Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information

RM734 droplets preparation

RM734 droplets were obtained following two steps. First of all, a small amount of RM734 powder is deposited at room temperature on a clean glass slide and heated to 150°C to have a melt. To create the initial droplets, a cold stainless needle is dipped into the melt and retracted, so that the droplet on its tip solidifies at contact with the surrounding air. To increase the size of the RM734 "pearl", rapid (to avoid re-melting) successive dipping are performed. Then, the pearl is remolten into a droplet on one heated LN substrate. Then, the cell was prepared as described in the main text.

Nematic phase

Mechanical rubbing with optical paper of bare LN substrates produces partially aligned liquid crystal cells, with quality that fluctuate from cell to cell. We obtained both samples exhibiting a good planar alignment (Fig. S1 a and b) and samples where rubbing is less effective and the typical Schlieren texture appears (Fig. S1 c and d). The N_F droplets shown in Fig. 1 of the main text are obtained from well aligned N cells, as in panels a and b. On the contrary, the N_F droplet shown in Fig. 4 results from cooling a N phase of the kind reported in panels c and d.

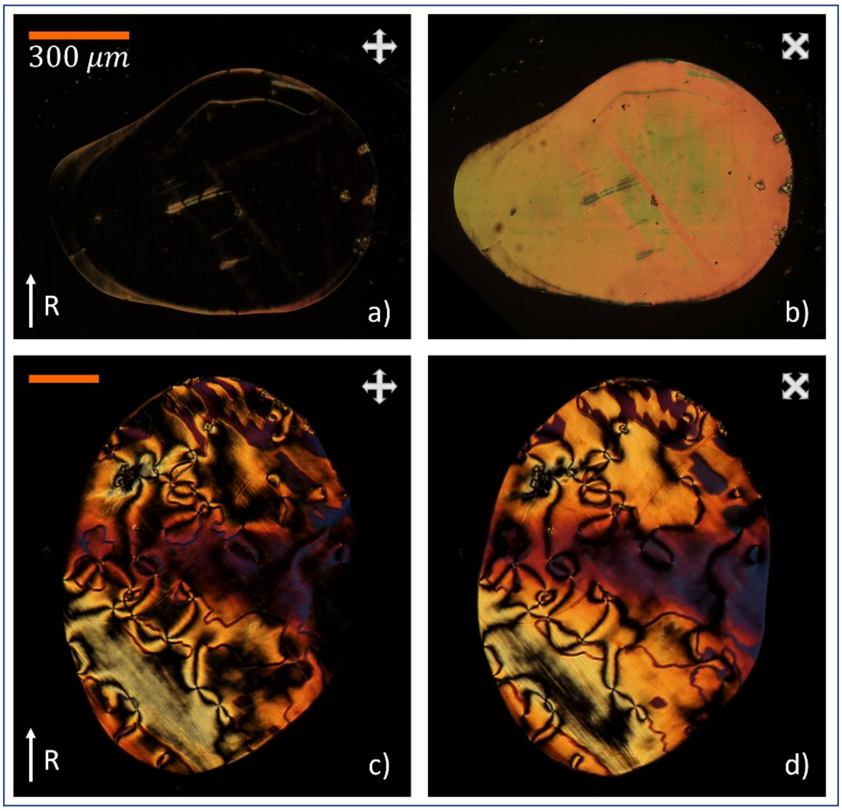

Figure S1: POM images of RM734 droplets confined between two LN crystals in the N phase (T = 160°C). Left hand side: well aligned droplet observed with crossed polarizers at 0/90 deg. (a) and at ±45 deg. (b) to the rubbing direction R; right hand panel: droplet in case of less effective substrates rubbing observed in the same two conditions (c and d, respectively).

Fringing field

The fringing field generated by the two LN crystals is reported in Fig. S2, in the absence of the LC. Noteworthy, the presence of the ferroelectric droplet changes the fringing field profile. Indeed, the fringing field polarizes the droplet, which happens through a small reorientation of **P** by an angle such to deposit polarization charges on the droplet surfaces that cancel the internal field. This leads to an additional component of the field parallel to the LN bounding plates, which affects the whole field profile.

