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Microscopic changing-mass model of PVA hydrogel under unidirectional compression

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ABSTRACT

PVA (Polyvinyl Alcohol) hydrogel is a kind of soft materials, with nontoxic and good biocompatibility. This kind of hydrogel shows strong nonlinearity in the static compression tests because of the high water content (~60-90%), and the water is squeezed out when the PVA hydrogel is compressed. It means that the PVA hydrogel losts the mass during compression. Aiming at the changing mass mechanism and constitution in the compression of PVA hydrogel, we established a simplified microscopic model which is a single layer frame composite structure consisting of PVA fibers, water, and virtual membrane, in which the membrane wraps outside surfaces of the cubic cells and has no mass, but its membrane force has same properties with the surface tension of water. In the model, the deformation of PVA fibers and the compressive water sustains the external stress when the PVA hydrogel is compressed. In addition, by considering the limitation of the maximum membrane force induced by compressive water, the squeezed water will be calculated in each compressive step and the mechanism of the changing mass is determined quantitatively; in the meantime, the constitution of the PVA hydrogel may be deduced.