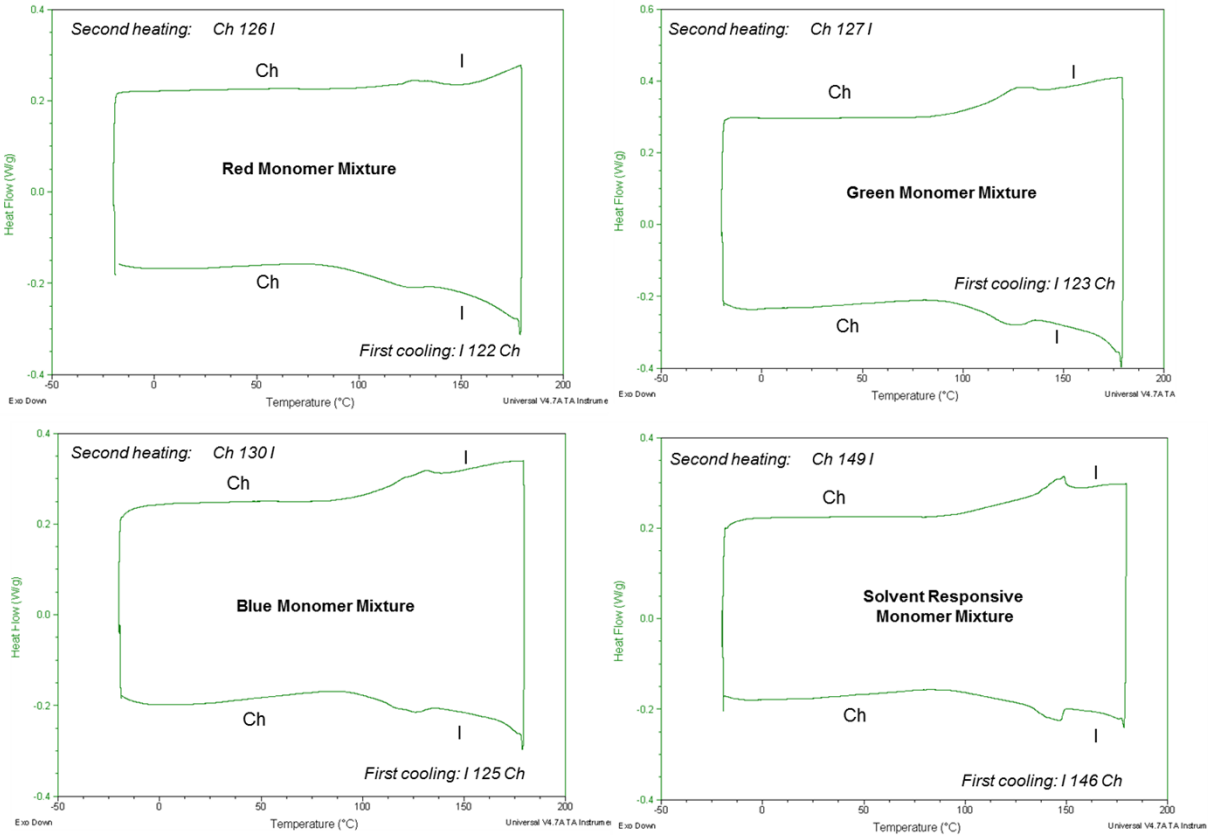


Figure S2. DSC thermograms of red, green, blue and solvent responsive monomer mixtures.

EXPERIMENTAL SECTION AND SYNTHESIS SCHEMATIC

Experimental Section

Materials:

RM257, RM520 and RM894 were received from Merck KGaA, Kraton G1701 EU was received from Kraton, Irgacure®369 and Irganox®1076 were purchased from BSAF and dodecane were purchased from Sigma-Aldrich. PMMA resin (Acryfix® 9019 Solar) was received from Evonik Industries. Epoxy resin (SU-2008) was purchased from Microchem. Materials were used without any further purification.

