**Temporally non-local unsaturated fluid transport theory for poroviscoelastic biomaterials**

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Requested Session: Transport in Food and Biomaterials-I

The hybrid mixture theory was used to obtain the two-scale unsaturated transport and thermomechanical equations for biomaterials. The two-scale laws of conservation of mass, momentum, energy and entropy were utilized, the constitutive theory was formulated and the entropy inequality was exploited to obtain various equilibrium, near- equilibrium and non-equilibrium relations. The system was treated as poro-viscoelastic with viscoelastic biopolymers interacting with the viscous liquid phases (water and oil) at pore-scale. The interaction of hydrophilic and hydrophobic biopolymers with the water and oil phases was included. The gas phase was considered as a mixture of air and water vapors, which exchanged mass with the liquid water due to evaporation/condensation away from equilibrium. The exploitation of entropy inequality resulted in temporally non-local generalized Darcy’s law relations for water and oil phases, near-equilibrium swelling and capillary pressure relations, generalized stress relations, near-equilibrium Gibbs free energy relation and the rate of evaporation relation. The generalized Darcy’s law relations include novel integral terms with long-memory effects. These can describe the effect of biopolymer-fluid interaction on both Darcian and non-Darcian modes of fluid transport depending upon the state of the biomaterial (glassy, rubbery or glass-transition). The resulting transport laws for various phases include the cross-effect terms in form of volume fraction gradients. The system of equations can be used to model unsaturated fluid transport during processing of biomaterials in a wide range of temperatures and fluid contents.