

Title: Incorporation of nanoparticles in silk fibroin solution: Toward water-stable silk fibroin films possessing silk I structure

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Abstract: Water-stable silk fibroin (SF) films are normally prepared by transforming the secondary structure of SF, from amorphous silk I (random coils) to silk II (β -sheet), via physical or chemical means. Although mechanically strong, these films are generally brittle. Herein, we prepared water-stable flexible SF films possessing silk I rather than silk II structure. Films were prepared by casting SF solution possessing SF nanoparticles induced by two different methods: (1) pre-prepared SF nanoparticles by ethanol were added into SF solution; (2) nanoparticles were induced in SF solution via autoclaving. These films were compared with each other and with water-annealed and methanol-annealed films for their secondary structure and physical properties. The as-prepared films were primarily composed of silk I structure, as validated by x-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy. However, the water-annealed and methanol-annealed films exhibited silk II structure. The films prepared by induction of nanoparticles were water-stable, transparent, mechanically strong (tensile strength as high as 5.14 ± 1.43 MPa), exhibited tunable degradation and sustained drug release properties. As for mechanical properties, these films displayed 4 times and 12 times improved mechanical ductility as compared with water-annealed and methanol-annealed films, respectively. Moreover, these films exhibited fast enzymatic degradation as compared with their counterparts with silk II structure. These films hold great promise as a biomaterial for tissue engineering applications especially where flexibility and fast degradation of scaffold are important.

Keywords: Silk fibroin (SF), Silk I structure, Drug release, Enzymatic degradation, Tissue engineering, Biomaterials

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