Abstract

Tissue regeneration is an intricate physiological phenomenon that involves the interplay of various factors to restore tissue formation and function. Diseased or damaged tissues have often been replaced with synthetic materials such as polymers, metals, ceramics or their composites to facilitate their normal functioning. Polymeric materials such as poly(caprolactone) and poly (lactic-co-glycolic acid) are widely used for engineering matrices for tissue development. However, many of these commercially available materials suffer from drawbacks such as slow degradation and high immune rejection. This necessitates use of immunosuppressive drugs and makes secondary surgery imperative.

The three vital properties of a material that play important roles in controlling cell behaviour are degradation, release and mechanical properties. Developing materials with properties that could appropriately replace the native tissue is a major challenge in this field. The present work focuses on developing a general strategy to develop a library of biodegradable, crosslinked polymers in which these properties can be independently tuned. A rapid screening platform was subsequently engineered to select the correct processing parameters to synthesize materials with tailored compendium of properties. A thermally curable gradient biomaterial was developed as a specific case study. This study further investigated the release of an entrapped drug from the gradient material and opened up a new avenue for developing resorbable materials with degradation-controlled drug release.

Polymer modifications to facilitate drug incorporation are important since implant related infections and inflammatory responses are a major healthcare burden. Thus further, three different generic synthesis strategies were developed to incorporate different anti-inflammatory and antimicrobial drugs onto injectable or implantable polymers. These bioactive materials exhibit high loading of the drug, controlled release and consequent antimicrobial activity. This work provides a basis for the future of tissue engineering by describing tools and strategies for the development of tailored, drug releasing, biodegradable polymers.