A color-changing biomimetic material simulating the UV-Vis-NIR spectrums and thermal infrared characteristics of plant leaves

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Abstract:

A color-changing biomimetic material (CCBM) was developed to simulate the UV-Vis-NIR spectral and thermal infrared characteristics of plant leaves of green and yellow colors by composition and structure imitating. The thermochromic capsule powders (TCPs) were used to simulate the generation and decomposition of chlorophyll in plant leaves, and titanium chrome yellow ($TiO_2 \cdot Cr_2O_3 \cdot Sb_2O_3$) particles were used to simulate carotenoid in plant leaves, which endows the CCBM with a near-infrared plateau. The lithium chloride (LiCl) powders, with characteristics of moisture absorption in high humidity and desorption in low humidity, were used to simulate the water absorption valleys in the NIR spectral and the thermal infrared characteristics of plant leaves. The CCBM was developed with the solution casting method by adopting TCPs, $TiO_2 \cdot Cr_2O_3 \cdot Sb_2O_3$ particles, and LiCl powders as fillers in a polyvinyl alcohol substrate. The proportion of the components of the CCBM was determined by a modified Kubelka–Munk four–flux model. The CCBM can reversibly change color between green and yellow with a CIE 1976 color difference of 40.89, and the color was stable at room temperature after the color conversion. The CCBM in green and yellow colors can both accurately reproduce the UV-Vis-NIR spectrums of green and yellow *Magnolia* leaves, with spectral correlation coefficients of 0.988 and 0.987, respectively. The 24 h outdoor average radiation temperature difference between the biomimetic material and *Osmanthus* leaves was 0.2°C, which indicates the two had similar thermal infrared characteristics. The CCBM developed in this study can be used in the fields of landscape and biomimetic camouflage.

Keywords: color-changing biomimetic material, UV-Vis-NIR spectrum, thermal infrared characteristics, plant leaves.

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