A multi-scale study of powders reconstitution phenomena

Thesis subject

Organic and biologically-derived materials under a powder form are involved in the manufacturing of many products available in the food industry (cosmetic, food, pharmaceutic…). In the food field (but not limited to), they are ranging from raw materials and ingredients, such as flours and spices, to processed products like instant coffee or powdered milk. They originate either from liquid conversion into powder by various techniques such as spray-drying, freeze-drying, drum-drying, belt-drying or crystallization, or from size reduction of solid materials induced by grinding, crushing, milling, attrition, or pulverization.

Among these questions, the reconstitution of powders is of upmost importance for the industry considering that most powdered ingredients are dissolved or infused before use. In order to improve our understanding, the reconstitution process is often divided into four separate but often overlapping steps. First, the wetting step can be described as the displacement of the solid/air interface by the solid/liquid interface as the powder enters into contact with the liquid. Then, the capillary step (leading to swelling) occurred thanks to the presence of intra- and inter-particle voids in which the liquid penetrates due to the action of capillary forces. The disaggregation step appears when the powder disperse into smaller units. Finally, during the final dissolution step, the particles dissolve into individual molecules and/or ions only if the particles are soluble.

Many techniques were used to describe and characterize these successive steps and interesting advancements have been made in that field. Nevertheless, deeper mechanistic understanding and systemic research is still needed regarding the great variety of powders industrially available. Also, fundamental understanding enabling improvement of the reconstitution of these powders is still lacking. Also, elements are still missing in the understanding of reconstitution in complex industrial environment (e.g. heterogeneous surface composition created upon spray-drying or dispersion in complex liquid flow).

This project aims at:

(1) Bringing new knowledge in the reconstituability of industrial powders with a focus on the particle surface. Even if the powder surface is the first player during the reconstitution (from particle/air to particle/water), the surface has been poorly studied in the literature.

(2) A reconstituability index will then be used to draw a predictive criterion for the classification of unknown industrial powders according to their reconstitution behavior from the knowledge of their physical and chemical characteristics.

Research Laboratory

The main objectives of LIBio researchers are to understand and control the structuring mechanisms of soft matter, to master mass transfer phenomena and stability of complex systems by considering biotic and abiotic interactions. LIBio combines biochemistry, physical chemistry and microbiology competences in order to design vectors and matrices with targeted functions. These works aim to the enhancement of agro resources for food and non-food purposes.

Candidate requirements

- Scientific background: master 2 or engineer diploma in **food processes, physico-chemistry and/or biophysics**
- **Food engineering** or related field (pharmacy, cosmetics…)
- Very good English knowledge (written and spoken), English native speaker welcome
- Strong appetite for research
- Appeal for interdisciplinary researches (modelisation, physico-chemistry…)
- Sociable person

Contact

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