Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information

Rheology of Liquid Crystalline Oligomers for 3-D Printing of Liquid Crystalline Elastomers

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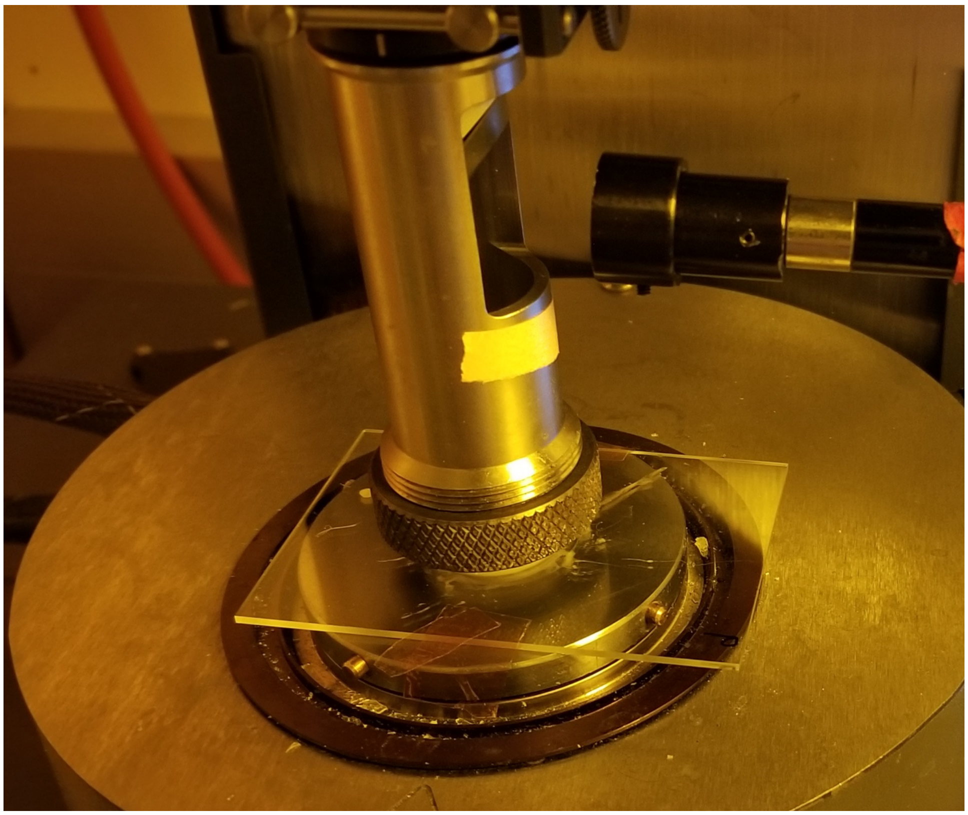

Figure S1. Picture of the UV curing rheometer setup. A glass slide is attached to the bottom rheometer plate with Kapton tape. After shearing and curing the glass slide and rheometer head can each be removed from the machine, allowing for polarized microscopy of the LCE.

