Reconfigurable building blocks for the construction of photonic devices

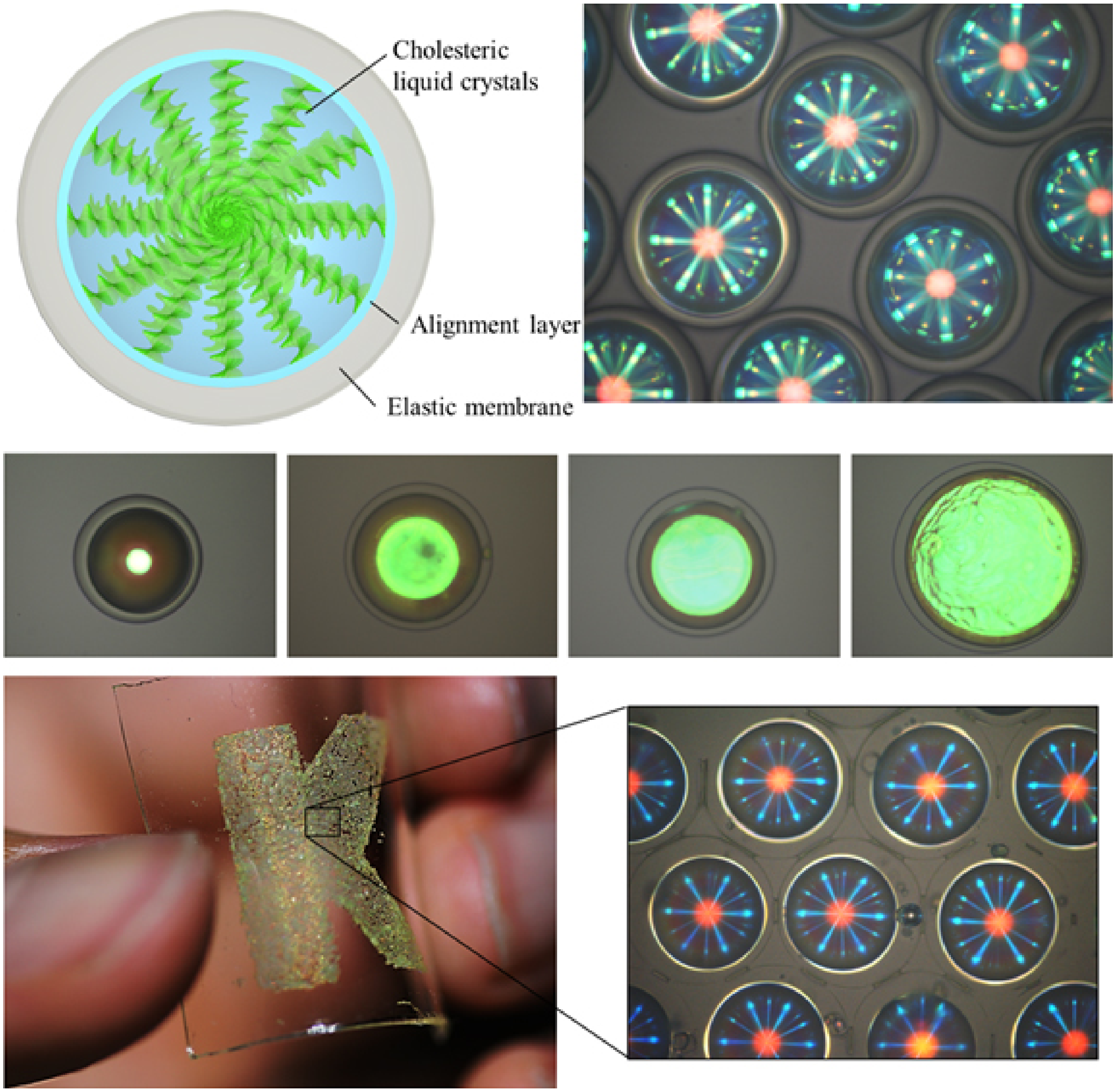
March 17 2016

Reconfigurable building blocks for the construction of photonic devices. Credit: KAIST

Liquid crystal (LC) molecules spontaneously form helical structures in the presence of chiral molecules, and these structures are referred to as cholesteric LC (CLC). The CLCs exhibit pronounced colors when the helical pitch is comparable with the wavelength of visible light. Such a photonic effect renders the CLCs promising for various photonic devices. Nevertheless, the fluidity of LCs severely limits the ease of processing and structural stability, restricting their applications.

To overcome this limitation, Prof. Shin-Hyun Kim's group at Korea Advanced Institute of Science and Technology (KAIST) has encapsulated the LCs with an elastic membrane. A droplet of LCs is enclosed in another droplet of elastomer precursors using a microfluidic technology. Such a drop-in-drop structure, called a double-emulsion drop, yields stable microcapsule as the precursors are polymerized. The microcapsules containing LCs can serve as building blocks that are assembled to construct any shapes of photonic devices. However, LC molecules in direct contact with the elastomer lose their planar alignment, which severely deteriorates optical performance.

To align the LC molecules at the boundary, an ultra-thin layer is inserted between the LC core and precursor shell. To fulfill this, triple-emulsion drops, composed of an LC core, aqueous inner shell, and precursor outer shell, are produced with a specially-designed microfluidic device. The aqueous inner shell makes the LC molecules have planar alignment at the boundary, resulting in striking colors with high reflectivity. Moreover, the thinness of the alignment layer provides a high lubrication resistance, preserving the layer integrity during elastic deformation of the outer membrane. Therefore, the microcapsules can maintain planar alignment of CLCs, even during microcapsule deformation.



Composition of photonic microcapsules: cholesteric liquid crystal, alignment layer, and elastomer membrane from the core (top). Compression of single photonic microcapsule with high reconfigurability (middle). Assembly of photonic microcapsules to compose a photonic device (bottom). Credit: KAIST

The elastic deformation of microcapsules and adaptive molecular orientation provide high reconfigurability as well as flexible shapes to present various optical features. This class of photonic ink capsules has great potential as new building blocks for the construction of [photonic devices](). For example, the microcapsules can be densely packed to form void-free panels with any shapes. More importantly, spontaneous rearrangement of CLC [molecules]() guided by an alignment layer in each deformed microcapsule can maximize the reflection intensity of the panels.

More information: Sang Seok Lee et al. Reconfigurable Photonic Capsules Containing Cholesteric Liquid Crystals with Planar Alignment, *Angewandte Chemie International Edition* (2015). DOI: 10.1002/anie.201507723

Provided by The Korea Advanced Institute of Science and Technology (KAIST)

Citation: Reconfigurable building blocks for the construction of photonic devices (2016, March 17) retrieved 23 July 2024 from https://phys.org/news/2016-03-reconfigurable-blocks-photonic-devices.html