Crystallization in Emulsions: Characterization of Lipid Nanostructures by coupled SAXS/WAXS and DSC

D.J.E. Kalnin, M. R. Ollivon§, Physico-Chimie des Systèmes Polyphasés, 92296 Chatenay-Malabry, France; daniel.kalnin@web.de

§ This contribution is dedicated to Michel Ollivon who passed away on June 16th, 2007.

Lipids are self-assembling molecules responsible for compartment formation in animal cells. Beside bilayer membranes, they also form all kind of aggregates and mesophases thank to their aptitude to modulate interface curvature. Thus, lipid-based structures such as Solid Lipid Nanoparticles (SLN), liposomes, cubosomes,… which are potentially interesting for drug delivery in pharmacy can be also employed in food science for instance for control release. The characterisation of the internal structure of such systems” is complex and requires the use of combined techniques. Up to recently, droplet size, dilution and complexity prevented any direct identification of the crystalline varieties formed by triacylglycerols inside emulsion globules. Crystallization within this submicron droplets can now be conveniently monitored using Synchrotron X-ray diffraction coupled with DSC. Our research focuses mainly on structural properties of lipid self assemblies at a nanometric scale. Triglycerides (TAGs), the main constituents of fats, exhibit a complex monotropic polymorphism that frequently forecloses the study of thermal and structural properties of the fats. Mono and Diglycerides that are lyotropic and thermotropic show phase transitions of different orders. Naturally lipid structures self-organization into complex structures whose periodicity spans from a few nanometres up to hundreds of nanometres. As the range of organization is variable, it may affect both nanometric and macroscopic properties at the same time using lipids as a molecular building block. Crystal forms and polymorphism can be influenced by different factors. I) Temperature profile of the initial crystallization influence the crystalline form of the crystals lipid crystals formed inside emulsion droplets. II) Mechanical stress such as shear stress largely influences crystallization kinetics of emulsified lipids. The polymorphic form and kinetics of polymorphic changes can then be used in reverse as a reporter of these influence factors.