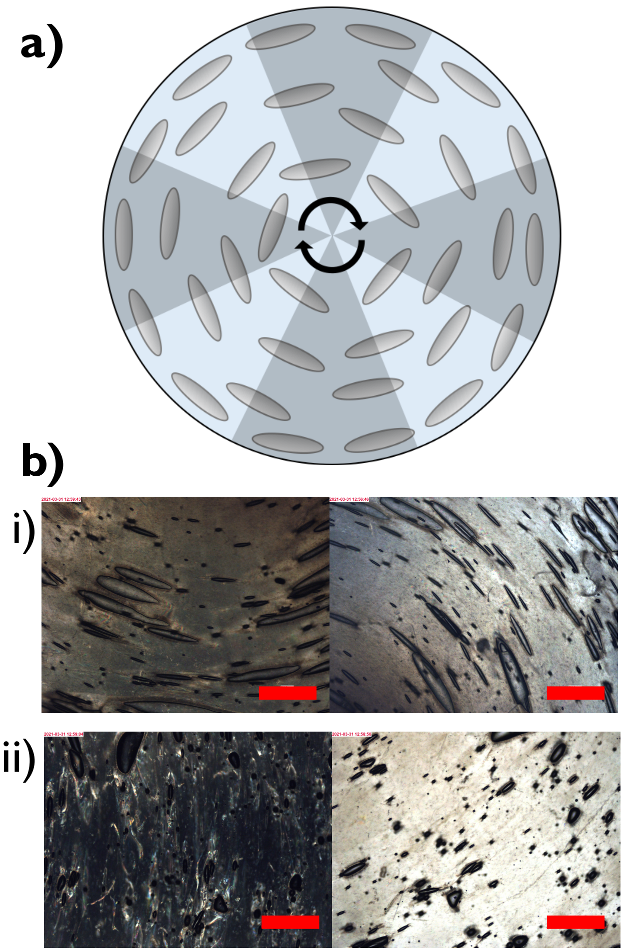

Figure S2. (a)Representation of the LC mesogen alignment generated by shearing on the parallel plate rheometer. This pattern, which approximates a +1 topological defect, will result in the appearance of 4 dark brushes when viewed under crossed polarizers. A greater degree of alignment will lead to a greater difference in brightness between the light and dark brushes. (b) Different areas of a polymerized LCE sheared for 2 seconds at 10 s^{-1} viewed under crossed polarizers. (i) Near the center of the sample, the birefringence is much weaker than near the edge of the sample (ii).

