QUANTIFICATION OF AN ALIGNMENT FACTOR FROM MICROSCOPY IN FLOW-INDUCED STRUCTURES IN VISCOELASTIC SUSPENSIONS

R. Pasquino[1], D. Panariello[2], N. Grizzuti[2]

1 - Forth, IESL, Heraklion, Greece
2 - University of Naples Federico II, Department of Chemical Engineering, Napoli, Italy

rossana@iesl.forth.gr

The self assembly of particles in complex media consists in the organization into ordered, macroscopic structures either through direct chemical or physical interactions or, indirectly, using an external field, e.g., flow, electric or magnetic fields ([1]). This is a very interesting area of research because in most industrial processes nano or micro particle suspensions are subjected to flow, thus allowing for the possible generation of specific micro-structures.
One dimensional string-like structures of spherical particles have already been observed in different viscoelastic fluids subjected to shear flow [2-4]. Information on alignment, however, is usually restricted to a qualitative indication. The quantification, when present, is indirect, as it is typically obtained by scattering techniques [3-5].
In the present work, very dilute suspensions of polymethylmetacrilate spheres suspended in a aqueous solution of hydroxypropylcellulose are subjected to simple shear flow in a parallel plate geometry using a rheo-optical shearing cell. Real-time optical microscopy observation along the velocity gradient direction allowed to detect the formation and evolution of flow-induced microstructures. A time dependent alignment factor, obtained from the quantitative analysis of the video frames, was measured. The effect of shear rate and volume fraction on the alignment factor are presented and discussed. It was found that the delay time of the alignment process does not change significantly with increasing volume fraction and that the kinetics of string formation are uniquely dependent upon the properties of the suspending medium.

[1] M. Grzelczak, J. Vermant, E. M. Furst and L.M. Liz-Marzan “Directed self assembly of nanoparticles”,. ACSNano, 4, 3591-3605, 2010.
[2] Michele J, Patzold R, Donis R “Alignment and aggregation effects in suspensions of spheres in non-Newtonian media”, Rheol. Acta 16, 317–321, 1977.
[3] Scirocco R, Vermant J, Mewis J (2004) “Effect of the viscoelasticity of the suspending fluid on structure formation in suspensions”, J Non-Newton Fluid Mech 117, 183–192, 2004.
[4] R. Pasquino, F. Snijkers, N. Grizzuti, J. Vermant, “Directed self-assembly of spheres into a two-dimensional colloidal crystal by viscoelastic stresses”, Langmuir 26, 3016-3019, 2010.
[5] R. Pasquino, F. Snijkers, N. Grizzuti, J. Vermant, “The effect of particle size and migration on the formation of flow- induced structures in viscoelastic suspensions”, Rheol. Acta 49, 993-1001, 2010.