BIOCOMPATIBLE MICROCAPSULES FUNCTIONALIZED WITH INORGANIC NANOCLUSTERS FOR ENHANCED EXTERNAL TRIGGERING VIA LIGHT AND ULTRASOUND

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Designing and fabricating functional composite capsules are of considerable interest to both academic and industrial fields. Inorganic nanoparticles (NPs) have great potential to modify properties of Layer-by-layer (LbL) polyelectrolyte (PE) capsules, but using prefabricated NPs to functionalize capsules still has considerable challenges such as poor distribution in the capsule walls. The present work proposed and validated a novel approach of fabricating functional capsules with in situ formation and incorporation of inorganic carbon dots (CDs), TiO2 and SiO2 NPs in PAH/PSS multilayers.[1,2] CDs were synthesized within capsule shells through autoclaving the PE capsules in dextran solution, while SiO2 and TiO2 NPs functionalized capsules were fabricated by hydrolysis of Titanium butoxide (TiBO), Tetraethyl orthosilicate (TEOS) respectively. The morphology, composition, shell thickness, permeability and stimuli sensitivity, etc. of the formed capsules with different composition were investigated, and characterized by SEM, TEM, EDX, FTIR, and CLSM. The three types of capsules demonstrated prominent properties compared with the traditional capsule without hybrid with inorganic NPs: i) the PE/CDs capsules displayed a rigid bowl-like morphology (Figure 1A), increased shell thickness (178.4nm, Figure 1B) and an excellent fluorescent property originated from the CDs (Figure 1D, E), and it can efficiently prevent the penetration of a small molecule Rhodamine B (Figure 1F); ii) the PE/SiO2 capsules showed a free-standing sphere morphology and a reduced permeability; iii) the capsules in situ composited with TiO2 NPs were found as a sphere shape and susceptible to UV irradiation (320-400nm, ~110 mW cm-2). Ultrasound irradiation tests demonstrated that all these three types of capsules possessed effective ultrasound sensitivity. It was validated by the fragmentation of PE/SiO2 and PE/TiO2 capsules in a few seconds of 50W ultrasound irradiation and the completely break of PE/CDs capsules in a few minutes of the treatment (Figure 1C). Besides, the cell viability data demonstrated that all the three types of composite capsules possessed good biocompatibility. In summary, those innovative composite capsules were demonstrated with great capability of small molecule encapsulation, high mechanical strength, good biocompatibility and high sensitivity to ultrasound and UV, which could be promising for various applications such as cosmetics, environment and biomedicine areas.

Reference