

Structural Coloration with Curved Interfaces



• Time: 2026.04.07. (Tue) 16:00-17:15

• Place: 104-E206 Classroom

Speaker

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Abstract

Structural coloration has traditionally relied on periodic nanostructures at sub-wavelength scales; however, their fabrication remains complex, costly, and often limited in scalability, even when employing bottom-up approaches. In this talk, I present a fundamentally different strategy for structural coloration that eliminates the need for nanoscale periodicity by exploiting microscale curved interfaces. In this approach, controlled curvature induces total internal reflection and multi-path optical interference, enabling vivid color generation without pigments or photonic crystals. Two representative architectures—micro-crescents and microdome arrays—are introduced as model systems that demonstrate this concept.

Micro-crescents are fabricated by emulsifying a polymer–oil mixture, dissolved in a co-solvent, into water. During solvent evaporation, phase separation between the polymer and oil results in the formation of paired droplets. Subsequent selective removal of the oil phase produces crescent-shaped polymer microparticles with well-defined asymmetric curvature. These particles exhibit vivid, angle-dependent structural colors under directional illumination, while appearing nearly colorless under diffuse ambient light. Such anisotropic optical responses make them particularly suitable for dynamic colorants in artistic and security applications.

Microdome arrays are constructed via thermal reflow of micropillars patterned from a positive photoresist using photolithography. The resulting dome-shaped microstructures, arranged in programmable layouts, enable high-resolution, pixel-free multicolor graphics with tunable brightness. By varying the diameter of the micropillars while maintaining a constant height, the curvature—and consequently the optical path difference—can be precisely controlled, allowing deterministic tuning of the reflected color. Importantly, integrating domes of different sizes within a single layout enables continuous and broadband color expression without relying on pigments or sub-wavelength structuring.

This curvature-driven coloration platform provides a new paradigm for structural color, offering exceptional flexibility in spatial patterning and chromatic design. Beyond its scientific significance, it establishes a foundation for a new class of pigment-free visual media that bridges photonic materials and artistic expression.