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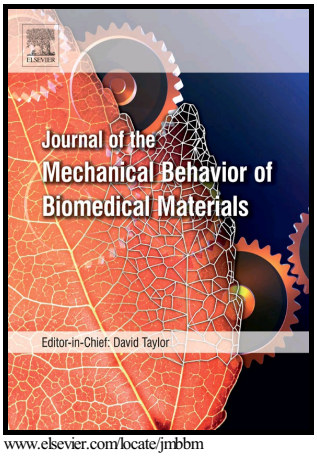

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Engineering hydrogel viscoelasticity

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Abstract:

The aim of this study was to identify a method for modifying the time-dependent viscoelastic properties of gels without altering the elastic component. To this end, two hydrogels commonly used in biomedical applications, agarose and acrylamide, were prepared in aqueous solutions of dextran with increasing concentrations (0, 2 and 5% w/v) and hence increasing viscosities. Commercial polyurethane sponges soaked in the same solutions were used as controls, since, unlike in hydrogels, the liquid in these sponge systems is poorly bound to the polymer network. Sample viscoelastic properties were characterised using the epsilon-dot method, based on compression tests at different constant strain-rates. Experimental data were fitted to a standard linear solid model. While increasing the liquid viscosity in the controls resulted in a significant increase of the characteristic relaxation time (τ), both the instantaneous (E_{inst}) and the equilibrium (E_{eq}) elastic moduli remained almost constant.

However, in the hydrogels a significant reduction of both E_{inst} and τ was observed. On the other hand, as expected, E_{eq} – an indicator of the equilibrium elastic behaviour after the occurrence of viscoelastic relaxation dynamics – was found to be independent of the liquid phase viscosity.

Therefore, although the elastic and viscous components of hydrogels cannot be completely decoupled due to the interaction of the liquid and solid phases, we show that their viscoelastic behaviour can be modulated by varying the viscosity of the aqueous phase. This simple-yet-effective strategy could be useful in the field of mechanobiology, particularly for studying cell response to substrate viscoelasticity while keeping the elastic cue (i.e. equilibrium modulus, or quasi-static stiffness) constant.