

Porosity Governs Mechanical Properties of Biopolymer Gels

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When sheared, most elastic solids including metals, rubbers, and polymer gels dilate perpendicularly to the shear plane. This behavior, known as the Poynting effect, is characterized by a positive normal stress. Surprisingly, fibrous biopolymer gels exhibit a negative normal stress under shear. Here we show that this anomalous behavior originates from the open-network structure of biopolymer gels. Using fibrin networks with a controllable pore size as a model system, we show that the normal-stress response to an applied shear is positive at short times, but decreases to negative values with a characteristic time scale set by pore size. Using a two-fluid model, we develop a quantitative theory that unifies the opposite behaviors encountered in synthetic and biopolymer gels. [1]

[1] H.C. de Gagny et al. Phys. Rev. Lett. 117, 217802 (2016)