Cholesteric Reactive Mesogen Particles Synthesis:

In the first step, the Kraton G1701EU (350 mg) is dissolved in dodecane (45 mL) at 100°C and poured onto the melted cholesteric mixture based on RM257 (3.0 g), RM520 (2.0 g), Irgacure®369 (150 mg) and Irganox®1076 (4.8 mg) and RM894 (85mg for Infrared particles, 155mg for Red particles, 165mg for Green particles and 210mg for Blue particles) at 90°C. The emulsion is formed and homogenised by using a IKA homogeniser (T25 digital Ultra-Turrax®) for 20 min at 14600 rpm. The previously formed emulsion is added to a flask previously heated to 90°C and the polymerization is initiated under UV light irradiation (10mW/cm^2) for 15 minutes. Finally, polymer particles formed are filtered by using a 50 micron filter cloth and are centrifuged at 10000rpm for 10 minutes. After the first centrifuge cycle, particles are washed with dodecane twice and toluene until the solution is clear.

Solvent ResponsiveCholesteric Reactive Mesogen Particles Synthesis:

In the first step, the Kraton G1701EU (350 mg) is dissolved in dodecane (45 mL) at 100°C and poured onto the melted cholesteric mixture based on RM257 (2.2 g), RM520 (2.8 g), Irgacure®369 (150 mg) and Irganox®1076 (4.8 mg) and RM894 (165mg) at 90°C. The emulsion is formed and homogenised by using a IKA homogeniser (T25 digital Ultra-Turrax®) for 20 min at 14600 rpm. The previously formed emulsion is added to a flask previously heated to 90°C and the polymerization is initiated

under UV light irradiation (10mW/cm^2) for 15 minutes. Finally, polymer particles formed are filtered by using a 50 micron filter cloth and are centrifuged at 10000rpm for 10 minutes. After the first centrifuge cycle, particles are washed with dodecane twice and toluene until the solution is clear.

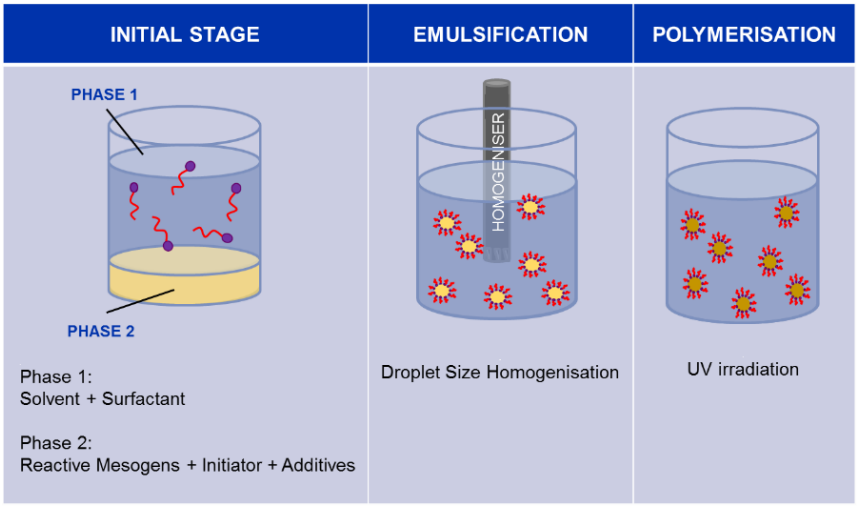
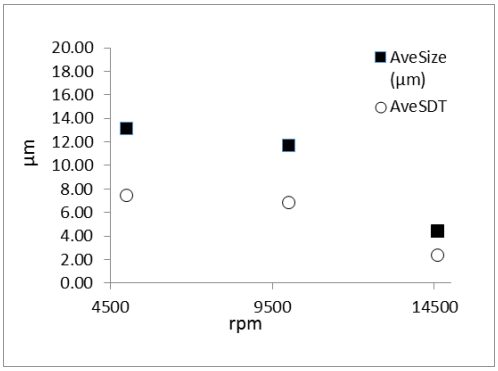


Figure S3. Scheme representing the synthesis of the particles.