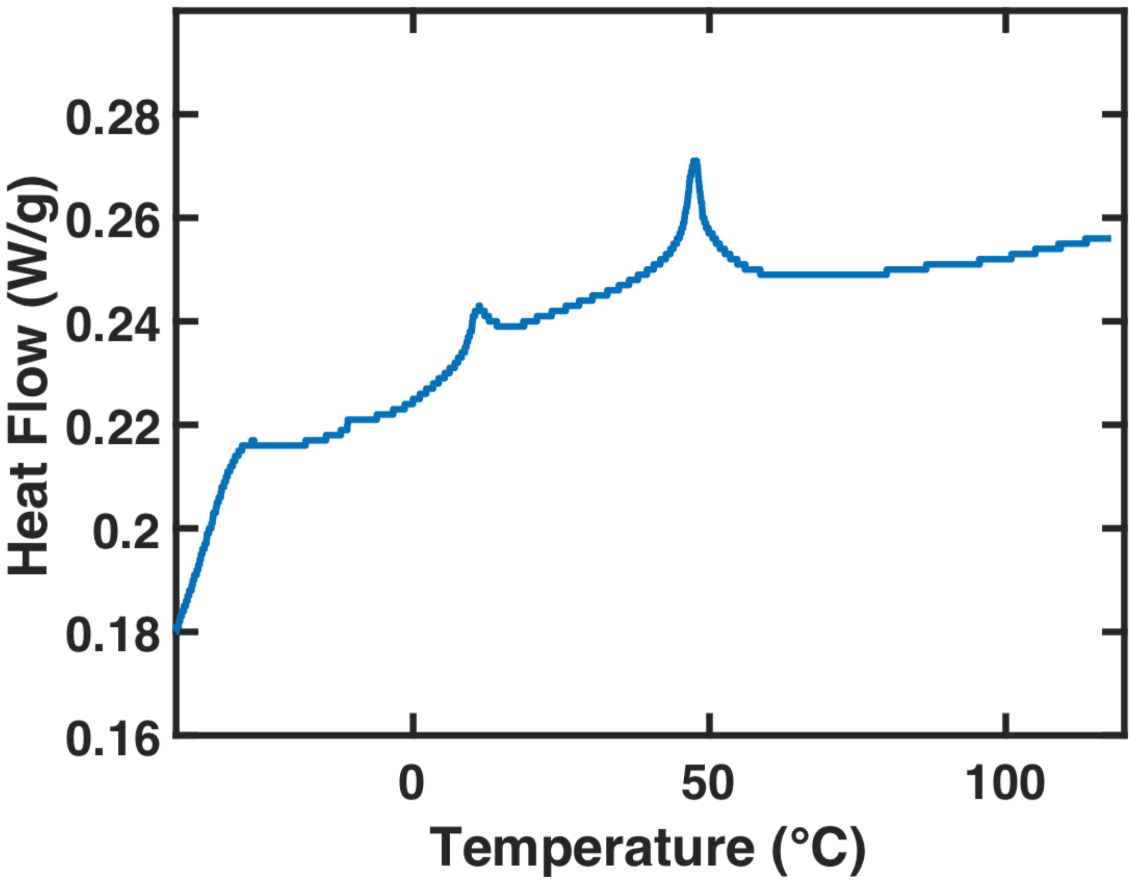

Figure S3. Differential Scanning Calorimetry data for the ink used in this study. The second endothermic peak, which occurs at approximately 50 °C, is indicative of the ink's nematic-isotropic transition temperature (T_{NI}).

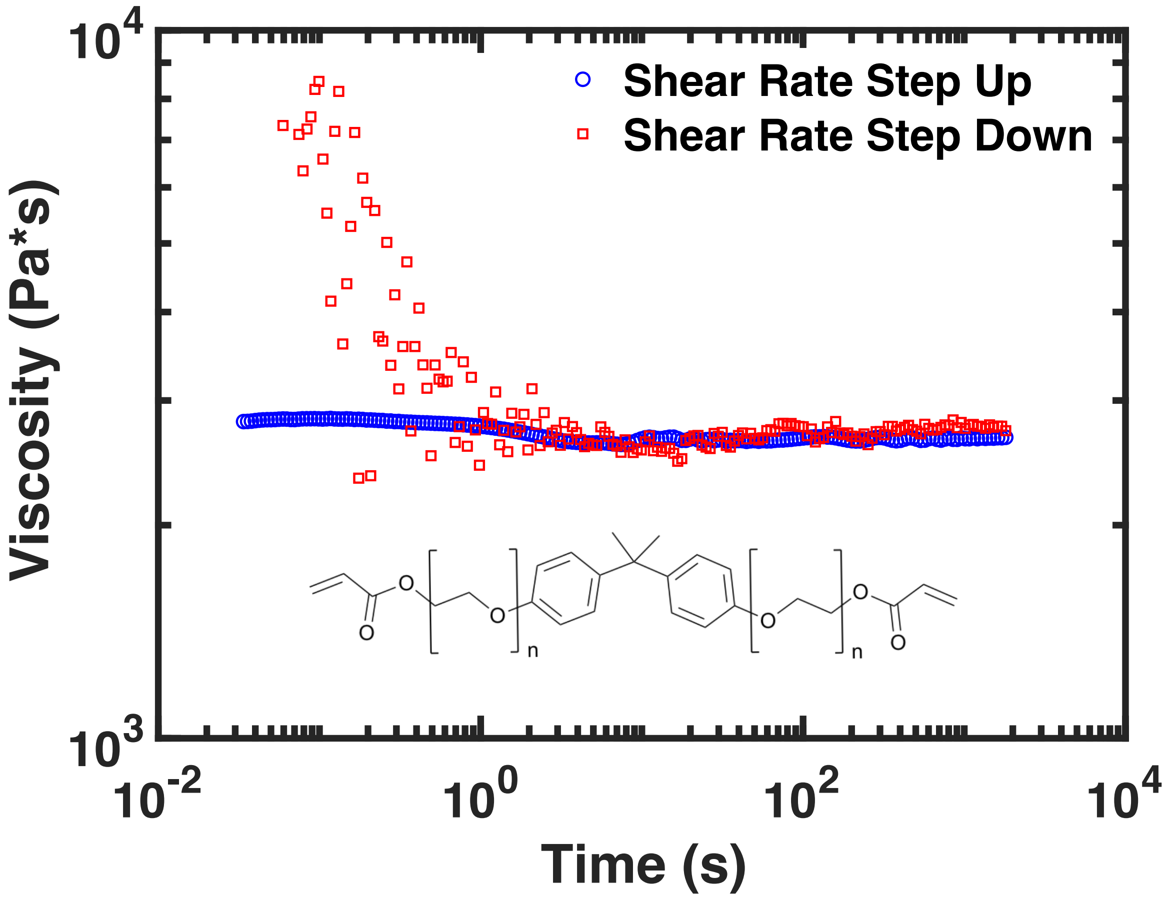

Figure S4. Shear rate step-up/step-down test performed on an ink prepared with a non-liquid crystalline diacrylate in place of RM82. As evidenced by the lack of pronounced thinning after the shear rate step-up (performed at 10 s^{-1} shear rate) and increasing viscosity after the shear rate step-down, the effects seen in this paper are related to the liquid crystalline nature of the ink used.

