**DNA-peptide hydrogel hybrids with continuously time-varying rheology**

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Hydrogels find broad applications in health care and biotechnology, e.g. in wound healing[1] and drug delivery[2]. While they are mostly made of water (up to 90%) they can display a range of elastic and material properties. Self-healing hydrogels are very attractive [3] as they are made by crosslinks that can reform once broken. A drawback of self-healing hydrogels is that they are typically not very strong[3]. Solving the tradeoff between “healability” and strength is an intense area of research. Hydrogels that can “switch” between two distinct states (self-healing or strong) have been developed[4] and, among these, DNA-based hydrogels hold great promise[5]. This project aims to couple the capabilities of DNA with more traditional hydrogels in order to unlock unique (meta-)material properties.

This project will be performed in collaboration with Biogelx, a Scottish company that has developed synthetic peptide-based hydrogels that have applications in bioprinting, 3D cell culture, and tissue regeneration. Their hydrogels display a range of stiffness that can be easily tuned by altering the amount of lyophilized peptide powder and this ability has been used to stimulate stem cells to differentiate into different cell types[7]. Yet, once these hydrogels are made, their material properties are not easily tuned. On the contrary, within in vivo environments, cells, tissues and organs develop in ever-changing microenvironments. In this project we will aim to enhance and finely control the material properties of Biogelx peptide-hydrogels by incorporating DNA strands into the hydrogel structure.

The student will learn how to prepare and handle peptide/DNA-based hydrogels and to test their self-healing and strength using a range of time-resolved (micro)rheology, spectroscopy (AFM, Raman scattering, UV-vis) and imaging techniques. If theoretically/computationally inclined, s/he will also be taught how to model the self-assembly of hydrogels using polymer physics and molecular dynamics simulations. Ultimately s/he will contribute to the development and design of novel smart hydrogels with potential real-life applications.

--The company--

Biogelx will provide in kind technical support and hands-on training as well as offering the student an understanding of the steps required to translate such a material into a commercial product. The student will have several placements with Biogelx during their PhD at the company site in Biocity Scotland. Throughout the PhD project, there will be regular contact between the company and the student in order to provide progress updates on the project. The student will also be given the opportunity to contribute to marketing and public outreach activities undertaken by the company during this time.

[1] Lokhande et.al. *Acta Biomaterialia*, **70** (2018)

[2] Li&Mooney *Nat Rev Mater* **1** (2016)

[3] Zhang&Khademhosseini, *Science* **356** (2017).

[4] Phadke *et.al.PNAS* **109** (2012).

[5] Lee et.al. *Nature Nanotech* **7** (2012)

[6] Alakpa *et.al* *Chem* **1** (2016).