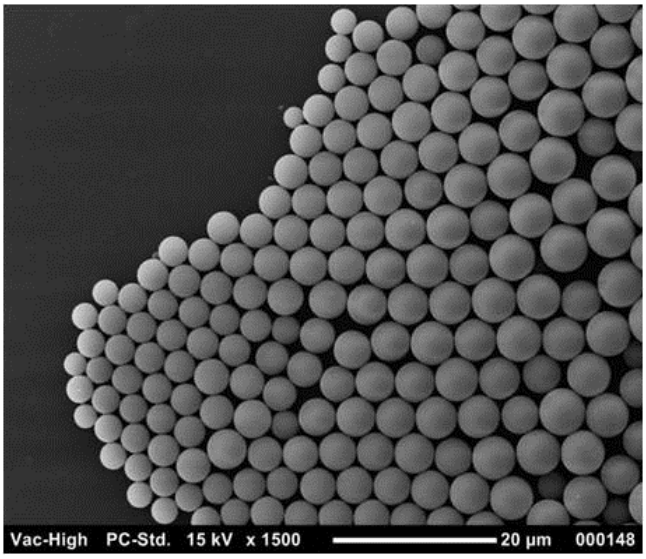
SIZE DATA ANALYSIS



				Reproducibility		
Batch	**rpm**	**Average Size (µm)**	**SDT**	**AveSize (µm)**	**Average SDT**	**>50µm[a]**
Sample 1a	14600	4.71	2.66	4.41	2.40	0
Sample 1b	14600	4.19	2.10			
Sample 1c	14600	4.33	2.45			
Sample 2a	10000	9.87	6.64	11.74	6.86	1.5
Sample 2b	10000	12.20	6.69			
Sample 2c	10000	13.14	7.26			
Sample 3a	5000	13.23	7.43	13.12	7.44	3
Sample 3b	5000	12.90	6.90			
Sample 3c	5000	13.24	7.99			

[a] Range of material found when filtering the dispersion of particles through a 50 micron cloth (0: no solid residue, 3: solid residue on the cloth)

a)



b)

Figure S4. a) Size *vs* Stirring power representation of the optimized formulation. The table represents data of each sample used in the analysis. b) SEM image of ChRMPs corresponding to the sample 1a.

RAMAN ANALYSIS

Residual surfactant content was analysed by using a Renishaw inVia Raman microscope. Samples are prepared by deposition of specimens on glass substrates.

Samples analysed were:

1) Kraton which is a clear, linear triblock copolymer based on styrene and ethylene/butylene with a polystyrene content of 30%. Styrene peaks at 1001.4cm^{-1} and 1031.8cm^{-1} are taking as a reference

2) Flakes created after evaporating all fractions obtained when washing particles

3) Particles after the washing step.

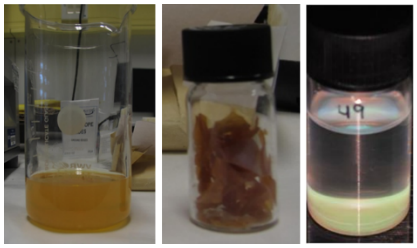


Figure S5. From left to right: fraction obtained after washing the particles, flakes produced and particles in clean solvent.

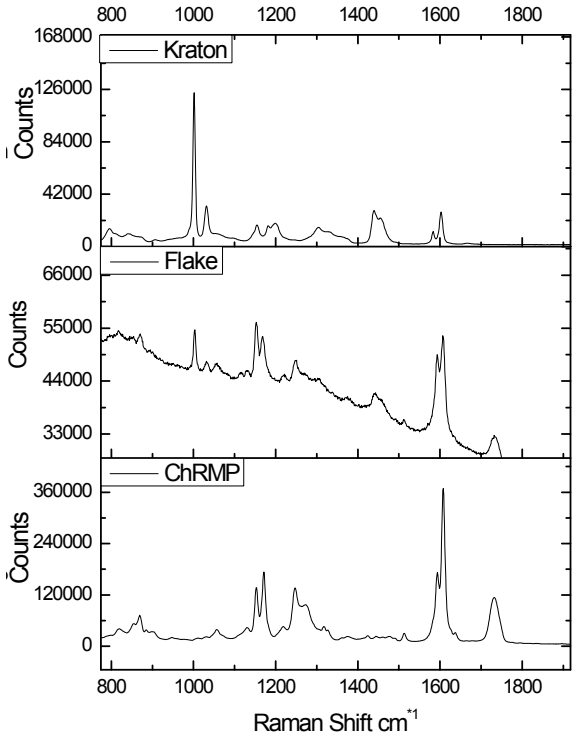


Figure S6. From top to bottom: Raman spectrum for Kraton, flakes and particles. Measurements are carried out in single specimens.

