INNOVATIVE EMULSION-TEMPLATED DOUBLE NETWORK HYDROGELS

Sebastijan Kovačič,[a,*] Ema Žagar,[a] and Michael S. Silverstein[b]

[a] National Institute of Chemistry, Department of Polymer Chemistry and Technology, Hajdrihova 19, 1000 Ljubljana, Slovenia
sebastijan.kovacic@ki.si
[b] Department of Materials Science and Engineering, Technion – Israel Institute of Technology, Haifa, Israel

Hydrogels are cross-linked polymers which can absorb large quantities of water without dissolving. As opposed to conventional single network (SN) hydrogels, double-network (DN) hydrogels are known for their excellent mechanical properties, i.e. nominal tensile strength between 1 – 10 MPa and strain at break between 1000 – 2000 %. DN hydrogels combine two hydrophilic polymeric networks with different physical nature. The first network, a highly cross-linked polyelectrolyte contributes the rigid part, whereas the second network, a loosely cross-linked neutral polymer contributes the ductile part of the macromolecular structure. Excellent mechanical properties can be merged with high pore volumes by synthesizing emulsion-templated DN hydrogels.

Highly porous hydrogels with double-network structures were successfully synthesized using a two-step, sequential, free-radical polymerization within high internal phase emulsions (HIPEs). Thus, the DN hydrogel polyHIPEs (DN-PHs) were synthesized within single network hydrogel polyHIPEs (SN-PHs). The fully swollen DN-PHs did not fracture up to compressive strains of 70 %. Some of the DN-PHs recovered their shapes upon the removal of stress, and interestingly, water was not released during the stress-strain tests. The modulus of a DN-PH based on a SN-PH with 70 % porosity was 8-fold that of the SN-PH, while the moduli of a DN-PH based on a SN-PH with 85 % porosity was 35-fold that of the SN-PH. The values of water uptake of up to 33 g/g were less than one fifth to those of the corresponding SN-PHs.