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Nature-inspired smart drug delivery platforms based on electrospun nanofibers and plasmonic hydrogels for near-infrared light-controlled polytherapy

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Abstract

Nature offers a large variety of examples of functional structures with different properties which are inspiring scientists to develop novel materials. One of the most fascinating characteristics of natural structures is the ability to evolve, adapt and improve their functionality to fulfil different tasks over time. This feature is of particular interest in the development of materials for biomedical applications, since the therapeutic needs of the treated tissues change in accordance with the patient treatment stage. Additionally, it is well known that monotherapeutic treatments are not effective enough to successfully fight the most challenging diseases (e.g. cancer). In recent years, huge efforts have been made by scientists to design and fabricate nanomaterials mimicking the typical multifunctional capability shown by natural materials.

The present study is based on the idea that the stimuli-responsiveness of hydrogels based on plasmonic nanoparticles can trigger a series of material physical changes, arranged in a nature-inspired cascade, when they are merged with electrospun nanofibers. The near-infrared light-stimulated changes can be used to activate and/or regulate specific therapeutic treatments simultaneously.

Here we describe a novel jellyfish-inspired material based on electrospun poly(L-lactide) nanofibers and a plasmonic hydrogel made by photothermal-responsive gold nanorods and a thermoresponsive hydrogel. The nanostructured material chemical, morphological and structural properties, as well as its biocompatibility, were investigated. Finally, the potential applicability in the field of on-demand polytheraply (e.g. photothermal therapy and controlled-drug delivery) was tested.

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