Block Copolymer Photonic Pigments for Optical Materials

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The natural world is a colorful environment. Stunning displays of coloration have evolved throughout nature to optimize camouflage, warning, and communication, and the resulting flamboyant visual effects and remarkable dynamic properties – often caused by an intricate structural design at characteristic sizes in the order of visible light wavelengths – continue to inspire scientists to unravel the underlying physics and to recreate the observed effects. Photonic materials could bring tremendous benefits to society as their capability to emit, detect, manipulate and control light is expected to be accompanied by several technological breakthroughs. In this context, photonic pigments consisting of dispersable solid microparticles displaying vibrant, long-lasting structural coloration have been attracting more and more attention as they possess great potential to substitute traditional pigments – either organic or inorganic – henceforth having a growing economic significance in various industrial products and end-user applications. Structural pigments are superior to pigmentary colors in many ways, because of their tunability, resistance to photo- or chemical bleaching, reduced dependence on toxic materials, and capability to create spectacular unconventional effects [1].

Here, we report on the fabrication of photonic microparticles via the three-dimensional confined self-assembly of block copolymers (BCPs) in emulsion droplets [2]. The accurate selection of the BCP properties and the emulsification conditions leads to either highly ordered (i.e., concentric lamellae) or quasi-random (i.e., presenting only a short-distance order) structures comprised of alternated domains with refractive index mismatch showing strong light reflection. Here, the bandgap spectral position can be finely tuned by using “swelling agents” enabling the formation of supramolecular comb-like assemblies that consent to control the domain spacing thus altering light-matter interactions. Therefore, photonic pigments with color brightness, full-spectrum tunability, and adaptive optical properties are rapidly and easily achieved. Finally, we demonstrate the possibility to combine these structurally colored particles with different nanomaterials – such as plasmonic and oxide nanoparticles or emitting quantum dots – that enable the unlocking of additional functionalities with promises in several breakthrough applications [3].

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