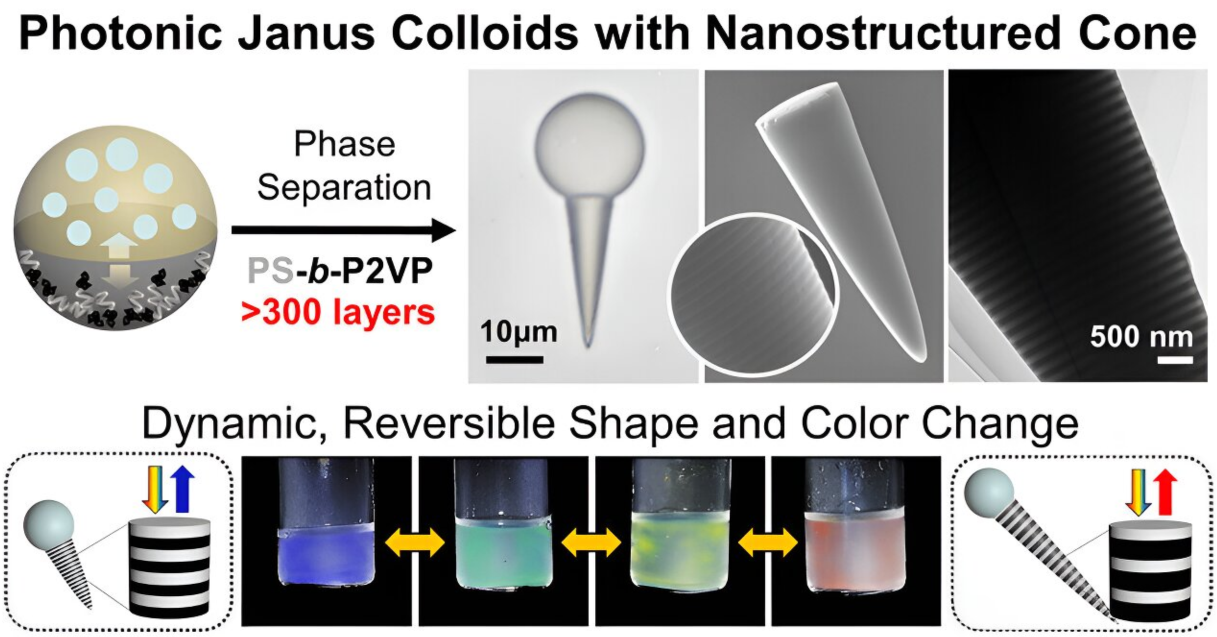
Breakthrough in nanostructure technology for real-time color display

March 5 2024, by JooHyeon Heo



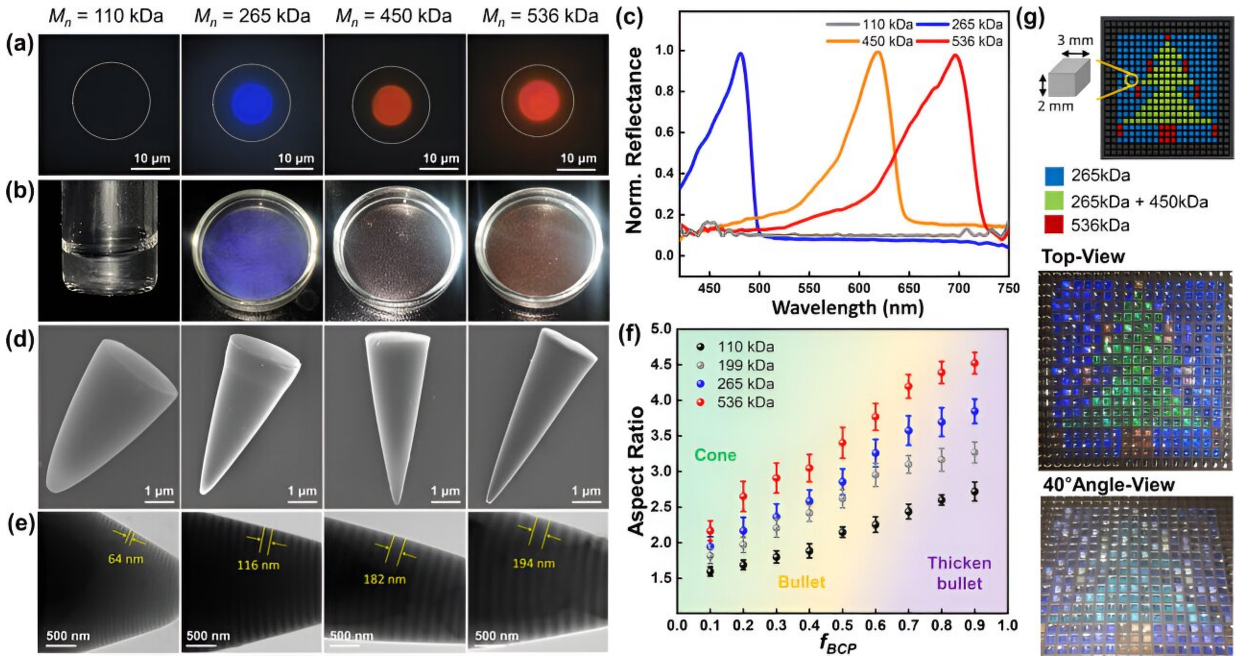
Photonic Janus colloids with nanostructured cone l. Credit: *ACS Nano* (2024). DOI: 10.1021/acsnano.4c00230

