

# Polarization-Dependent Synaptic Behavior with Ferroelectric Nematic Liquid Crystals

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We present, “**Polarization-Dependent Synaptic Behavior with Ferroelectric Nematic Liquid Crystals**”, to be considered as an oral presentation at the **52<sup>nd</sup> German Liquid Crystal Conference**”.

In our work, we have functionalized a newly-developed class of stimuli-responsive materials, named ferroelectric nematic liquid crystals (FNLCs), for their potential application as neuromorphic hardware. The realization of neuromorphic hardware requires materials that can combine non-volatility, low power consumption, and stable analog memory [1]. To fulfill this demand, FNLCs are a promising candidate of materials which exhibit switchable polarization at electric fields as low as  $0.1 \text{ V } \mu\text{m}^{-1}$ , providing a unique platform for low-power optic and electronic applications [2]. FNLC-based devices face a key limitation: after reaching “saturation polarization ( $P_s$ )”, the rapid relaxation occurs once the electric field is removed [3]. This loss of “remanent polarization ( $P_r$ )” arises from molecular elasticity and interfacial anchoring in FNLCs, causing dipoles to reorganize and cancel each other at zero field. To hurdle this challenge, FNLCs are integrated with semiconductors in a configuration that mimics the operation of a biological electric synapse, including long and short-term electro-optical responses. This synaptic behavior is enabled by our composite, suppressing the intrinsic polarization relaxation of FNLCs; our innovation allows for a 1.5 times higher memory and 90% signal retention based on an FNLC system, even after repeated cycles. Thus, we are able to generate ferroelectricity with long-lasting polarization response at low-voltage, thereby unlocking the use of FNLCs as synaptic elements in non-volatile memory applications.

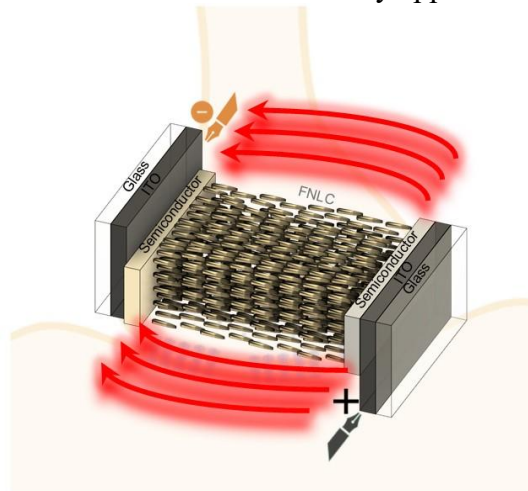


Figure 1: Depiction of the FNLC device architecture with polar arrangements in the electric field.

## References

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