MICRORHEOLOGY OF GELS BASED ON POLYMERS AND ON DIFFERENT COLLOIDAL SYSTEMS

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Gels are ubiquitous materials in Biology and in many technological fields such as cosmetics, pharmacy, food, science. A distinctive feature of gels is their mechanical properties, which are intermediate between those of concentrated polymer solutions and of rigid solids. Focusing on the complex shear modulus, G*, the gelling point at a given temperature is frequently defined as the frequency at which the real, G', and the imaginary, G", contributions are equal. Understanding the gelling kinetics is another issue of key importance for designing gels under pre-specified conditions. A short cut in most papers G* is measured in a short low-range frequencies. Passive microrheology is a good tool for extending the frequency range. Despite it is only useful for the linear range, it has the advantage of enabling to probe the spatial heterogeneity.

In this communication we will use passive microrheology and standard low-frequency rotational rheology to study the gelling kinetics of concentrate polysaccharide solutions at different concentration and temperatures. It has been found that the use of the extended Jeffrey's model fits the results and allows one to calculate the short- and long-time node-node diffusion coefficients and mean node-node molecular weight. It was found that the mean-squared displacement does not only depends on the size of the particles, but also on their chemical nature because in some cases, e.g. TiO_2, there can be strong particle-monomer interactions that slow down the motion of the microparticles.

Similar studies have been done using gels based on colloidal systems such as lamellar phases or emulsions, including active molecules or not. More sophisticated systems are nano- or microgels inside liposomes or giant vesicles. In this case hyaluronic acid is encapsulated and then crosslinked by Fe^{3+} ions that diffuse through the phospholipidic membrane. In this case a heterogeneous gelling process takes place due to the gradient of Fe^{3+} ions from the membrane to the center of the capsule.

Finally, gel-like materials are formed by adsorption of polyelectrolytes or their mixtures with surfactants from their aqueous solutions on solid substrates. Their mechanical properties at high frequencies can be estimated using a quartz-crystal microbalance with dissipation. In most cases the values of G' are in the MHz range despite the water content inside the adsorbed film can vary between 20 and 70 wt%. Despite it is possible to follow the adsorption kinetics, the precision on G' does not allow following the gelling kinetics in terms of the shear modulus.