

MULTIDISCIPLINARY PH.D POSITION BETWEEN STLO (RENNES), FAST (ORSAY) AND LGC (TOULOUSE)

Multi-scale exploration of the drying dynamics of dairy colloids and their rehydration

Keywords : colloids, liquid-solid transition, evaporation kinetics, drying, dairy proteins

APPLICATION BEFORE JUNE 28TH

Research description

Drying is a key stage in dairy processing, with 50% of collected milk dry matter currently being converted into powder. Due to the still relatively empirical control of the drying process, problems are encountered on an industrial scale, both in terms of product properties (non-conformity with expected properties, e.g. rehydration) and process performance (e.g. sticking). Indeed, the mechanisms of particle formation during spray drying are not yet fully understood, the drying chamber being a “black box” making on-line observation of droplet-particle formation impossible.

We therefore aim to develop a **multi-scale physics approach** that brings together **two complementary approaches in a single, original scientific approach** :

- a **local approach**, with detailed analysis of elementary phenomena based on fundamental laws and principles ;
- a **systemic approach**, integrating phenomena on a process scale, right down to rehydration properties in our case.

This exploration of drying dynamics represents a **relevant method for observing the drying phenomenon directly, flexibly and in detail**, and for understanding the influence of different colloids on the characteristics of the products obtained. Thus, the **study of drying in a confined environment** represents an interesting means of gathering **new information on the behavior of matter in a concentrated state**, consistent with what can be observed at higher scales.

The research questions addressed in this Ph.D. project will follow a deductive logic, from the observation of the phenomenon to its physical interpretation :

1. Direct observation of the organisation of dairy colloids during drying under controlled conditions. **What is the specific role of constituents preferentially involved in self-stratification mechanisms during evaporation of dairy colloidal dispersions ?**
2. Physical interpretation of the various stages of the drying dynamics using model colloids. **What are the mechanical and rheological parameters that govern the solid-liquid transition in dispersed colloidal systems ?**
3. Transfer of knowledge acquired in 1D to 3D systems of binary colloid mixtures. What is the impact of **stratification on the formation of interfacial skin** during the drying of drops of colloid mixtures (dairy and model) ? How can we link the morphological characteristics of powder particles and their reconstitution in water, by **characterizing water diffusion on the surface of the particles** ?

Context

The Ph.D. work will benefit from the fruitful collaboration between the research teams of STLO (Rennes; <https://eng-stlo.rennes.hub.inrae.fr/umr-stlo>), the FAST (Orsay; <http://www.fast.u-psud.fr/>) and the LGC (Toulouse ; <https://lgc.cnrs.fr/>). This scientific synergy has been largely set off in the course of the last years and especially in the framework of the scientific network of the GDR SLAMM (Solliciter LA Matière Molle).

Candidate profile

The project is at the interface between several disciplines (physics, process engineering, dairy physicochemistry). A profile with a master's degree in physics, with research experience in biological systems if possible, or in chemical or process engineering, will be preferable.

The potential candidate should have an interest for the investigation of soft matter physics and in particular colloidal systems, as well as an ability to work in a multidisciplinary team, combining fundamental research and potential functional applications in the industrial domain.

Duration, contact and application

Duration : 3 years, based in Rennes (STLO)

Starting date : September-December 2024

Gross month salary : 2100 €

Director : Pr. Cécile Le Floch-Fouéré (Institut Agro-STLO)

Co-director : Dr. Luca Lanotte (INRAE-STLO)

Co-supervisor : Dr. Kevin Roger (LGC(Toulouse)

Dr. Ludovic Pauchard (FAST-Orsay)

Applications, including a motivation letter, CV and the contact information of 2-3 references, as well as informal questions and enquiries can be addressed to Pr. Cécile Le Floch-Fouéré (cecile.lefloch@agrocampus-ouest.fr), to Dr. Luca Lanotte (luca.lanotte@inrae.fr), to Dr. Ludovic Pauchard (ludovic.pauchard@u-psud.fr) or to Dr. Kevin Roger (kevin.roger@toulouse-inp.fr).