Spiropyran-functionalized photochromic nylon webbings for long-term ultraviolet light sensing

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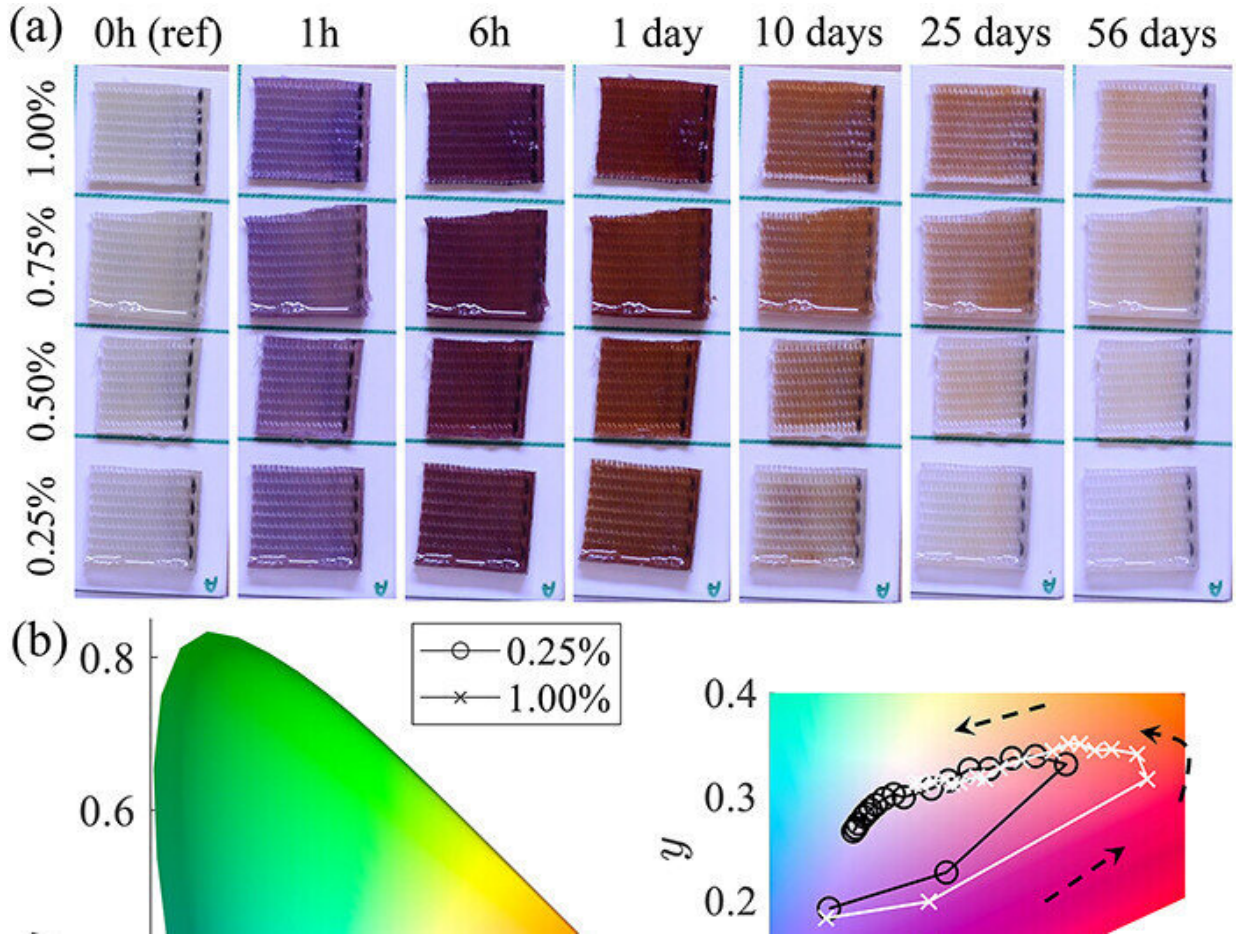

(a) Snapshots of SP-functionalized webbings over eight weeks of UV exposure. (b) Temporal evolution of the webbings' color represented in the CIE 1976 color space. The inset is a zoomed-in view, and the black dashed arrows indicate the direction of color evolution. Credit: *Journal of Applied Physics* (2022). DOI:

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Webbing structures—from chin straps and parachute material to space habitats—are extensively employed in engineering systems as load-bearing components. They are frequently subjected to extended ultraviolet (UV) light irradiation, which can affect their integrity and reduce their mechanical strength. Despite technological advancements in structural health monitoring, long-term UV sensing techniques for webbings remain under-developed.

In this research the investigators explored an enticing solution: a photochromic nylon webbing that, because it comprises spiropyran (SP) functionalized polymers, demonstrates color variation in response to extended UV exposure with controlled, color variation over multiple time scales that is conducive to UV sensing.

The team developed a mathematical model grounded in photochemistry to interpret experimental observations, unveiling the photochromic phenomenon as a multi-step, multi-timescale photochemical process involving several chemical species offering the basis for the inference of the webbing's color

In their research published in the *Journal of Applied Physics*, the team found that the decay rate of the webbings' color demonstrated a dependence on the initial concentration of the SP dye. Webbings with the lowest dye concentration maintained sensitivity for four weeks, whereas at the highest dye concentration, they exhibited sensing capability after eight weeks. Thus dye concentration could be customized to meet the lifetime of the targeted applications.

The proposed photochromic webbing and the photochemistry-based

mathematical model could inform future designs of UV-sensitive structures that maintain sensitivity under weeks of continuous sunlight UV exposure.

More information: Peng Zhang et al, Spiropyran-functionalized photochromic nylon webbings for long-term ultraviolet light sensing, *Journal of Applied Physics* (2022). DOI: 10.1063/5.0093641

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