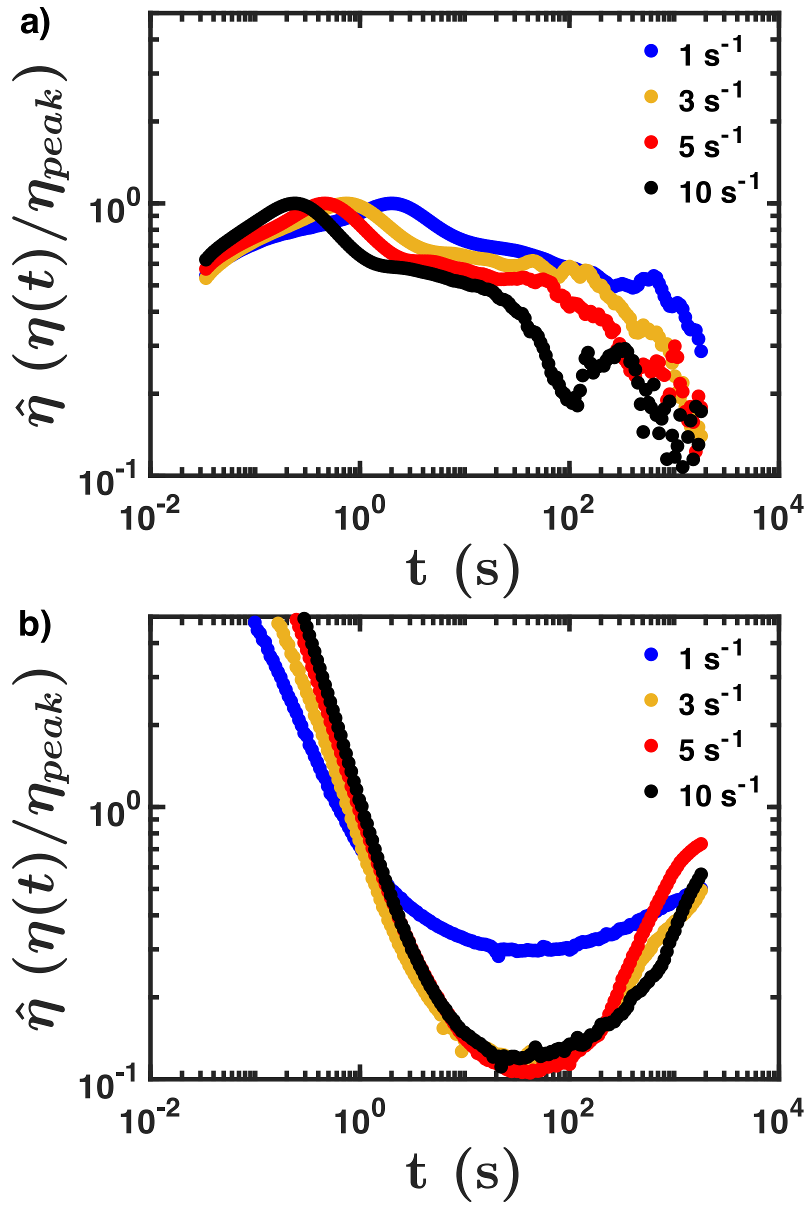

Figure S5. (a) Ink sheared at various shear rates for 30 minutes. It can be clearly seen that the applied shear rate has an effect on the time at which the initial viscosity overshoot is observed as well as both regimes of thinning. (b) The viscosity of the inks from (a) after subjected to a step down to 0.01 s^{-1}. The inks sheared at the three highest shear rates all show similar minimum viscosities while the ink sheared at 1 s^{-1} has a larger minimum viscosity. This indicates that the ink sheared at 1 s^{-1} was aligned less than the inks sheared at the other three shear rates.

