ECOLE DOCTORALE DES SCIENCES POUR L'INGENIEUR

PhD Subject: **Study of the deformation and break-up of bubbles in biological and food media : impact on the bubble size and mass transfer**

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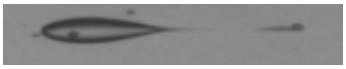
Abstract :

Form and size of bubbles are of crucial importance in foam generation and gas/liquid mass transfer in a bioreactor. Either in a foaming process or in the aeration of a bioreactor, bubbles are deformed due to the effect of mechanical stirring in laminar regime. This deformation, possibly leading to break-up, is strongly influenced by the composition of the surrounding continuous medium. In a foaming raw material or in a culture medium, proteins, sugars, salts or lipids can reach the gas/liquid interface and deeply modify the deformation and bubbles break-up phenomenon, and the mass gas/liquid transfer as well.

- Bubble break-up in presence of proteins : 
- No break-up in presence of another surfactant in the same conditions : 

The aim of this work is thus to better understand what happens at the scale of the bubble or even at the gas/liquid interface in order to interpret and model the results observed at the process scale. In particular, the finality of this work is to identify the respective impacts of a surfactant (type, concentration) that modifies the behavior of gas/liquid interfaces, of the type of flow (pure shear, elongation) and of the rheological behavior (Newtonian, shear-thinning) on the deformation and break-up of bubbles as well on the mass transfer.

The work is mainly experimental work using methods from fluid mechanics and image analysis. It will start with a flow visualisation apparatus (2 high-speed cameras) in shear flow developed in a former PhD that will give preliminary results on 2D. Then, a new device, as a complement for the existing one, should be conceived in order to generate simple flows and follow the 3D deformation of bubbles due to stress on the interface up to the bubble break-up in complex media that can be found in biological or food systems. Based on the results obtained and the physico-chemical properties of the liquid phase and the surfactant, the aim is finally to obtain an explanatory model or even a predictive model of the stresses inducing bubble break-up or limiting mass transfer. This model could be compared to the already available data on bioreactors or foaming devices used in the laboratory.

Required competences of the candidate: Master 2 or Engineer specialized in Transport phenomena (fluid mechanics, mass transfer) or in biochemical, chemical or food engineering.