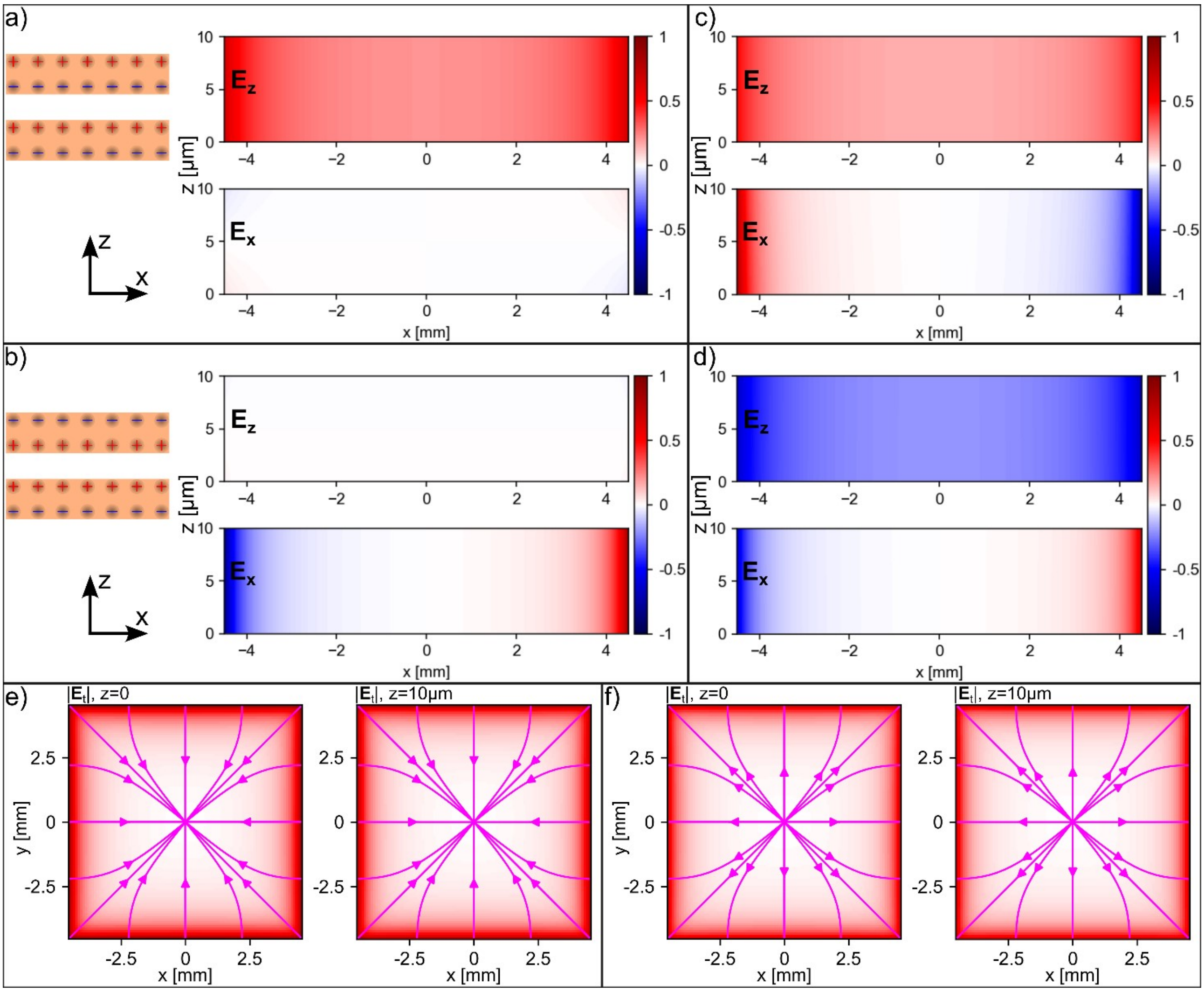

Figure S2: Vertical, E_Z, and horizontal, E_x, components of the fringing field $\mathbf{E_f}$ in the region between the LN substrates in case of equal (a) or opposite (b) LN polarizations, for equal amount of charge on the two crystals. E_x is maximum while E_z vanishes in a); the contrary holds in b). Panel c and d show the same components in the condition of our experiments, where the temperature gradient, and thus the pyroelectric charging, is higher on the top substrate. This produces a non-vanishing vertical component of the field in case of equal LN polarizations (c) and a non-vanishing in-plane component in case of opposite LN polarizations (d). Panels e and f show the in-plane field lines in case of unbalanced pyroelectric charging for equal (e) and opposite (f) LN polarizations. The profiles shown in panels c, d, e and f have been obtained assuming a pyroelectric charging of the top substrate twice as high as that of the lower one.

