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Color-Adaptive Microstructures Enabled by Liquid Crystal Emulsions

Mauricio Vera-Arévalo[1,*], M. Blanca Ros[1], and Alberto Concellón[1]
[1] *Instituto de Nanociencia y Materiales de Aragón (INMA), CSIC-Universidad de Zaragoza (Spain)*
**Presenting author e-mail: m.vera@unizar.es*

Cholesteric liquid crystals (CLCs) are well-known for their ability to tune their helical pitch in response to changes in chiral dopant concentration or twisting power. Moreover, the incorporation of functional molecules responsive to stimuli such as light, pH, or specific chemical species has significantly expanded their potential in optical sensing and responsive photonic devices.[1] To overcome the inherent viewing-angle dependence of their selective reflection, spherical confinement of CLCs into droplets has emerged as an attractive strategy for the development of smart materials.[2]

In this work, we first optimized a novel crosslinked CLC formulation. We then incorporated functional compounds sensitive to ultraviolet (UV) light, pH, or chemical cues, obtaining multi-stimuli-responsive photonic platforms. All formulations were effectively emulsified both in bulk and via microfluidics and subsequently integrated into a PEGDA-based ink, yielding polymer-embedded CLC droplet sensors after UV photoirradiation. Characterization of their reflection bands under different external stimuli revealed clearly distinguishable pitch variations, demonstrating their ability to discriminate between multiple environmental changes.

Overall, this work highlights the potential of multi-responsive CLC droplets as versatile photonic building blocks capable of responding to a broad range of external factors, including pH, UV light, temperature, and chemical substances. Importantly, their compatibility with microfluidic fabrication enables scalable and controlled production, positioning these systems as promising components for next-generation adaptive, structurally colored, multifunctional materials.

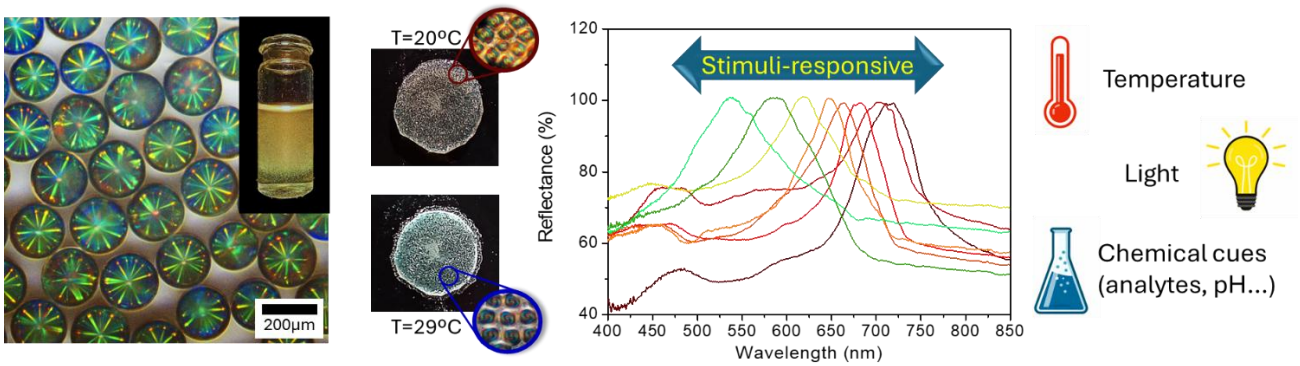

Figure 1. CLC droplets in a 1% PVA aqueous solution and embedded in PEGDA to form a thin film sensitive to multiple stimuli such as temperature, UV light, and chemical cues (analytes, pH…).

References

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