OSTE Microfluidic Technologies for Cell Encapsulation and Biomolecular Analysis

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Abstract

In novel drug delivery system, the encapsulation of therapeutic cells in microparticles has great promises for the treatment of a range of health conditions. Therefore, the encapsulation material and technology are of great importance to the validity and efficiency of the advanced medical therapy. Several unsolved challenges in regards to versatile microparticle synthesis materials and methods form the main obstacle for a translation of novel cell therapy concepts from research to clinical practice.

Thiol-ene based polymer systems have emerged and gained great popularity in material development in general and in biomedical applications specifically. The thiol-ene platform is broad and therefore of interest for a variety of applications. At the same time, many aspects of this material platform are largely unexplored, for example material and manufacturing technology developments for microfluidic applications.

In this Ph.D. thesis, thiol-ene materials are explored for use in cell encapsulation. The marriage of these two technology fields breeds the possibility for a novel microfluidic cell encapsulation approach using a novel encapsulation material. To this end, several new manufacturing technologies for thiol-ene and thiol-ene-epoxy droplet microfluidic devices were developed. Moreover, core-shell microparticle synthesis for cell encapsulation based on a novel co-synthesis concept using a thiol-ene based material was developed and investigated. Finally, a thiol-ene-epoxy system was also used for the formation of microwells and microchannels that improve protein analysis on microarrays.

The first part of the thesis presents the background and state-of-the-art technologies in regards to cell therapy, microfluidics, and thiol-ene based materials. In the second part of the thesis, a novel manufacturing approach of thiol-ene-epoxy material as well as core-shell particle co-synthesis in microfluidics using thiol-ene based material are presented and characterized. The third part of the thesis presents the cell viability studies of encapsulated cells using the novel encapsulation material and method. In the final part of the thesis, two applications of thiol-ene-epoxy gaskets for protein detection microarrays are presented.

Keywords: Microfluidics, microfabrication, cell encapsulation, core-shell particle, microparticle synthesis, off-stoichiometry-thiol-ene, OSTE, OSTE+, lab-on-a-chip, surface modification, core-shell particle co-synthesis, microarray, micromixer, bonding, surface modification, droplet microfluidics, protein screening.

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