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Release kinetics of gold nanoparticles from collagen microcapsules by total reflection X-ray fluorescence

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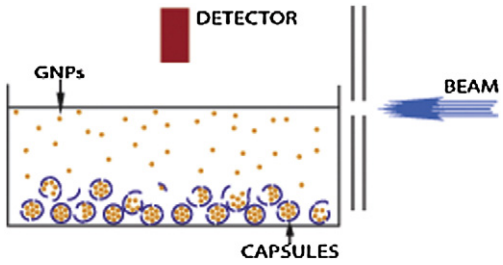
HIGHLIGHTS

- Collagen based microcapsules for smart drug delivery.
- Disease triggered release by over-expressed enzymes.
- Synchrotron radiation based total reflection X-ray fluorescence.
- Real-time release kinetics of gold nanoparticles.

GRAPHICAL ABSTRACT



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ABSTRACT

One of the main challenges in nanotechnology based drug delivery systems is the design of novel materials for patient specific therapeutic efficacy. This can be achieved taking into account changes in the expression profiles of related proteins. Here, we focus on collagen type I micro-capsules for releasing molecules using a biological stimulus elicited by over-expressed collagenolytic matrix metalloproteinase I (MMPI). We have carried out label-free real time monitoring of the release kinetics of gold nanoparticles induced by MMPI in order to define the pore opening process by synchrotron radiation based total reflection X-ray fluorescence. Scanning electron and confocal laser scanning microcopy investigations have been carried out in order to further characterize the interaction between collagen micro-capsules and MMP1. The results enable to predict and to engineer the release time for drug molecules of different sizes. Moreover, the proposed label-free approach can be adopted for the visualization of pore formation and of release kinetics for nano-engineered polymeric capsules.

1. Introduction

Nanoengineered polymeric capsules have been shown to be promising perspective candidates for use as smart containers for targeted drug release [1–7]. First, it allows decreasing the release rate of the core substance [8]. Second, the possibility of pore opening in the shell of the capsules allows the controllable release of the encapsulated substance. Pore opening usually results from pH variation even though it is also possible to induce the release by other factors, such as light, ultrasound and magnetic field [9–16]. It was reported also an utilization of ultrasonic treatment for these reasons [17]. We proposed collagen based nanoengineered capsules as smart drug containers for the therapy of diseases characterized by its up-regulated degradation, such as arthritis, cancer and cardiovascular diseases [18,19]. Such pathological states are characterized by the over expression of the collagenolytic enzymes

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