Hyper-branched Hydrocolloids

Leon Bremer, Frank Derks, Eric Arts, and Ronald Tennebroek

1 DSM Research Geleen, P.O. Box 18, 6160 MD Geleen, The Netherlands
2 DSM Neoresins, Sluisweg 12, 5145 PE Waalwijk, The Netherlands
*e-mail: leon.bremer@dsm.com

Hyper-branched polymers prepared by the poly-condensation of diisopropanolamine and succinic-anhydride are soluble in water and form dense particles with a diameter of a few nanometers. The molecules can be modified by grafting functional groups to the –OH moieties and this enables producing a huge variety of hydrocolloids.

We studied the effect of grafted fatty-acid groups and the combination of fatty acid and neutralized carboxylic acid groups on the properties and association of these molecules. Some properties are strongly affected by the broad molecular weight distribution the poly-condensation gives rise to. However, association colloids that are much less poly-disperse are formed in the case of fatty acid grafted molecules. Without charged groups the solutions have a cloud point depending on the amount and size of the fatty acid groups and on the particle concentration. At most about 20% of the molecule can be grafted with lauric acid groups in order to obtain a completely soluble system at room temperature. With charged groups a larger number of fatty acids can be grafted to a single molecule that is still water-soluble.

At higher particle concentrations the fatty acid groups can lead to connections between the colloidal particles whereas the charged groups lead to repulsion. This enables the formation of structures with a very interesting behavior. We believe that a structured liquid with two continuous liquid phases is formed over a broad concentration range, i.e. behavior like a Windsor type III micro emulsion. The viscosity of such structured liquids is Newtonian and determined by the viscous “oil phase”. Analysis of the correlation function from dynamic light scattering reveals two relaxation times. The fast relaxation can be attributed to a diffusion process in water whereas the slow relaxation occurs in the polymer phase. A sharp phase transition to a Windsor type I micro-emulsion behavior can be triggered by temperature and the transition temperature can be tuned by the salt concentration and the composition of the hyper-branched polymer. This reversible transition results in a change in viscosity of several orders of magnitude.