Light-driven Adaptive Camouflage Structures Based on Photoprogrammable Printing Ink

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In nature, many animals change their colors or shapes to adapt to various environments, sparking a research trend in environmental adaptive materials. Light-responsive cholesteric liquid crystal materials have attracted extensive attention from researchers due to their remote, contactless, and dynamically adjustable properties. However, the development of a wide-ranging and precisely controllable helical superstructure remains a significant challenge, primarily due to the lack of suitable photoswitches and the unpredictability stemming from their low viscosity. Therefore, this study focuses on light-responsive chiral diarylethene liquid crystal systems, aiming to address the limitations in the current light-controlled liquid crystal systems, such as a narrow dynamic tuning range and poor precision control. By optimizing the ratios of chiral photoswitch (3.8 wt%), liquid crystal molecule (96.2 wt%), and polymer ink (100 wt%), the viscosity of the liquid crystal system is enhanced, striking a delicate balance between precise stable printing of patterns and dynamic wide-ranging tuning. This research introduces a class of flexible liquid crystal superstructures that are photoprogrammable, wide-ranging manipulable, and precisely printable. Specifically, we have successfully achieved a wide range of reflection colors from 470 nm to 800 nm on different kinds of flexible substrates, including PET, paper and wood. These innovative superstructures advance the development of adaptive camouflage materials, revealing the underlying scientific principles behind adaptive structural colors in nature. According to this research result, they hold significant potential in advanced anti-counterfeiting and national defense camouflage applications.