Stress-stiffening materials: tuning the properties

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Hydrogels made of oligo(alkylene glycol) polyisocyanopeptides (PICs) represent an interesting class of materials because their stress-stiffening behaviour mimics that of natural hydrogels, e.g. fibrin and collagen. A remarkable discovery made by Rowan's group was that the fate of stem cell differentiation could be controlled by tuning stress-stiffening behaviour of PIC hydrogel-based 3D cell growth environments.[1] It was shown in further studies that stress-stiffening of the PIC hydrogel could be controlled by other factors, such as addition of salts[2] or by the presence of a second component.[3] Recent mechanical studies of the hybrid hydrogels showed that if a thermoresponsive poly(*N*-isopropylacrylamide) (PINIPAM) is used as a second component, the stiffness of this hybrid network can be increased by 10–100 times via heating the hydrogel above lower critical solution temperature of PNIPAM. To be able to create bespoke hydrogels each component has to have well-defined properties. Therefore, we are interested in studying the properties of PIC–PNIPAM conjugates in which PNIPAM is prepared via 'living' radical polymerization.[4]

Here, we demonstrate a new class of thermoresponsive materials that can be synthesized by covalently coupling α,ω-heterodifunctional PNIPAM to PICs. We want to study the properties of both individual polymer chains and the hybrid networks made from these grafted copolymers. In addition, we aim to compare the properties of the hybrid networks depending on the way the architecture is build-up. Finally, we aim to use pending chain-end functionality of PNIPAM for conjugational chemistry carried out via strain-promoted alkyne–azide cycloaddition. We believe that knowledge of fundamental mechanical and structural properties of these materials will be useful for various bioapplications, such as drug delivery, wound healing and 3D cell growth environments. One direction this research will be channelled to, is to use chain-end functionality of PNIPAM and/or similar biocompatible polymers to couple procoagulants using strain-promoted alkyne–azide cycloaddition and create smart wound healing materials.

References

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