Stimulating changes in complex nanostructures – lasers, acids and enzymes

Wye-Khay Fong[1,2], Raffaele Mezzenga[2], Ben J Boyd[1]

[1]Drug Delivery, Disposition and Dynamics, Monash Institute of Pharmaceutical Sciences, Monash University, 381 Royal Parade, Parkville, Victoria 3052, Australia. [2]Food and Soft Materials Science, Department of Health Science and Technology, ETH Zurich, Schmelzbergstrasse 9, CH-8092 Zurich, Switzerland.

khay.fong@monash.edu

Stimuli responsive nanomaterials are being developed as novel approaches to overcome complicated drug delivery issues such as those found in the treatment of cancer. These responsive materials have been of recent interest in the drug delivery field as it can take advantage of enzymes that are over-expressed in diseases such as cancer in order to trigger the release of encapsulated molecules. These 'smart' materials have the potential to provide early detection of disease and provide site selective drug release, thereby minimising exposure of healthy tissues to toxic drug, whilst maximising drug effectiveness.

My research utilises lipid based lyotropic liquid crystalline materials for this purpose. These biocompatible, multi-compartmental matrices can accommodate drug molecules with a wide range of physicochemical properties. The retention and release of drug from these materials is dependent on the internal nanostructure of the gel, whereby release characteristics can be tailored by selection of materials that form phases with specific dimensions of internal aqueous channels.

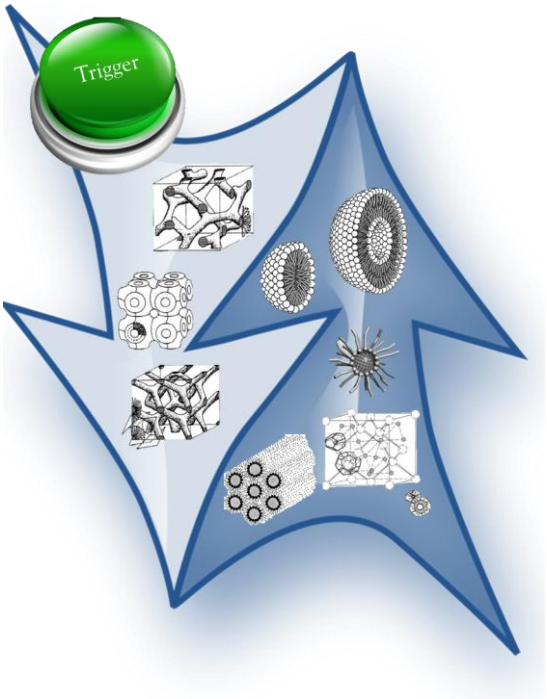

Fig. 1 – Lyotropic liquid crystalline materials can be specifically designed to be responsive to stimuli such as temperature, pH, light and enzymes. Upon exposure, these materials will change nanostructure on-demand, resulting in the triggered release of encapsulated contents.

Manipulating environmental variables, such as temperature [1] and pH [2], and the incorporation and activation of responsive molecules or nanoparticles, such as gold nanorods [3], photochromics [4] and digestible amphiphiles [5], can enable switching between different LC phases and so provide opportunity to trigger release of encapsulated material. Additionally, as these materials are thermodynamically stable in excess water, they can be dispersed into nanostructured particles. This presentation will give a short overview of the triggers that we have utilised in order to exert exquisite control over the nanostructures formed.

References

[1] W.K. Fong, T. Hanley, B.J. Boyd, J Contr Release, 135 (2009) 218-226.
[2] R. Negrini, W.K. Fong, B.J. Boyd, R. Mezzenga, Chem Comm, 51 (2015) 6671-6674.
[3] W.K. Fong, T.L. Hanley, B. Thierry, N. Kirby, B.J. Boyd, Langmuir, 26 (2010) 6136-6139.
[4] W.K. Fong, N. Malic, R.A. Evans, A. Hawley, B.J. Boyd, T.L. Hanley, Biointerphases, 7 (2012) 3.
[5] W.K. Fong, S. Salentinig, C.A. Prestidge, R. Mezzenga, A. Hawley, B.J. Boyd, Langmuir, 30 (2014) 5373-5377.