Photoactuating Artificial Muscle of Motor Amphiphiles as an Extracellular Matrix Mimetic Scaffold for Mesenchymal Stem Cells

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ABSTRACT: Mimicking the native extracellular matrix (ECM) as a cell culture scaffold has long attracted scientists from the perspective of supramolecular chemistry for potential application in regenerative medicine. However, the development of the next-generation synthetic materials that mimic key aspects of ECM, with hierarchically oriented supramolecular structures, which are simultaneously highly dynamic and responsive to external stimuli, remains a major challenge. Herein, we present supramolecular assemblies formed by motor amphiphiles (**MAs**), which mimic the structural features of the hydrogel nature of the ECM and additionally show intrinsic dynamic behavior that allow amplifying molecular motions to macroscopic muscle-like actuating functions induced by light. The supramolecular assembly (named artificial muscle) provides an attractive approach for developing responsive ECM mimetic scaffolds for human bone marrow-derived mesenchymal stem cells (**hBM-MSCs**). Detailed investigations on the photoisomerization by nuclear magnetic resonance and UV−vis absorption spectroscopy, assembled structures by electron microscopy, the photoactuation process, structural order by X-ray diffraction, and cytotoxicity are presented. Artificial muscles of **MAs** provide fast photoactuation in water based on the hierarchically anisotropic supramolecular structures and show no cytotoxicity. Particularly important, artificial muscles of **MAs** with adhered **hBM-MSCs** still can be actuated by external light stimulation, showing their ability to convert light energy into mechanical signals in biocompatible systems. As a proof-of-concept demonstration, these results provide the potential for building photoactuating ECM mimetic scaffolds by artificial muscle-like supramolecular assemblies based on **MAs** and offer opportunities for signal transduction in future biohybrid systems of cells and **MAs**.