Self-Organization and Rheology of Star Polymers with Varying Attraction

Esmaeel Moghimi[1, 2], Iurii Chubak[3], Antonia Statt[4], Michael P. Howard[5], Dimitra Founta*[1, 2],
George Polymeropoulos[6], Konstantinos Ntetsikas[6], Nikos Hadjichristidis[6], Athanassios Z. Panagiotopoulos[4], Christos N. Likos[3, 7], and Dimitris Vlassopoulos[1, 2].

1. Institute of Electronic Structure and Laser, FORTH, Heraklion 71110, Crete, Greece
2. Department of Materials Science and Technology, University of Crete, Heraklion 71003, Crete, Greece
3. Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria
4. Department of Chemical and Biological Engineering, Princeton University, Princeton, New Jersey 08544, United States
5. Department of Chemical Engineering, University of Texas at Austin, Austin, Texas 78712, United States
6.Physical Sciences and Engineering Division, KAUST Catalysis Center, Polymer Synthesis Laboratory, King Abdullah University of Science and Technology (KAUST), Thuwal 23955, Kingdom of Saudi Arabia
7. Isaac Newton Institute for Mathematical Sciences, 20 Clarkson Road, Cambridge CB3 0EH, United Kingdom

*dfounta@iesl.forth.gr

ABSTRACT

We investigate the responsive and tunable character of telechelic star polymers (TSPs), which act like soft patchy particles, using a combination of synthesis, computer simulations and physical experiments. The system of interest is a star consisting of asymmetric block copolymer arms with the inner blocks being solvophilic and the outer solvophobic. Dynamic light scattering experiments in dilute solution reveal the emergence of a second slow mode in the intermediate scattering function as the temperature is decreased, indicating cluster formation. Both the single star and the cluster shrink on cooling, the being attributed to an interplay between inter- and intra-star associations. Linear viscoelastic measurements indicate a rich phase behavior, characterized by re-entrance because of the formation of a mixed order of the patches, as supported by X-ray measurements. Interestingly, stress relaxation upon shear flow cessation in concentrated solutions exhibit an unexpected non-monotonic behavior in a certain range of concentrations, temperatures and rates. TSPs are proposed as ideal paradigms for designing and exploring the properties of soft patchy particles.