Polyurethane-based hydrogels as promising drug-loaded coatings for biomedical devices

Polyurethane-based hydrogels as promising drug loaded coatings for biomedical devices

Rossella Laurano, Monica Boffito, Valeria Chiono, Gianluca Ciardelli

Politecnico di Torino, Department of mechanical and aerospace engineering, Corso Duca degli Abruzzi 24, 10129, Turin, Italy

Recently, the research of new functional biomaterials to be integrated with biomedical devices has become a challenging issue aiming at improving the immune system response. In this regard, polyurethane (PU) biomaterials are gaining increasing interest due to the high versatility of their chemistry, which paves the possibility to modulate their physico-chemical and mechanical properties by simply changing their building blocks. In this work, an amphiphilic PU was successfully synthesised [Boffito et al., 2016, DOI: 10.1002/pi.5080] starting from Poloxamer® P407 (Poly(ethylene oxide)-Poly(propylene oxide)-Poly(ethylene oxide) PEO-PPO-PEO triblock copolymer, 70% PEO, M_n 12600 Da) as macrodiol, 1,6 hexanodiisocyanate and N-Boc diethanolamine as chain extender for the design of thermosensitive hydrogels for drug delivery applications. The characteristic amphiphilic PEU molecular organisation into micelles in response to a temperature increase allowed the encapsulation of drugs with different wettability (i.e., hydrophobic drugs inside the micelle core, hydrophilic drugs within the interstitial space between micelles). Drug encapsulation did not induce changes in gelation conditions (sol-gel transition at 37 °C within 5 minutes), but different payload release kinetics were observed because of their different loading site. Furthermore, after Boc protecting group cleavage, the high number of -NH groups exposed along the polymer chains was exploited to graft photosensitive molecules (i.e., thiols and acrylate groups). In this way it was possible to further increase hydrogel residence time in aqueous environment through crosslinking upon UV or Vis light irradiation. Moreover, hydrogel cytocompatibility was also evaluated according to ISO10993.

Hence, due to their high versatility and easy processability, PU-based hydrogels, either physically or chemically cross-linked, can be further exploited as promising drug-containing coatings for biomedical devices, such as urinary of cardiovascular stents and prosthesis, providing a localized and controlled release of active principles for the treatment of infections and inflammations.