Muscle Tissue-inspired High-strength and High-toughness Conductive PVA Hydrogels with In-situ Self-assembled Dual Nano-networks

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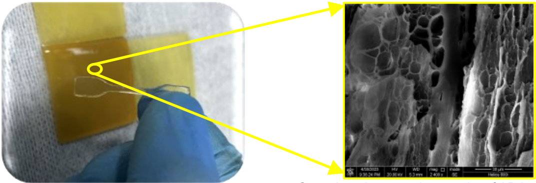
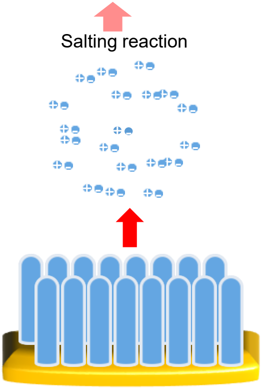
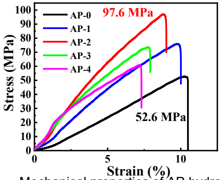
ABSTRACT: Hydrogel is a new multifunctional tissue-like material that possesses a Three-dimensional (3D) network structure. However, the fragile mechanical properties of hydrogels have been criticized in the past. In muscle tissue, highly oriented collagen nanofibers provide exceptional strength and toughness. This work applies the same idea to prepare polyvinyl alcohol (PVA) hydrogels. PVA solution was subjected to directed freezing and salting to allow in situ directed self-assembly of a double nanofiber network (DNN). Using the nanofiber as a template, the conductive polymer polypyrrole was also polymerized to impart good electrical conductivity to the PVA hydrogels. The resulting DNN-PVA hydrogel has a high modulus of about 1.5 GPa, strength of about 90 MPa, fracture toughness of 25 KJ/m2, and electrical conductivity of 100 S/cm. Furthermore, this hydrogel was found to be biocompatible and allowed cells to proliferate well on the hydrogel. These exceptional properties make the DNN-PVA hydrogel promising for a wide range of applications in tissue engineering, biosensors, electronic skin, among others.

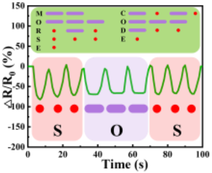


Scanning electron micrographs of AP hydrogels





Mechanical properties of AP hydrogels



The raw signals of "SOS" Morse codes by controlling the deformation time of the gel