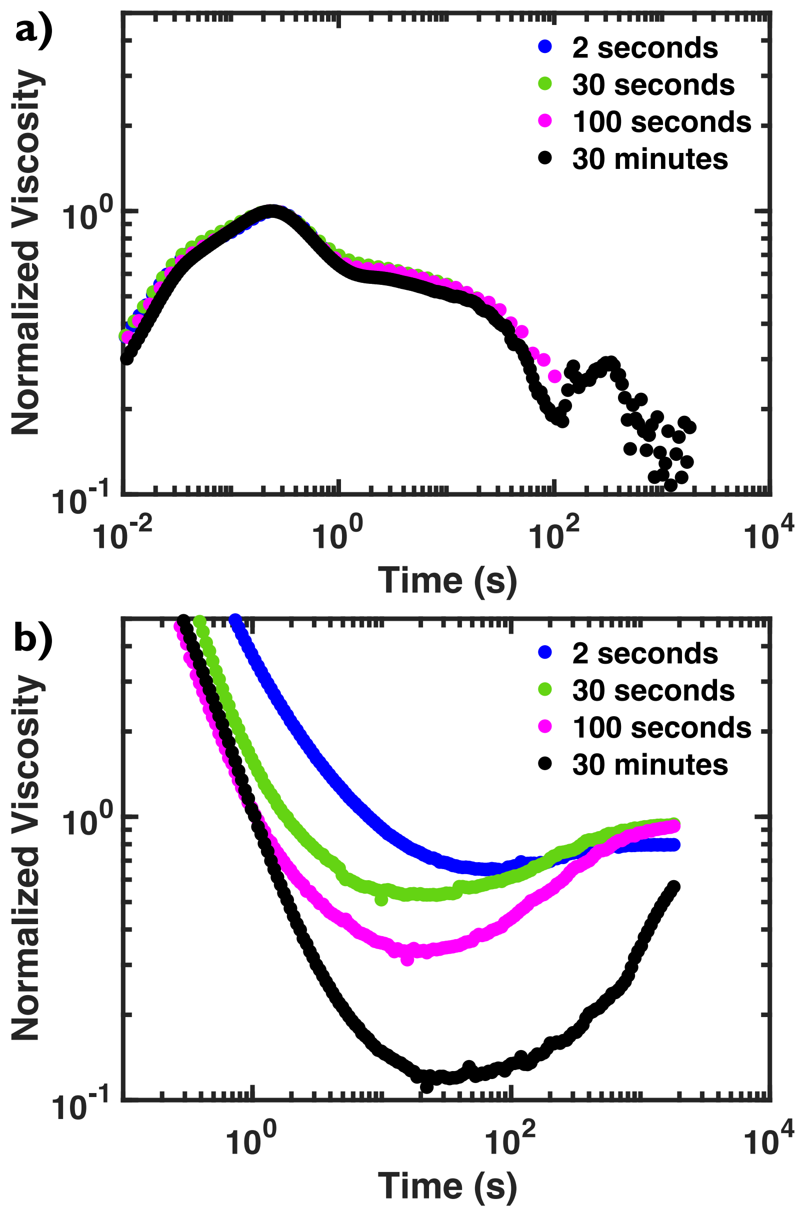

Figure S6. (a) Inks after being subjected to a shear rate step-up to 10 s^{-1}. This shear rate was then maintained for various times. It can be seen that the data overlay on top of each other well, indicating a degree of replicability. (b) The inks from (a) after being subjected to a shear rate step-down to 0.01 s^{-1}. The inks sheared for longer times show smaller minimum viscosities, which correlates with better liquid crystalline alignment.

Shear rate applied (s^{-1})	10	10	10	1	3	5	10
Time of applied shear rate (s)	2	30	100	1800	1800	1800	1800
Total strain applied (%)	2000	30,000	1E5	1.8E5	5.4E5	9E5	1.8E6
Minimum normalized viscosity	.65	.53	.31	.295	.11	.11	.12

Table S7. Table of experimental conditions and minimum normalized viscosity reached for tests where the shear rate or time of applied shear was varied. It can be seen that increasing total applied strain leads to decreasing minimum normalized viscosity up to a certain point at which a saturation effect is observed.