Green approaches to develop patient-specific drug-releasing patches for chronic wound treatment

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The design of patient-specific wound patches is gaining increasing interest due to the lack of wound dressings able to effectively treat chronic ulcers supporting tissue regeneration. The main factors limiting their effectiveness lie in the uncontrolled drug release mechanism and in the availability of standard formats requiring adaptation to the irregular morphology of the wound cavity. To overcome these criticisms, we engineered multi-stimuli-responsive polymers, starting from customized poly(ether urethane)s (PEUs), to obtain biomaterial-inks able to work as smart drug carriers and be processed in the form of 3D patches perfectly replicating the wound bed. This purpose was achieved by exploiting two green functionalization procedures, i.e., the water-based carbodiimide chemistry and the solvent-free plasma treatment to graft photo-sensitive (i.e., thiol and acrylate moieties) and carboxylic acid groups, respectively. PEU-based hydrogels showed responsiveness to temperature, alkaline-pH and Vis-light, which were exploited to encapsulate the payload and tune system viscosity, release their content via a pH-controlled mechanism and reinforce the network upon light exposure, respectively. Results evidenced hydrogel capability to modulate payload (e.g., Ibuprofen) release in response to wound clinical needs (e.g., alkalinity of infected wound exudate) and to be processed through solvent-free bioprinting techniques obtaining 3D constructs with patient-personalized morphology. Lastly, PEU-based biomaterial-inks showed excellent cytocompatibility according to the ISO 10993:5 regulation. Hence, the versatility of PEU chemistry and the exploitation of green functionalization and fabrication approaches resulted in the development of smart wound dressings with promising features to overcome current drawbacks.

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