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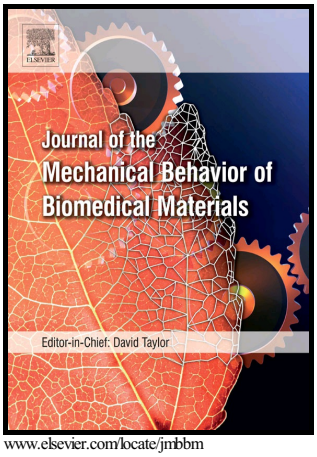

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Dynamic Properties of Hydrogels and Fiber-reinforced Hydrogels

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Abstract:

Hydrophilic polymers, or hydrogels, are used for a wide variety of biomedical applications, due to their inherent ability to withhold a high-water content. In recent years, a large effort has been focused on tailoring the mechanical properties of these hydrogels to become more appropriate materials for use as anatomical and physiological structural supports. A few of these such methods include using diverse types of polymers, both natural and synthetic, varying the type of molecular cross-linking, as well as combining these efforts to form interpenetrating polymer network hydrogels. While multiple research groups have characterized these various hydrogels under quasi-static conditions, their dynamic properties, representative of native physiological loading scenarios, have been scarcely reported. In this study, an E-glass fiber reinforced family of alginate/PAAm hydrogels cross-linked by both divalent and trivalent cations are fabricated and investigated. The effect of the reinforcement phase on the dynamic and hydration behaviors is then explicated. Additionally, a micromechanics framework for short cylindrical chopped fibers is utilized to discern the contribution of the matrix and fiber constituents on the hydrogel composite. The addition of E-glass fibers resulted in the storage modulus exhibiting a ~50%, 5%, and ~120%, increase with a mere addition of 2 *wt.* % of the reinforcing fibers to Na-, Sr-, and Al-alginate/PAAm, respectively. In studying the cross-linking effect of various divalent (Ba, Ca, Sr) and trivalent (Al, Fe) cations, it was noteworthy that the hydrogels were found to be effective in dissipating energy while resisting mechanical deformation when they are cross-linked with higher molecular weight elements, regardless of valency. This report on the dynamic properties of these hydrogels will help to improve their optimization for future use in biomedical load-bearing applications.