THERMAL STABILITY

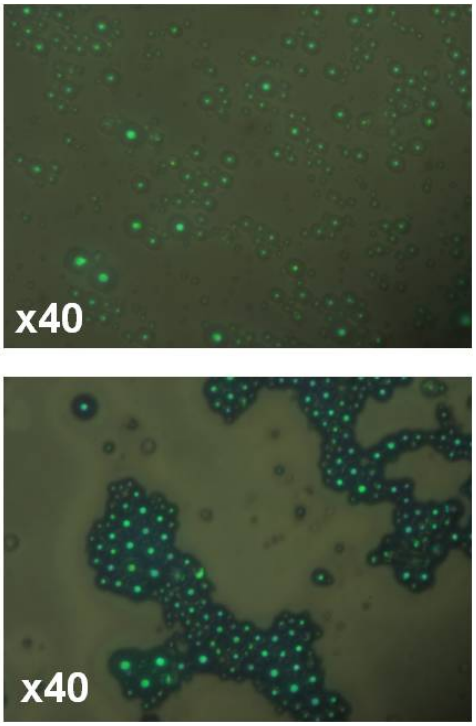


Figure S7. Dispersion of particles in dodecane at room temperature (upper image) and at 220^{o}C after evaporating all the solvent (lower image).

CROSS-SECTION TEM ANALYSIS

Dispersion of Ch RMPs in poly(methylmethacrylate) (PMMA) was coated on triacetyl cellulose (TAC). Early prepared film is embedded in a resin and by using a microtome the cross-section of the particles is ready to be studied

