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Cross-linked polyamidoamine/non-woven fibroin fabric composite hydrogels for tissue engineering applications

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Cross-linked polyamidoamines (PAAs) absorb large amounts of water and form hydrogels that can be designed to be biocompatible and biodegradable to nontoxic products. PAA hydrogels were tested as substrates for cell culturing and found adhesive toward different cell types [1-3]. However, PAA hydrogels have poor mechanical properties, and can not be fixed to the surrounding tissues by stitching, but only with fibrin glue. PAA composite hydrogels obtained either by adding inorganic fillers [4] or embedding electrospun PLLA mats were previously investigated [5]. In this work, PAA hydrogels were strengthened by embedding non-woven fibroin fabrics. These composite hydrogels were cured by UV-induced radical polymerization of double bond terminated PAA oligomers obtained from N,N-bis(2-hydroxyethyl)ethylenediamine/1,4-bis(acryloyl)piperazine mixtures with 10% and 20% excess, on a molar basis, bisacrylamide. According to a first procedure, pre-synthesized PAA oligomer solutions containing a radical initiator were used to impregnate the non-woven fibroin fabric within a glass mold. Curing was then obtained by irradiating with a UV lamp. A second procedure relied on the impregnation of the non-woven fabric with the monomer mixture, followed by in situ polymerization and finally by UV-induced curing of the reactive oligomer. Best results were obtained with the second procedure. Slightly milky, soft and pliable hydrogels were obtained, which maintained shape and morphology after several swelling - deswelling cycles, owing to the formation of covalent bonds between the PAA matrix and fibroin. For comparison purposes, the same synthetic procedures were applied for the synthesis of fibroin-embedded poly-4-acryloylmorpholine (PACM) hydrogels with different degrees of crosslinking. Swelling-deswelling tests showed that PACM/fibroin hydrogels had poor strength, likely due to the low PACM-fibroin adhesion. The good PAA/fibroin adhesion was ascribed to the establishing of covalent bonds by surface NH_2 of fibroin with the bisacrylamide monomers during PAA formation.

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