Multifunctional Micro- and Nanoencapsulation technology with Remote Controlled Delivery and Release of various cargos

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One of the challenges in the (bio)-nanotechnology field is development of micro or nano-sized delivery systems comprising different functionalities. These systems should be able to ship and to carry bioactive substances to pre-defined site and unload it in designed time and place predominantly with remote physical signalling. Layer-by-layer assembled capsules have been intensively studied in recent years owing to their ability to encapsulate a wide range of chemicals from complex biomacromolecules to small water soluble compounds, for their permeability to be modified and their responsiveness to different factors and functionalities to be tailored in one capsule entity. Current research leads to the fabrication of carriers with remote guiding and activation by optical, magnetic and ultrasound addressing, what envisages unique applications as multifunctional biomaterials, including intracellular entering and in-vivo delivery with remote controlled release of micropackaged (bio)-chemicals. Release and encapsulation of materials by light and/or ultrasound and their navigation with magnetic field is a particularly interesting topic for chemical and biomedical applications. Microcapsules display a broad spectrum of qualities over other existing microdelivery systems such as high stability, longevity, versatile construction and geometry of micropackeging and a variety of methods to retain and release the substances.

The talk highlights recent advances in polyelectrolyte multilayers relevant to in vivo delivery of capsule to side of interest by magnetic field [1] as well as make the cells magnetic upon their uptake by various cells lines. Another particular attention in areas of polyelectrolyte multilayers is given on formation of defined microstructures on patterned surfaces. Polyelectrolyte multilayers can be deposition onto widely used PDMS stamps forming, so called, microchamber arrays enabled to accommodate various biologically active molecules. These chambers can be sealed over with another thin made of polymeric layers and resulted structure is pulled off to form free standing microchambers (figure, left). Entrapment of water soluble molecules into sealed chambers is performed by depositing hydrophobic layer polylactic acid on the top of multilayers and water soluble molecule make precipitate inside wells upon drying. Sealing results on formation of microsized air-bubble what can keep water soluble molecules inside the chamber until it released upon remote signalling via ultrasound or light [2]. The perspectives of biomedical application of remote activation and microchambers and capsule delivery and microchamber activation are discussed.

References

1.D. Voronin et al, ACS Applied Materials & Interface, 2017, 9(8), 6885.

2. M. Gai et el. ACS Applied Materials & Interface, 2017 (ASAP published)