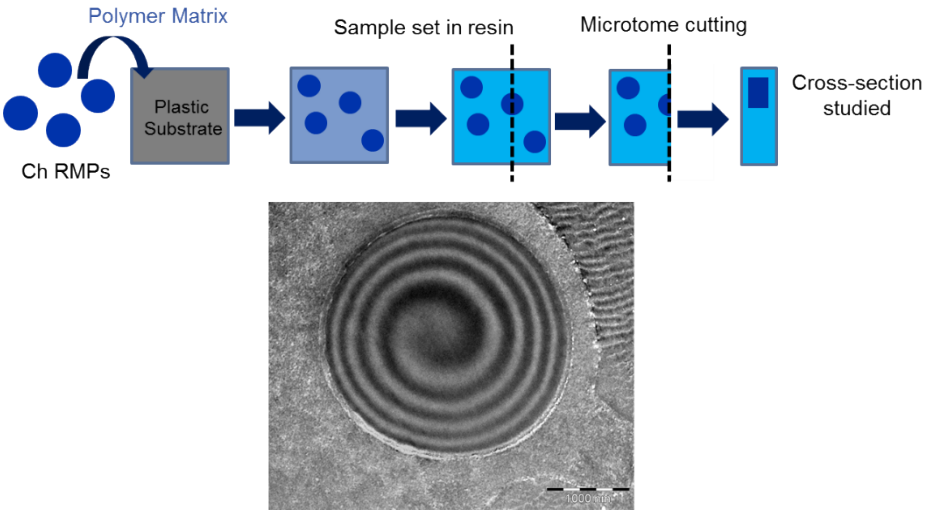


Figure S8. TEM image from the cross-section of particles

RGB DISPERSION

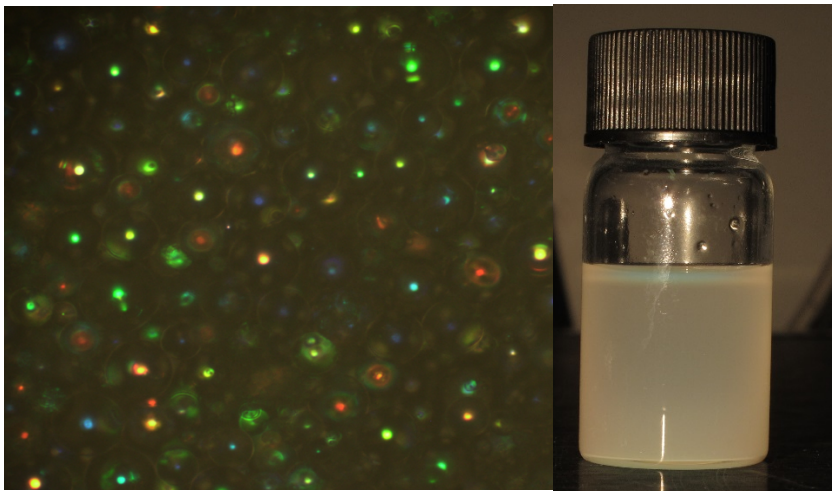


Figure S9. Polarised Optical Microscopy image of RGB dispersion based on Ch RMPs (left). Picture of the RGB dispersion (right).

REFLECTED AND TRANSMITTED LIGHT ON FILM

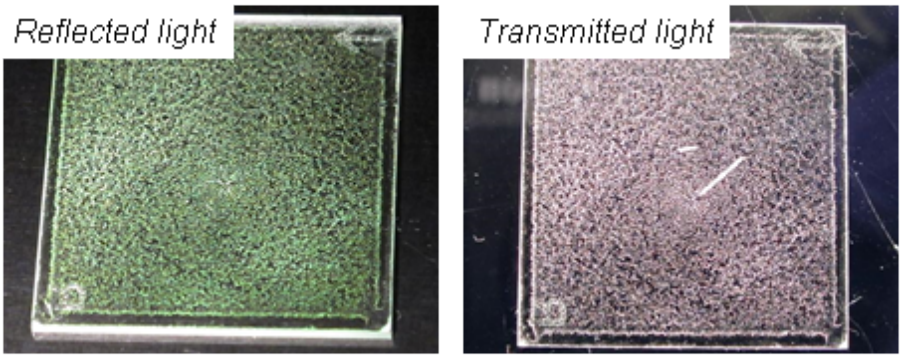


Figure S10. Reflection and Transmission of a film containing green ChRMPs.

REFLECTION SPECTRA OF FILM A AND FILM B

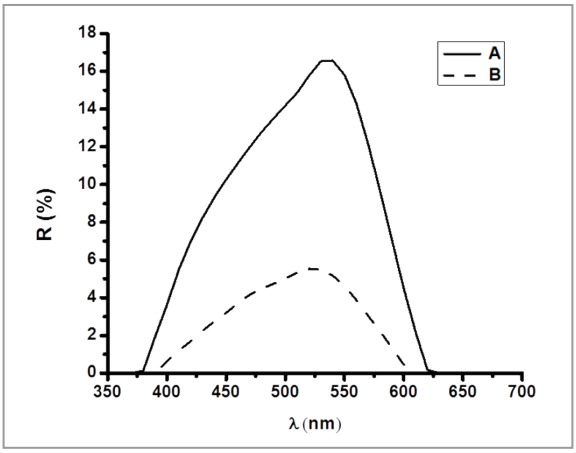


Figure S11. Reflection spectra of Film A (solid line) and Film B (dashed line).

VIEWING-ANGLE DEPENDENCE OF CONVENTIONAL CHOLESTERIC FILM

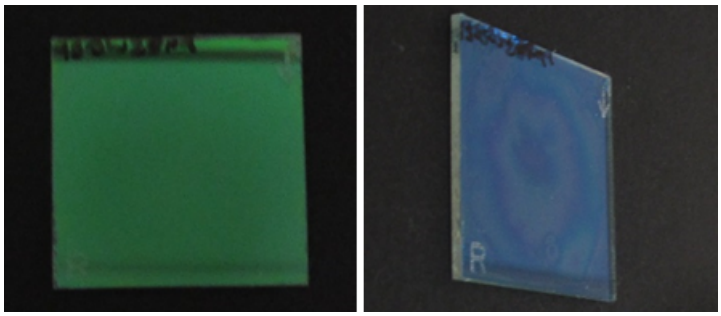


Figure S12. Viewing-angle dependence of a conventional Green cholesteric film on rubbed PI glass.