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Controlling the stiffness of biomimetic silica nanocapsules and its impact on cellular uptake

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Over the past decades, advances in nanotechnology have led to the emergence of myriad nanomaterials that are promising for biomedical applications including bio-imaging and drug delivery. To better understand and predict the biological performance of these materials, effects of their physicochemical properties (e.g., size, charge and surface chemistry) have been extensively explored, providing valuable rules for the design of next-generation nanomaterials. Another equally important yet often overlooked character, the mechanical property of nanomaterials (e.g., deformability and stiffness), has recently been recognized to influence and even control their biological fates including vascular circulation and cellular uptake, while a better understanding upon this is still lacking. In this study, we synthesized oil-filled Silica Nanocapsules (SNCs) having variable stiffness and investigated the impact of their stiffness on both non-specific and ligand–receptor mediated cellular uptake. The prepared SNCs had a diameter of approximately 150 nm, a high-efficiency encapsulation (>90%) to the fluorescent dye DiI and good biocompatibility, with their stiffness ranging from highly deformable to rigid. Compared to deformable SNCs, rigid SNCs showed higher uptake in both macrophage and ligand–receptor mediated tumor cell internalization, while no significant difference was observed between their non-specific tumor cell uptakes. These results indicate the existence of an optimal stiffness to balance non-specific macrophage clearance with receptor-mediated cellular internalization, which may guide the design of new nanomaterials that link chemistry, mechanics and biology for enhanced nanomedicine.

Biography

Yue Hui is currently a PhD candidate from the Australian Institute for Bioengineering and Nanotechnology, the University of Queensland. He has an academic background of Materials, Chemistry and Nanotechnology. He aims to develop a nanocarrier for drug delivery application based on a biomimetic dual-templating platform technology developed at The University of Queensland. He is now investigating the effect of nanocapsules' stiffness on their biological performance including cellular uptake and biodistribution.

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