SCIENCESPRINGDAY

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

DCM – Departamento de Ciência dos Materiais and Cenimat/I3N

Rheology at FCT/UNL

Maria Teresa Cidade
(in collaboration with: Catarina Rosa Leal, Pedro Almeida, Raquel Portela, Rita Sobral, Pedro Patrício, Ana Aguiar-Ricardo, Eunice Costa, Fernando Henriques, Luís Baltazar)

Maria Teresa Cidade

PhD in Materials Science – Polymeric and mesomorphic materials
Main scientific interests: materials characterization, in particular rheological, morphological and mechanical properties.
President of the Portuguese Society of Rheology
Editor of Physica Scripta & e-rheo.iba
Author of more than 60 publications, 40 in journals of ISI

Objectives

Rheology is a powerful tool in materials characterization. The determination of the viscosity and complex modulus and its components is very important in the characterization of the flow of different kind of fluids allowing to optimize its composition as well as fully understand the importance not only of its components but also of parameters influencing its behaviour, as is the case of temperature and pressure.
The rheological characterization of the fluids is also of upmost importance when processing polymeric fluids. It has proved to be helpful for the following of dendrimers growth as well as bacteria growth, just to mention a few.
In this poster illustration of the capacities of rheology is presented.

Methodology

Works representative of the capabilities of rheology include:

1. Electrorheology – the increase of the viscosity with the application of an external electric field that is observed with some kind of fluids, like the liquid crystals, allows for its use in valves, damping systems and displays (figure 1).
2. Rheologial characterization of biomaterials – the knowledge of the complex modulus, G* and its components (G' and G'') is very important when using them in biomedical applications like in tissue engineering (figure 2).
3. The growth of bacteria may be screened by rheological means (figure 3).
4. The rheological characterization of hydraulic grouts for mansonary repair allows for the optimization of the grouts (water/binder ratio, content of superplasticizer and other additives, like silica fume or fly ashes (figure 4).)

Expected Results

The results may be found in literature. Some examples are:

Increase of about four times of the viscosity of LC cyanobiphenyls, under E = 3 kV/mm.
P. Patrício, C.R. Leal, L.F.V. Pinto, A. Boto, M.T. Cidade, "Electrorheology study of a series of LC cyanobiphenyls: experimental and theoretical treatment", *Liquid Crystals*, **39**, 25-37, 2012.

PNIPAAm microgels present G' and G'' of the some order of magnitude of the target tissue.
Eunice Costa, Jorge de-Carvalho, Teresa Casimiro, Cláudia Lobato da Silva, Maria Teresa Cidade and Ana Aguiar-Ricardo, "Tailoring thermoresponsive microbeads in supercritical carbon dioxide for biomedical applications", *The Journal of Supercritical Fluids,* **56**, 292–298, 2011.

Rheology allowed for the characterization, in real-time, of the mechanical behavior of an actively growing *S. aureus* culture
R. Portela, P.L. Almeida, P. Patrício, M.T. Cidade, R.G. Sobral and C.R. Leal, "Real time rheology of actively growing bacteria*", Phys. Rev. E.* (in print).

The water/binder ratio and superplasticizer dosage are the most determinant factor in fresh grout behavior
L. Baltazar, F.M.A.. Henriques, F. Jorne, M.T. Cidade, "The use of rheology in the study of the composition effects on the fresh behaviour of hydraulic lime grouts for injection of masonry walls", *Rheologica Acta*, 52, 127-138, 2013.

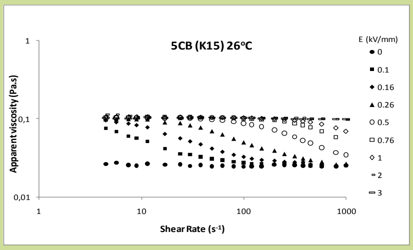

Figure 1. Flow curves (for different values of electric field at temperatures near the crystal –nematic transition temperatures, for 5CB.

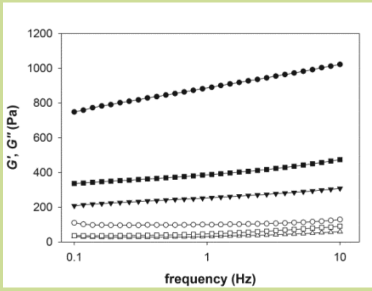

Figure 2. Elastic (G') and Viscous (G'') modulus of hydrogel microbeads of PNIPAAm homopolymer

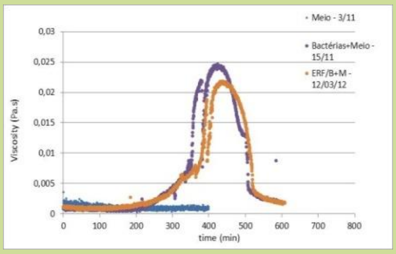

Figure 3. S. aureus culture characterized by steady-state shear growth curve, η(t), measured at a constant shear rate of $10s^{-1}$

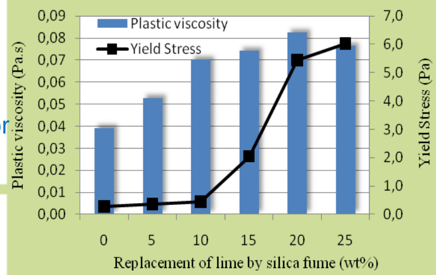

Figure 4. Influence of silica fume replacement on the grout viscosity and yield stress

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