Liquid crystals that can replace color-shifting ink and prevent money counterfeiting

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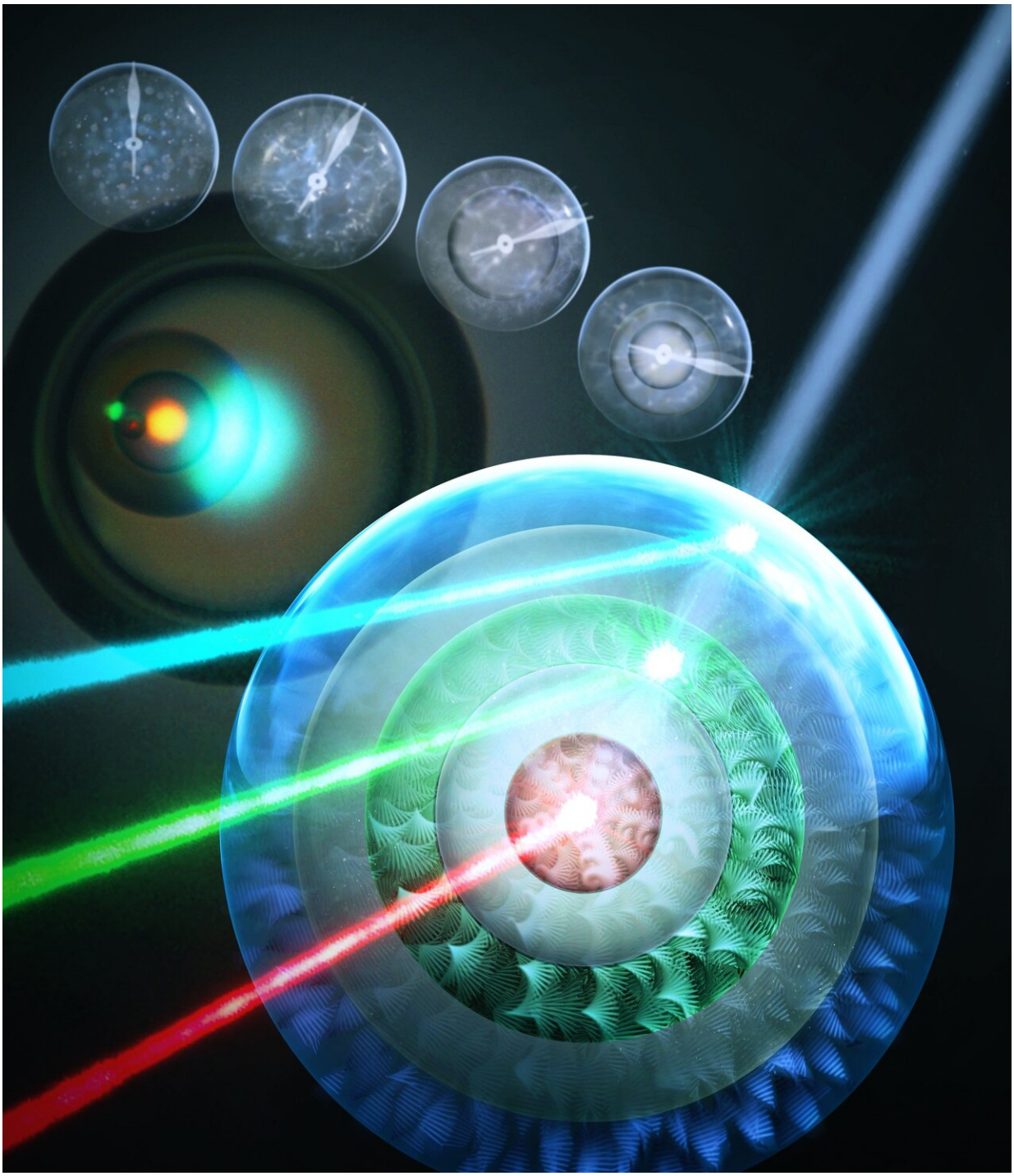
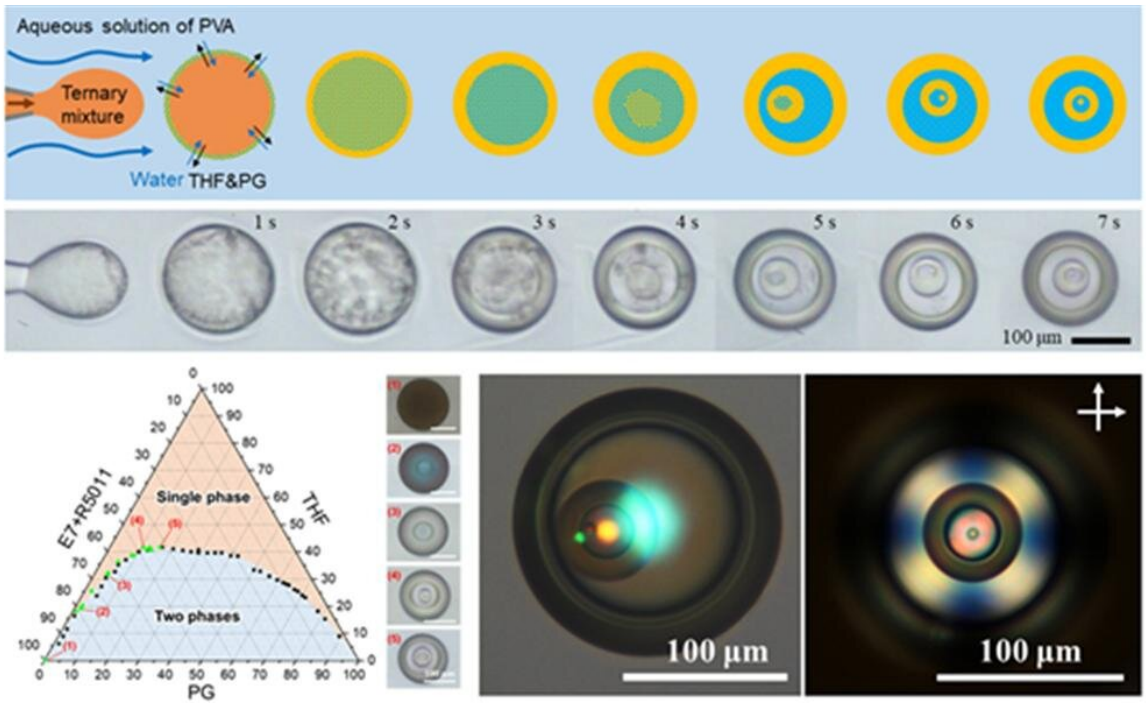