Other figures

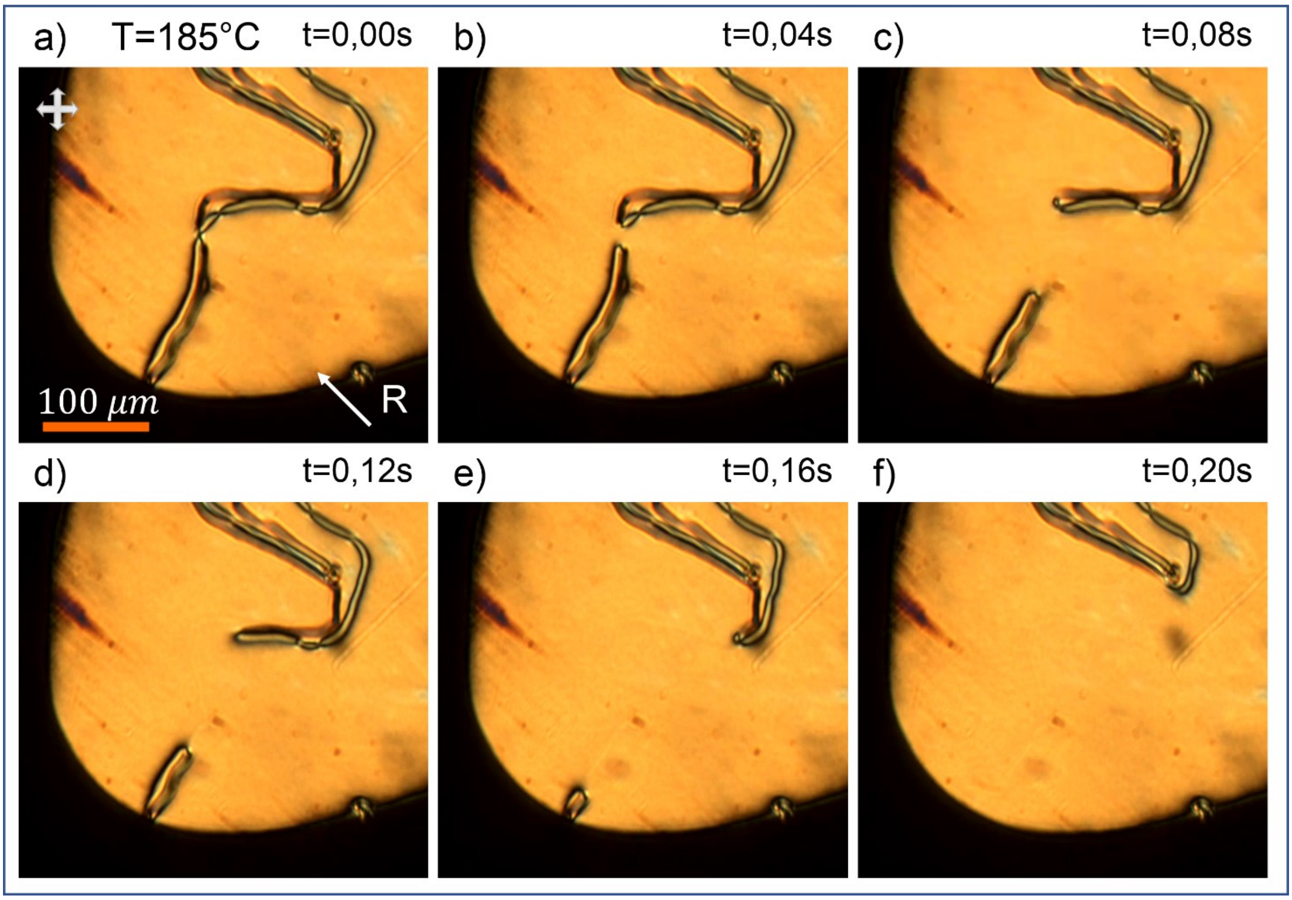

Figure S3: Defect lines breaking at the defect points trapped in kinks upon heating to the N phase. The images are consecutive frames representing different instants during heating at a temperature close to T = 185°C.

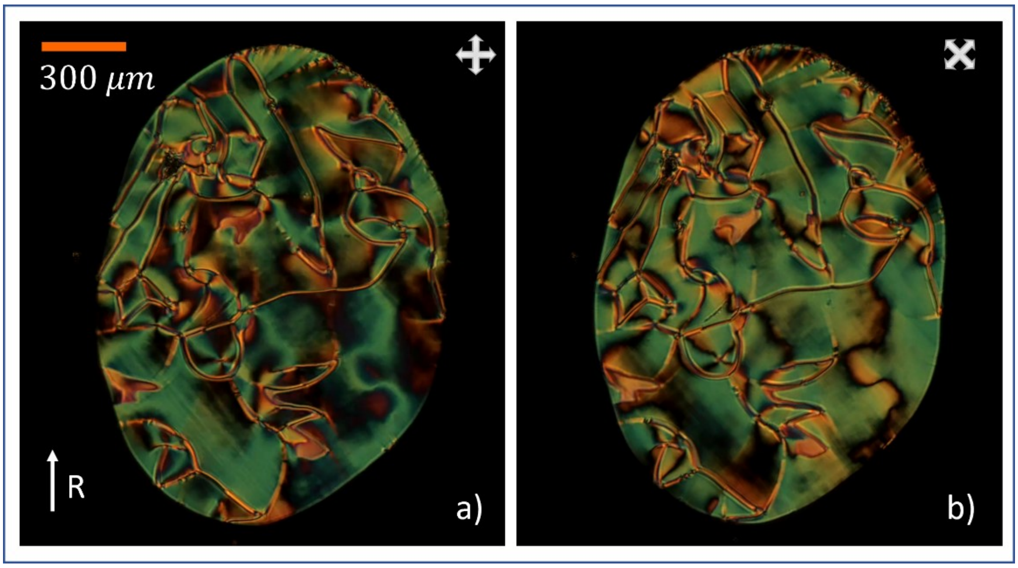

Figure S4: POM images of a N_F RM734 droplet (T = 130°C) confined between two LN crystals in case of not effective rubbing. The pictures correspond to crossed polarizers at 0/90 deg. (a) and at ±45 deg. (b) to the rubbing direction **R**. Polar domains close to droplet edge are mainly tangent to the rim.

