

Year of CfP: 2009

Project No 0900-002 Completed

Project title: Acquisition of competencies in soft matter rheology

Unit managing the project: UMR IATE, Agropolymer Engineering and Emerging Technologies [CIRAD, INRA, Montpellier SupAgro, Université Montpellier II]

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Countries involved in the project: USA

Sub-thematic axes: STDI-2 Socio-Technical Dynamics of Innovation 2: *Agrifood innovations, food and non-food use of plant crops*

Objectives:

The objectives of the project are to develop new competencies within the IATE research unit in the area of rheology of soft matter.

Paul Menut is assistant-professor at Montpellier SupAgro, affiliated to the research group "Agropolymers structuring under stress" of IATE RU. The team investigates the structuring of food and non-food products under stresses (flow, pressure, temperature). Understanding how such factors affect the structure of products all along the technological processes is of high importance for the control of final quality. Additionally, it should also lead to the development of newly design materials thereof exhibiting original structure and properties.

Paul Menut especially works on protein-based materials, which are mainly prepared from wheat gluten or feather keratin. Those co-products of the food industry exhibited specific properties that can lead to the production of innovative and environmentally-friendly materials, generally considered as "soft" materials due to their mechanical properties. Up to now, the approach has been to describe the material mechanical and physico-chemical properties and to relate these to the process variables (shear, temperature...) involved during the material production. The ultimate objective is to be able to trigger the process variables in order to produce material with improved specific properties.

In this situation, becoming conversant with the rheology concepts and tools will offer Dr Menut the capability to explore in depth the material mechanical properties and to investigate finely its structure. As rheology is the study of the response of a product submitted to a deformation, it is also a convenient tool to characterize *in-situ* the structuring of a product under shear.

Whereas rheology appears as a key approach in the IATE RU application field nobody in the team has specific competencies on it. Thus, with the full support of the team, the objective is to spend one year in a lab that works in the area of soft matter rheology, focusing on research with a complete exemption of teaching.

Action carried-out and results obtained:

Microgels are soft particles composed of a cross-linked polymer network swollen in a solvent. They are deformable and can thus be packed to effective volume fractions greater than the random close packing limit for hard spheres. Moreover, their softness can be tuned by varying their cross-link density. Hence, they offer great potential to study the behavior of suspensions at high packing fraction, exploring phenomena such as the colloidal glass transition or aging in colloidal glasses. Microgels are also excellent model systems to mimic natural products like globular proteins, casein micelles, or swollen starch granules, thus helping to gain insights into the behavior of these complex materials. In this project, the particle-to-polymer transition in paste of microgel particles at high concentration was studied. In isotropic compression the transition is observed directly at

the onset of mechanical rigidity. In linear shear deformation however, non-affine motions shift the appearance of the transition to much higher compressions. Once yielded, the particulate nature of the material is refound even at very high compressions.

Three communications have been released in International Conferences (two in the US, one in Europe). Two publications are actually under redaction.

Prospects for the future:

Such results open new routes to analyze the rheological behavior of natural products like wheat gluten which exhibit exceptional viscoelastic properties but which structure (polymeric or colloidal-like) remain subject to hot debate. Indeed, they show that a macroscopic rheological behavior at low deformation exhibiting the traditional feature of polymeric system is not incompatible with a colloidal structure at a microscopic level. A PhD thesis will be launch in 2010 in UMR IATE in order to explore the structure of wheat gluten suspensions with the background acquired during the project.

Total Agropolis Fondation funding: €20,000

Funding category(ies): Release from teaching duties

Project duration: 01 March 2009 - 31 March 2010

Keywords: soft matter rheology – products - flow – pressure – temperature – structure – mechanical properties – soft materials – shear