Rheological manifestation of microstructural change of colloidal gel under oscillatory shear flow

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The rheological manifestation of intra-cycle microstructural change of a model colloidal gel under oscillatory shearing is studied with Brownian dynamics simulation and a fully quantitative sequence of physical processes (SPP) techniques. The microstructural change of the model colloidal gels is identified with the rigidity concept and correlated to rheological behavior quantified via the SPP metrics. The model colloidal gel exhibits complex nonlinear stress response in the large amplitude oscillatory shearing (LAOS) that is divided into four physical processes: 1) Viscoplastic flow of broken network with soft chain structure, 2) Recovery of the rigid and soft chain coexisting network structure, 3) Early stage yielding with stretching of bonds within bonding range, and 4) Late-stage yielding accompanying catastrophic network structure failure. It has been shown that the wide range of intra-cycle rheological transition is the consequence of decrease or increase in the rigid and soft chain structure. The result of this study suggests that rich rheological behavior of colloidal gel is originated from structural evolution of rigid network chain.