Synopsis of Original Research Paper

Development of water-soluble molecular assemblies that detect tiny mechanical forces to evaluate and prepare cosmetic products

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Molecular assembled materials that change emission properties in response to tiny mechanical forces are valuable to develop various cosmetic products. In this study, we developed a green-emissive, one-dimensional supramolecular fiber consisting of fluorescence dumbbell-shaped amphiphile 1 having 9,10-bis(phenylethynyl)anthracene as the emission core. Mechanical grinding leads to emission color change from green to yellow on glass substrates under ambient condition. The emission spectrum shows a further red-shift when the ground sample was exposed to water vapor. Interestingly, the green fluorescence recovers after exposure to methanol vapor. Emission lifetime measurements and steady-state spectroscopic measurements reveal that the observed color change from green to yellow is ascribed to mechanical stimuli-induced excimer formation between the fluorescent cores. Infrared spectroscopic measurements clarified the amide groups are involved in hydrogen bonding and closer inspection revealed that a peak corresponding to C=O stretching becomes broad after mechanical grinding, which suggested that a linear hydrogen-bonds become disordered ones upon grinding. One-dimensional linear supramolecular fibers with width of ca. 5 nm were observed in transmission electron microscope images for the initial samples, while micellar structures were found to attach the both edges of short fibrous structures for ground samples. These results indicated that mechanical stimuli cut the supramolecular fiber and the micellar molecular assemblies form at the cut positions. The emission cores never form excimer in the initial fibers. In contrast, excimer should form in the mechanical stimuli-induced micellar molecular assemblies. Because the green-emissive fibers do not dissolve in water, we searched suitable amphiphilic molecular structures. Though we were not able to find the best amphiphiles, correlation between the dendritic structures and the molecular assembled structures in water have been partially clarified.