Tendon-mimicking Strong Tough Braided Hydrogel with Anisotropic and Hierarchical Structure

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Owing to the anisotropic and hierarchical structure, tendon exhibit outstanding mechanical performance despite high water content and softness of constituent materials. Mimicking the structural characteristics has been regarded as a promising strategy for manufacturing strong tough hydrogel. Here, a tendon-mimicking method for development of a strong and tough hydrogel is presented. An anisotropic hydrogel was prepared from isotropic precursor double network hydrogel by unidirectional stretching, solvent exchange, and subsequent ionic crosslinking. Solvent exchange, the key step, induces contraction in the stretched state, which leads to densified linear alignment of polymer chains and microphase separation, resulting anisotropic reinforcement of the hydrogel. The resulting anisotropic hydrogels exhibited high strength and high toughness, which could be tailored over a wide range by varying the degree of pre-stretching. In addition, the anisotropic hydrogels are braided into hydrogel rope, and the ropes are braided into hydrogel cable to construct a hierarchical architecture, exhibiting improved mechanical performance compared to unbraided counterpart.