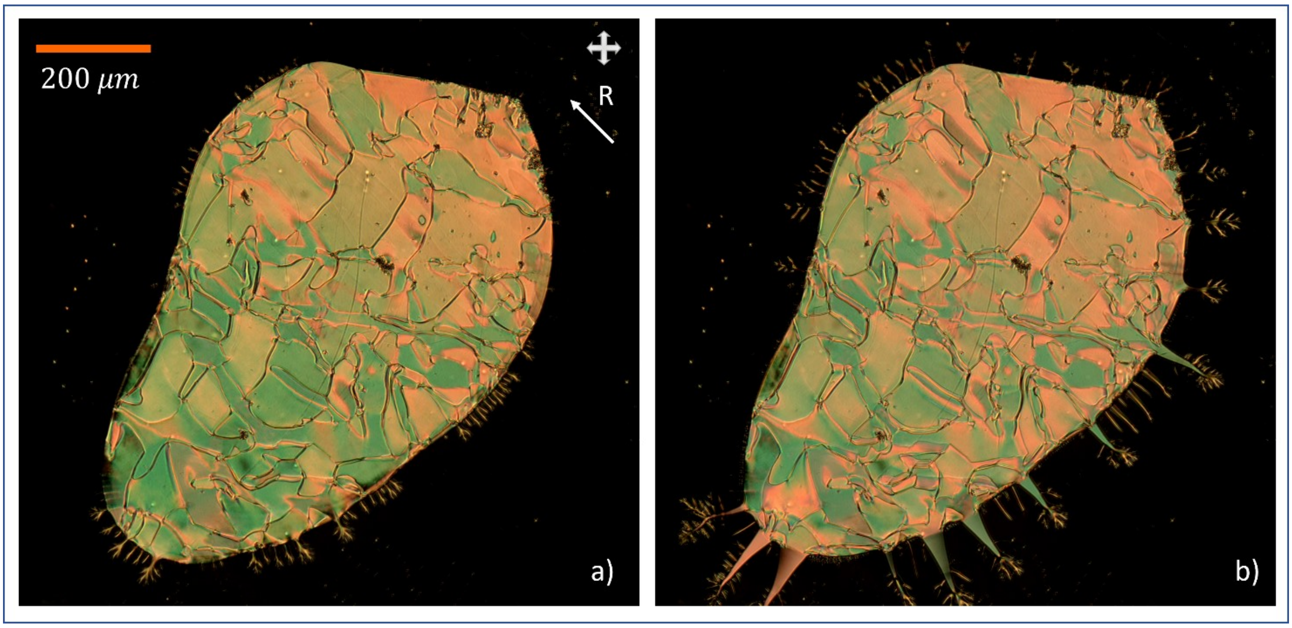

Figure S5: Example of droplet instability consisting in the emission of a large number of small, quasi-periodic spikes. a) First stages of instability (within 40 ms, corresponding to one video frame). Many small fluid jets protrude from almost everywhere along the droplet perimeter with an approximately uniform spatial density and a quasi-periodic distribution; b) Following frame: some of the jets grow and some other retract, as described in the main text. Figure S5 has been extracted from Video S5.

Videos

Video S1: N-N_F phase transition of a RM734 droplet confined between two LN substrates. Temperature decreases from 134 °C to 126 °C. The formation of the elongated domains and of the twisted structures described in the main text, are visible. Note that the speed of the video has been doubled.

Videos S2: RM734 droplet texture on heating to the N phase and up to isotropic phase. a) N_F-N phase transition. The disappearance of the green twisted areas is visible, followed by a progressive breaking of the walls that delimited polar domains in the lower temperature phase and by the shrinkage of the remaining lines. Variations of the droplet color due to a decrease of the birefringence can also be observed. T varies between 130 °C and 155 °C; b) keeping on heating, from T = 155 °C to 184 °C, almost all the remaining defect lines disappear; c) those that remain develop into a topology analogous to Schlieren textures as visible by the end of the video, close to the transition to the isotropic phase. T varies between 184 °C and 188 °C. The speed of the three videos has been doubled.

Video S3: RM734 droplet confined between two LN substrates in the N_F phase, during an instability event (T = 85°C). The ejection of quasi periodic jets from a portion of the droplet rim is visible. As the instability proceeds, the fluid jets that easily connect to domains with polarity in the direction of the jet axis grow, while the other retracts, resulting in the lost of the periodicity.

Video S4: RM734 droplet confined between two LN substrates in the N_F phase (T = 105°C). Two different instability events are visible, both characterized by the ejection of an isolated jet.

Video S5: RM734 droplet confined between two LN substrates in the N_F phase (T = 109°C). The instability is here characterized by the ejection of a large number of small fluid spikes, which are quasi periodic and approximately uniformly distributed all along the droplet perimeter.