Conference Report II

Flow in Glassy Systems European School of Rheology

Les Houches, France February 4 - 9, 2007

Glasses are well-known as matter intermediate between solids and liquids. Roughly speaking, due to their very large viscosity they look like solids but their structure appears as disordered, or amorphous, similar to that of liquids. In many common heterogeneous materials, such as gels, suspensions, foams, emulsions, granular materials, a "glassy" transition seems to take place around some critical volume fraction of elements, or some critical stress, pH, electrolyte concentration, etc. The material behavior turns from solid-like to liquid-like, the apparently solid phase being often described as a "soft" glass. Also these systems are seen to age and rejuvenate under appropriate flow histories, in mechanical terms they are said to be yielding, thixotropic fluids. Although their formulation and control remain difficult the versatility of these systems make them quite useful in various industrial applications (concrete, paints, drilling mud, cosmetic gels, creams of foams, chocolate, mayonnaise, etc), and innovative materials might be devised on the basis of a better physical understanding. Besides, the ability of heterogeneous systems to liquefy when submitted to a small additional stress may lead to catastrophic events in nature (debris flows, mudflows, snow avalanches, lavas).

From the February 4 to 9 in total 75 persons were present at Les Houches, a small city close to Chamonix, at the foot of the Mont-Blanc, for a European School of Rheology focused on recent advancements in the field of these "glassy systems". More precisely the objective of this meeting was to gather leading experts in the rheology and physics of complex glassy systems of various types, in order to present a review of the state of the art and as far as possible address the extent of "universality" of these systems and in particular: the possibility of "quasi thermodynamic" descriptions in terms of effective temperatures; the interaction between local events and the global organisation of the flow such as shear localization; the derivation of the macroscopic constitutive equation from microscopic models.

The school was organized on the basis of 18 invited lectures. Also 31 posters, covering analogous topics, were presented by the participants after a short oral presentation of their work in the conference room. M. Robbins (John Hopkins Univ.) opened the meeting with a talk on yield, aging and strain hardening in glasses. A. Liu (Univ. Pennsylvania) went on by addressing the existence and usefulness of effective temperatures in sheared glasses. Then F. Lequeux (ESPCI, Paris) examined our current understanding of the plasticity of glasses. M. Dennin (UC Irvine) showed us the possibilities of understanding flow transitions from original 2D experiments with bubble rafts. H. Winter (Univ. Massachusetts) reviewed the great amount of existing knowledge concerning the rheological expression of chemical and physical gelation. Y. Forterre (IUSTI, Univ. Marseille) reviewed the recent advances in the rheology and physics of dense

Figure 1 (left):
The participants in the conference room.
(Photo: F. Mahaut)

Figure 2:
Our view from the conference center.
(Photo: F. Mahaut)

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granular flows. G. Ovarlez (Institut Navier – CNRS) presented a thorough MRI study of jamming and flow properties of dense suspensions. T. Mason (UCLA) gave a talk on the structure-rheology relationships in concentrated emulsions and nanoemulsions, that he called "From mayonnaise to nano-naise". D. Bonn (Univ. Amsterdam & CNRS) focused on the peculiar properties (viscosity bifurcation) of aging and rejuvenation of soft-glassy materials. D. Durian (Univ. Pennsylvania) presented an original study of the dynamic heterogeneity in air-fluidized beads on approach to 'Point-'J. C. Ancey (EPFL) reviewed laboratory and in-situ approaches of the dynamics of snow avalanches and debris flows, and threatened us with a video of an avalanche seemingly just about to overwhelm us. G. Ruocco (Univ. Roma) reviewed physical analyses of aging and flow in a colloidal suspension. S. Manneville (Univ. Lyon) presented the recent experimental advances on shear banding in micellar solutions, emulsions and suspensions. S. Fielding (Univ. Manchester) reviewed the modelling approaches of shear-banding in complex fluids. A. Lemaitre (Institut Navier – ENPC) focused on the dynamical noise and avalanches in quasi-static plastic flow of amorphous solids. E. Weeks (Emory Univ.) addressed the impact of confinement on the colloidal glass transition. L. Cipelletti (Univ. Montpellier – CNRS) focused on "compressed" exponential relaxations in soft glasses and L. Bocquet (Univ. Lyon) on some aspects of modeling of flows in glassy materials.

From the impressive number of questions (often up to about 30) during and following each lecture (and the extremely weak percentage of people on the ski pistes during the presentations), there is no doubt that this school aroused a great interest from participants. From the debates and lecture contents we can conclude that the topic of this meeting contribute to build new bridges (or even "a cement"?) between rheology and physics. A number of questions are left open but from the common efforts of both communities some important points already emerge: the critical role of shear-banding in flows of various soft-glassy systems, and for example for model foams, emulsions and colloidal suspensions, a clear view of macroscopic behavior types as a function of the main components of the materials and a general description of the link between local and macroscopic properties.

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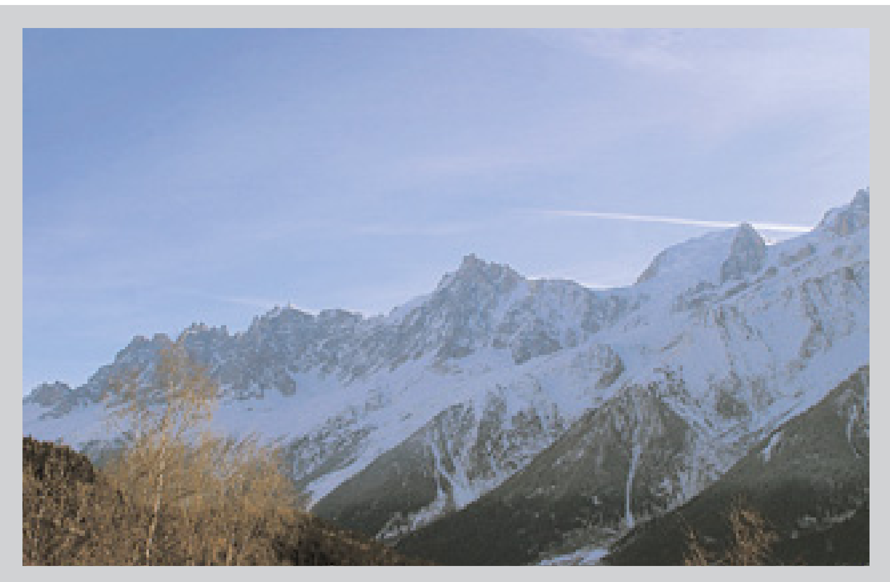

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