Fabrication of collagen-based materials and analyses of the structure and properties

CHEN XUEFEI

This dissertation focuses on two types of collagen-based biomaterials: collagen film for sausage casing and collagen tube for tissue engineered scaffold.

The structure and properties differences between natural casing and artificial collagen films were investigated. The thick collagen fibers interwove into a high-density network structure, giving natural casing the special mouthfeel of 'cracking bite'. Whereas, layered structure filled with fine collagen fibrils and large gaps in collagen film resulted in poor mechanical properties and higher swelling ratio. Accordingly, glutaraldehyde (GTA) treatment and dehydrothermal (DHT) treatment were applied to improve the properties of collagen film. Due to the formation of crosslinking, collagen films with treatments showed higher mechanical properties and lower swelling ratio compared to the untreated collagen film.

To improve the efficiency of DHT treatment, the relationship among the treatment conditions including temperature and time, crosslinking and denaturation was discussed. The degree of crosslinking increased with increasing treatment temperature and time, contributing to the continuous improvement of mechanical properties. Meanwhile, the denaturation of collagen was detected according to the changes of collagen high order structure. Increase of treatment temperature and time leaded to the increase of denaturation degree, resulting in the deterioration of mechanical properties at higher temperature or for longer time.

Collagen tube with smooth and random continuous nanofibers was fabricated by adjusting the parameters of electrospinning. Then various post-treatments were applied to enhance the properties of collagen tube. Ammonia treatment can recovery the higher

order structure of collagen partially but had no influence on preserving the morphology and improving mechanical properties of collagen tube in wet state. Crosslinking treatments including GTA treatment and DHT treatment can improve the mechanical properties of collagen tube. By comparison, GTA treatment had the higher efficiency to improve the properties and can preserve the morphology of collagen fibers in wet state.