Electroconvective vortices in microfluidics using nematic liquid crystals

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Nematic liquid crystals with negative dielectric and positive conductivity anisotropies ($\varepsilon_a = \varepsilon_{||} - \varepsilon_{\perp} < 0$ and $\sigma_a = \sigma_{||} - \sigma_{\perp} > 0$, respectively) become unstable above a critical voltage and ordered flow vortices appear as roll structures in one dimensional confinement (sandwiched between two glass plates) [1]. Our investigations showed that such vortices may exist in different geometries of confinement as well; their presence was confirmed also in microfluidic channels (Figure 1). In flows of isotropic liquids in microfluidic channels, it is difficult to observe turbulent vortices, since the system is typically characterized by low Reynolds numbers. As a consequence, mixing of fluids in laminar flow is slowly achieved by diffusion. Nematics, however, offer an electrically adjustable way to generate vortices with flow velocities comparable to typical flow speeds applied in microfluidics. We show the characteristics of electric field induced vortex formation (vorticity, flow field) and present its application in microfluidic mixing. We will reveal, which geometry of electric field with respect to the net flow direction exhibits the highest mixing efficiency in microfluidic Y-junctions.

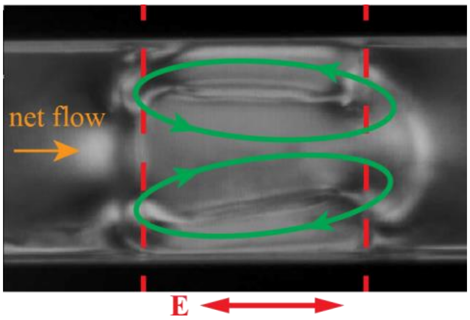

Figure 1. Electro-hydrodynamical vortices in a nematic liquid crystal flowing in a microfluidic channel.

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References
[1] N. Éber, P. Salamon, and Á. Buka, *Liquid Crystals Reviews*, **4**, 101 (2016).

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