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Solid-State Crosslinking of water soluble polymers by Atmospheric Pressure Non-Equilibrium Plasma: A Novel Straightforward Approach

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An interesting class of polymers for applications in pharmaceutical and biomedical field is represented by biopolymers. Due to their high biocompatibility, biopolymers are also ideal building blocks and protective agents to improve performances of biologically active molecules. Despite their interesting properties, the range of applications of biopolymers is not as high as expected, since the majority of them turns out to be extremely soluble upon water contact, bringing out the necessity to crosslink the polymeric chains to insure stability in a wet environment. Many chemical and physical methods have been so far investigated. However, the most common crosslinking agents often give rise to cytotoxicity and are therefore not suitable for biomedical applications. This work reports an innovative, easy and environmentally friendly approach to successfully crosslink electrospun mats of polysaccharides, gelatin and gelatin + genipin, directly in the solid state, through exposure to non-equilibrium atmospheric pressure plasma, generated by a Dielectric Barrier Discharge (DBD) source operated in air under various operating conditions. Plasma treated mats showed increased structural stability and excellent retention of fibrous morphology after 24 h of immersion in water or aqueous solutions. The mats also displayed improved mechanical properties, as shown by the slightly increased values of elastic modulus and stress at break, and the significantly reduced value of strain at break. Interestingly, as assessed also by the determination of the crosslinking extent, further stabilization of mats in gelatin and gelatin+genipin was obtained through immersion in PBS after plasma exposure. PBS is proposed to promote the formation of covalent bonds involving reactive groups originated by plasma treatment and ε-amino groups of gelatin.

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