A technology that enables the real-time display of colors and shapes through changes in nanostructures has been developed by Professor Kang Hee Ku and her team in the School of Energy and Chemical Engineering at UNIST. The technology has the potential to revolutionize various fields, including smart polymer particles.

Utilizing block copolymers, the research team has achieved the self-assembly of photonic crystal structures on a large scale, mimicking natural phenomena observed in butterfly wings and bird feathers. By reflecting the shape and direction of nanostructures, this technology allows for the visualization of vibrant colors and intricate patterns in real time. The paper is published in the journal *ACS Nano*.

Block copolymers, composed of two or more different monomers covalently bonded in a block shape, were strategically employed to induce phase separation using a non-mixing liquid droplet. Professor Ku emphasized the significance of this achievement, stating, "We have successfully generated hundreds of flawless photonic crystal structures through the autonomous organization of block copolymers, eliminating the need for external manipulation."

Setting itself apart from conventional methods, this cutting-edge technology leverages internal nanostructures to create colors that are vivid, long-lasting, and sustainable. Furthermore, its enhanced applicability in display technology is evident through its capability to pattern large areas efficiently.



(a) Reflective optical micrographs, (b) photographs of particle suspensions, and (c) corresponding reflectance spectra of Janus colloids prepared with different molecular weights of PS-b-P2VP: PS55k-b-P2VP55k, PS133k-b-P2VP132k, PS250k-b-P2VP200k, and PS240k-b-P2VP296k. (d) SEM and (e) TEM images of PS-b-P2VP cones (fBCP = 0.2 for SEM and 0.6 for TEM) after the removal of silicone oil. (f) A plot of AR values of PS-b-P2VP cones as a function of fBCP depending on the Mn of PS-b-P2VP. (g) Patterned RGB pixel array of a colloidal suspension: PS240k-b-P2VP296k (red), a blend of PS250k-b-P2VP200k and PS132k-b-P2VP133k in a 1:1 weight ratio (green), and PS133k-b-P2VP132k (blue). Credit: *ACS Nano* (2024). DOI: 10.1021/acsnano.4c00230

The key innovation lies in the use of a polymer that can dynamically adjust the size of microstructures within particles in response to changes in the external environment. By leveraging the unique properties of polystyrene-polyvinylpyridine (PS-b-P2VP) block copolymers, the structure, shape, and color of the particles can be tailored, reverting to their original state despite environmental variations.

Real-time monitoring of structural changes revealed that the size and color of micro-nanostructures adapt to fluctuations in alcohol concentration or pH value. Notably, the particles produced through this technology exhibit an innovative "Ice Cream Cone" shape structure, combining aspects of solids and liquids to visualize fluid vibrations and dynamically alter shape and color in response to external stimuli.

Professor Ku said, "This study opens doors to the creation of self-assembling optical particles, streamlining the complex process conditions typically associated with colloidal crystal structure and pattern formation. The technology's practical applications in smart paint and polymer particles across various industries are envisioned."

More information: Juyoung Lee et al, Dynamic Photonic Janus Colloids with Axially Stacked Structural Layers, *ACS Nano* (2024). DOI: 10.1021/acsnano.4c00230

Provided by Ulsan National Institute of Science and Technology

Citation: Breakthrough in nanostructure technology for real-time color display (2024, March 5) retrieved 28 April 2024 from https://phys.org/news/2024-03-breakthrough-nanostructure-technology-real-display.html