Flow and Processing of Highly Filled Materials Workshop (2016)

Paris, France
January 28 – 29, 2016

This Workshop, co-organized by IMP Lyon, CEMEF Sophia Antipolis and SIMM-ESPCI, was held at the Institute Pierre-Gilles De Gennes in Paris on January 28 – 29, 2016. The scientific program was organized around 17 lectures given by recognized experts, both academic and industrial, in their respective areas: rubber, thermoplastics, concrete suspension and ceramic pastes. The objective of the workshop was to bring together a broad community of scientists, engineers and students involved in highly filled materials to discuss recent progress. During two days, almost 120 participants, about half from academic and half from industry, enjoyed the multidisciplinary talks on recent advances in experimental rheology tools, theoretical concepts and numerical models which have been developed to understand flow and process issues of highly concentrated materials.

Part of the lectures were dedicated to the basics of the role of particle interactions on the rheology of non-Brownian particles: based on numerical and experimental results, and recent models, it was evidenced that the role of interparticular friction was crucial for the rheological behavior (Elisabeth Lemaire, Université Nice). Indeed, in the case of soft particles, the lubrication in the contacts originates only in elastohydrodynamics (Michel Cloitre, ESPCI-MMC). Thus the rheological behavior depends on the elastic modulus of the particles. On the contrary for rigid particles, the solid friction dominates. In that case particles may form a network. The suspending – thus interstitial – fluid flow behavior modifies the rheology, and it is now possible to account quantitatively for this effect (Olivier Pouliquen, IUTSI Marseille). In addition the friction may depend on the particle pressure, inducing either discontinuous or continuous shear thickening transition (Matthieu Wyart, EPFL). In addition, these concentrated suspensions reveal non-local rheological effects required to be analyzed properly by techniques like ultrasonic Doppler velocimetry (Guillaume Chatté & Annie Colin, ESPCI-SIMM). These peculiar behaviors have indeed huge effect on the process of ceramic injection molding, where in some case it is impossible to manipulate polymer melt/ceramic mixtures (Thomas Périé, Saint-Gobain). In the unusual case of concrete rheology, Lafarge has developed a tricky smartphone application that quantifies the "slump test" and that allows the sizing of pipes and pumps (Fabrice Toussaint, Lafarge Holcim).

In practice, in many industrial processes, particles – or fillers – are constituted of agglomerates of aggregates, and have to be efficiently dispersed in a polymer matrix. Thus the action of flow and thus the process have an important role on disaggregation and thus on final properties of the materials (Laurent Guy, Solvay). This process can be modeled thanks to Leonov inspired equations (Christian Carrot, IMP Saint-Etienne). It was

Figure 1: Impressions from the workshop.

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shown that the precise interaction between polymer and particles strongly affects this disagglomeration (Marc Couty, Michelin).

The fact that particles may aggregate or disaggregate under flow, and with time, leads to thixotropic behavior that can be modeled by constitutive equations (Philippe Coussot, IFSTTAR) that are now able to be implemented in flow software. The consequence of this complex rheology may be a strong localization of the flow in complex geometry (Rudy Valette, CEMEF Mines ParisTech). Rheology of anisotropic particles suspensions originates in complex behaviors that can now be described quite precisely even in confined geometry (P. Chinesta, Ecole Centrale Nantes). Finally, all the concepts presented during the workshop appear to be relevant in various industrial applications such as solid propulsion process (Christine Marraud, Safran-Herakles), electric cables (Gérard Bacquet, Nexans) and in Lithium battery processes (Bruno Dufour, Hutchinson). The coffee breaks and meals provided opportunities for numerous discussions and contacts between the academic and industrial communities. The organizers gratefully acknowledge support given to the workshop by Groupe Français de Rhéologie, Chaires ESPCI-Total, ESPCI-Saint-Gobain et ESPCI-Michelin, SA ESPCI, and Hutchinson.

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Figure 2: Participants during the poster session.

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