RHEOLOGICAL BEHAVIOR OF 10WT% GELATIN

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Gelatins are widely used materials in food and pharmaceutical industries, as well as in terminal ballistic trauma simulations. Collagen has a triple-helix structure which is hydrolyzed to produce random coil chains of the gelatin-molecules in water above 40°C. Below 30°C, a reversible coil-helix transition takes place, forming partial crystallization and partial coil-chain network structure. Well above the melting temperature the viscosity of gelatin is independent of the shear rate, while near the melting temperature, gelatins show ageing behavior, as manifested by the evolution of dynamic moduli at large time scales. Our experiments on the 10wt% gelatin further explored the shear rejuvenation effects, that is, the competition between the crystallization-ageing and the shear-stress-melting. Starting the shear rate of 10/s in a cone-plate fixture and at the temperature 29 or 30°C, the viscosity gradually increased but was superimposed by regular oscillations, and the normal stress strongly oscillated between 800Pa and zero, as shown in Fig.1. This implies that while in structural evolution, the gelatin transformed between viscoelastic fluid and Newtonian fluid repeatedly. At the low temperatures of 9, 7, 5°C, we imposed low shear rates from 0.003/s to 0.3/s. The solid gelatin first showed perfect linear elastic behavior. At yielding, the shear stress dropped to a much lower value followed by ageing-and-yielding oscillations with lower yielding stresses, in which the rising slopes indicated the same elastic modulus as the original one. This implies that the strain was ‘forgot’ or ‘relaxed, by yielding. Finally, the ageing process may be completely overcome by the shearing and the gelatin solid transformed to a viscoelastic fluid, as shown in Fig.2. Modeling such rheological behavior of the gelatin is a challenging task.

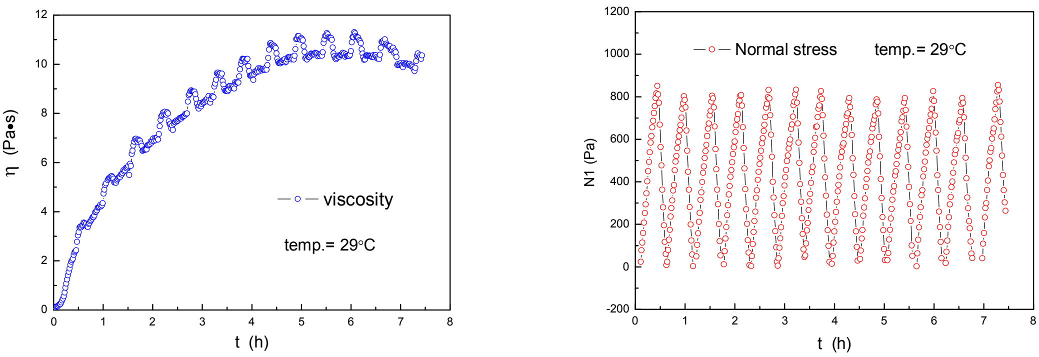

Figure 1 Evolution of the viscosity and normal stress of 10wt% gelatin near the melting temperature.

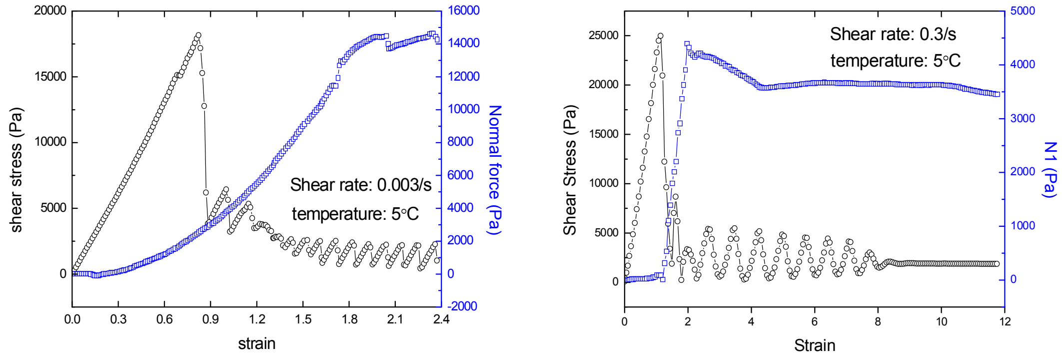

Figure 2 Evolution of the shear stress and normal stress of 10wt% solid gelatin at low shear rates