

## Diffusion-Controlled Electrochromic Heat Shutters for Ultra-Low Power Multifunction Smart Windows

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In this work, we propose low-power consumption, all-in-one type electrochromic devices (ECDs) for effective heat shutters. Considering diffusion-controlled device operation, polymeric viologens (poly-viologens) are synthesized to lower the diffusivity of EC chromophores and to minimize self-bleaching. In comparison with devices based on mono-viologens corresponding to the monomer of poly-viologens, poly-viologen-containing ECDs exhibit advantages of lower coloration voltage and higher coloration/bleaching cyclic stability (> 90,000 s). In particular, poly-viologen ECDs show remarkably reduced self-bleaching with an extremely low-power consumption ( $\sim 8.26 \mu\text{W}/\text{cm}^2$ ) to maintain the colored state. Moreover, we successfully demonstrate solar heat shutters that suppress the increment of indoor temperature by taking advantage of NIR absorption of the colored ECDs.