ULTRA-RESPONSIVE SOFT MATTER FROM STRAIN-STIFFENING HYBRID GELS

Paul H. J. Kouwer

Radboud University, Institute for Molecules and Materials, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands, p.kouwer@science.ru.nl

ABSTRACT

The stiffness of cells and the extracellular matrix if governed by fibrillar hydrogels. Already at low concentrations, these soft gels form porous network that become rapidly stiffer as soon as they are strained. Cells can actively impose these strains on the gels and, consequently, tailor their local stiffness and modulate their function. When optimised, such strain-stiffening materials become extremely sensitive and very responsive to stress. Strain-stiffening, however, is unexplored in synthetic gels since the structural design parameters are unknown. We recently reported one of the first synthetic hydrogels that is truly mimicking biogels in morphology and mechanical properties,[1] and uncovered how readily tuneable parameters such as concentration, temperature, polymer length and salt addition impact the stiffening behaviour.[2,3] This work in combination with network theory yields universal design principles for future strain-stiffening materials and recent cell studies highlight that these materials indeed can be used to as 'smart' hydrogels in wound healing and tissue engineering.[4] In this presentation, we will discuss how hybrid networks, composed of multiple components, all with clear biological analogies, can be used to further tailor the architecture and mechanics of hydrogels.

References:

1. P.H.J. Kouwer, M. Koepf, V.a.A. Le Sage, M. Jaspers, A.M. Van Buul, Z.H. Eksteen-Akeroyd, T. Woltinge, E. Schwartz, H.J. Kitto, R. Hoogenboom, S.J. Picken, R.J.M. Nolte, E. Mendes, A.E. Rowan "Responsive biomimetic networks from polyisocyanopeptide hydrogels" *Nature* **493**, 651-655 (2013).
2. M. Jaspers, M. Dennison, M.F.J. Mabesoone, F.C. Mackintosh, A.E. Rowan, P.H.J. Kouwer "Ultra-responsive soft matter from strain-stiffening hydrogels" *Nature communications* **5**, 5808 (2014).
3. M. Jaspers, A.E. Rowan, P.H.J. Kouwer "Tuning Hydrogel Mechanics Using the Hofmeister Effect" *Adv. Funct. Mater.* **25**, 6503-6510 (2015).
4. R.K. Das, V. Gocheva, R. Hammink, O.F. Zouani, A.E. Rowan "Stress-stiffening-mediated stem-cell commitment switch in soft responsive hydrogels" *Nat. Mater.* **15**, 318-325 (2016).