Shearing colloidal gels

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Soft matter systems have the intriguing property to be able to form a variety of different arrested states, encompassing (among others) repulsive, attractive glasses and gels. In this work, we numerically study a gel-forming colloidal system[1,2], modeled as a modified Lennard-Jones potential complemented with a repulsive Yukawa tail, under the effect of shear. Starting from an off-equilibrium arrested state at low temperature, we have sheared the system using Lee-Edwards boundary conditions at different shear rates. We find that at high shear rates the energy of the system increases, reaching a non-equilibrium steady state (Fig.1a). We thus identify a mapping between shear rate and temperature which enables us to connect sheared gels to equilibrium states: for each shear rate we consider the equilibrium system having the same potential energy and we compare the structure of the two states. We find that shear does not significantly alter the local scales but has a profound effect at large length scale, inducing the system closer to a phase separation (Fig.1b-d). For low shear rates, instead the sheared gel is actually able to visit lower energy states with respect to equilibrium simulations (Fig.1a), reaching a crystal state. We then consider a polydisperse version of the model, in order to avoid crystallization and to examine the gel rearrangements at low shear rates.

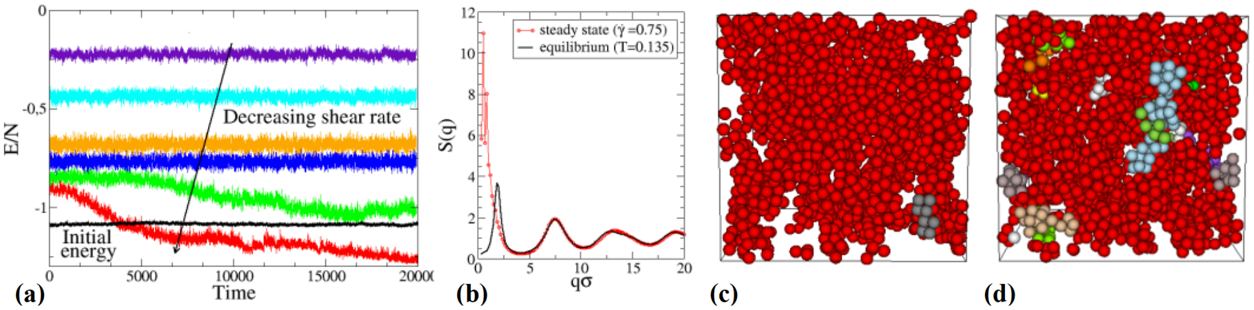

Figure 1 (a) Potential energy per particle E/N versus time for different shear rates starting from an initial gel state; (b) Comparison of S(q) for sheared (shear rate=0.75) and equilibrium (T=0.135) states having the same potential energy; (c) Snapshot of a gel sheared into a steady-state at a shear rate 0.75; (d) Snapshot of the corresponding system in equilibrium (T=0.135).

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[1] Campbell, Anderson, van Duijneveldt, Bartlett, *Phys. Rev. Lett.*, **94**, 2005, 208301.
[2] F. Sciortino, P. Tartaglia, E. Zaccarelli, *J. Phys. Chem. B*, **109**, 2005, 21942.