A schematic diagram of multi-layered liquid crystal particles developed by the KIST-KAIST joint research team. Credit: Korea Institue of Science and Technology(KIST)

A research team in Korea has developed a material that may potentially replace color-shifting ink in prevention of forgery of bank notes, ID cards and so on. A team headed by Dr. Sang-seok Lee from the Functional Composite Material Research Center of the Korea Institute of Science and Technology(KIST) announced that it has successfully developed a technology to fabricate liquid crystals comprising several layers with a thickness comparable to that of a hair strand using hydrophilic and hydrophobic properties. The study was led by Kim Shin-Hyun, professor of chemical and biomolecular engineering at the Korea Advanced Institute of Science and Technology (KAIST).

When a special additive called a chiral dopant is mixed with the liquid crystal material commonly used in display devices, the liquid crystal molecules rotate spontaneously to form a spiral structure. This is referred to as "cholesteric liquid crystal," a photonic crystal material that can exhibit color without the addition of pigments via a periodic nanostructure that selectively reflects light of certain wavelengths. The light has a circular polarization property, rotating in only one direction, by which it is possible to make colors appear and disappear by changing certain polarization conditions.

If this liquid crystal structure is repeated, it is possible to make a material that can exhibit two or more characteristics at the same time. Liquid crystals with diverse optical characteristics can be used as a material to prevent counterfeiting. However, to make a material consisting of several layers, there is a need to build each layer on top of the one before in a repeated fashion using a elaborately designed device. The researchers developed the technology for this complex process.



Liquid crystal particles with multiple layers formed through phase separation process developed by KIST-KAIST joint research team. Credit: Korea Institue of Science and Technology(KIST)

The KIST-KAIST research team added a cosolvent that dissolved in both oil and water as a way to mix organic alcohol, a hydrophilic moisturizing agent and the hydrophobic liquid crystal material for all three substances to become evenly mixed together. Then, the mixture was emulsified in water to form microemulsion drops. Exchanges occurred among the cosolvent, moisturizing agent and water molecules through the surfaces of the emulsion drops, which resulted in a separation of the hydrophobic and hydrophilic layers.

Depending on the initial mixing ratio of the substances, they separated into multiple layers ranging from one to five, and these layers could be freely controlled. Also, with the phase separation occurring continually

within each emulsion drop, the concentration of the chiral dopant inside the liquid crystals changed, resulting in multiple structural colors. This is a new technology to fabricate liquid crystals of multiple layers through a simple process of emulsifying the mixture.

Dr. Lee from KIST said, "What we've developed is a simple method of creating multi-layered liquid crystals and we expect it will serve as the basis for adding unique optical characteristics to materials," and added, "Based on this new technology, we plan on developing diverse functional particles to develop composite materials."

More information: Sihun Park et al, Photonic Multishells Composed of Cholesteric Liquid Crystals Designed by Controlled Phase Separation in Emulsion Drops, *Advanced Materials* (2020). DOI: 10.1002/adma.202002166

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