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Srinivasa R Raghavan, J Pharm Drug Deliv Res 2017, 6:5
DOI: 10.4172/2325-9604-C1-023

11TH WORLD DRUG DELIVERY SUMMIT

October 16-18, 2017 Baltimore, USA

Nature-inspired multilayered capsules based on stimuli-responsive polymers: A new design for the multi-step release of drugs

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Diverse structures in nature such as eggs, embryos, body parts like the spinal disc, plant seeds, and the onion all have a common structural motif, which is the presence of multiple concentric layers. Individual layers are often composed of distinct materials because the layers serve different purposes. The creation of these structures in nature (morphogenesis) typically proceeds by the initial formation of an inner layer or core, followed by a first shell, and a further progression outwards to add more shells. Here, we draw inspiration from natural morphogenesis to create multilayered polymer capsules by an "inside-out" technique. First, an aqueous gel core is loaded with an initiator. This core is placed in a solution of monomer 1, whereupon a shell of polymer 1 grows around the core. Thereafter, this core-shell structure is loaded with fresh initiator and placed in a solution of monomer 2, which causes a concentric shell of polymer 2 to form around the first shell. This process can be repeated further to obtain multiple layers of distinct polymers. Each polymeric shell grows outward from the surface of the previous shell; thus, the thickness of a given shell steadily increases with time and can be controlled. A highlight of this technique is the ability to juxtapose different polymers next to each other among the concentric layers in an onion-like capsule. For example, layers of a non-responsive polymer can be placed next to either a temperature-responsive or a pH-responsive polymer. By varying the location of the stimuli-responsive layer(s), we demonstrate that the release of solutes (e.g., drugs) from the capsule can be made to follow unique multi-step release profiles as the stimulus is varied.

Biography

Srinivasa R Raghavan is the Patrick and Marguerite Sung Professor in the Department of Chemical and Biomolecular Engineering at the University of Maryland, College Park (UMD). He received his B Tech and PhD in Chemical Engineering from the Indian Institute of Technology, Madras, and North Carolina State University, respectively. His research on self-assembly, nanostructured fluids and soft materials has resulted in more than 150 publications and 20 US patents. He has received several national and University-wide awards for his teaching and his research (including the CAREER award from the National Science Foundation in 2004 and UMD Invention of the Year in 2009). He is also the scientific co-founder of three startup companies based on technologies invented in his laboratory.

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