MMB16 "The drying dynamics in complex systems: from colloidal solutions to biological suspensions"

Thématiques:

We aim to provide an overview on the state of the art and the latest advances regarding the drying of complex physical systems (solutions, suspensions). The main goal is to better understand the physico-chemical mechanisms governing the evaporation process and to highlight the multiple applications of the physics of drying in everyday life (ink deposition, dairy industry, diagnostic devices, forensic investigations, biofilm development).

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Lien avec GDR ou autres structures:

GDR SLAMM (Solliciter LA Matière Molle)
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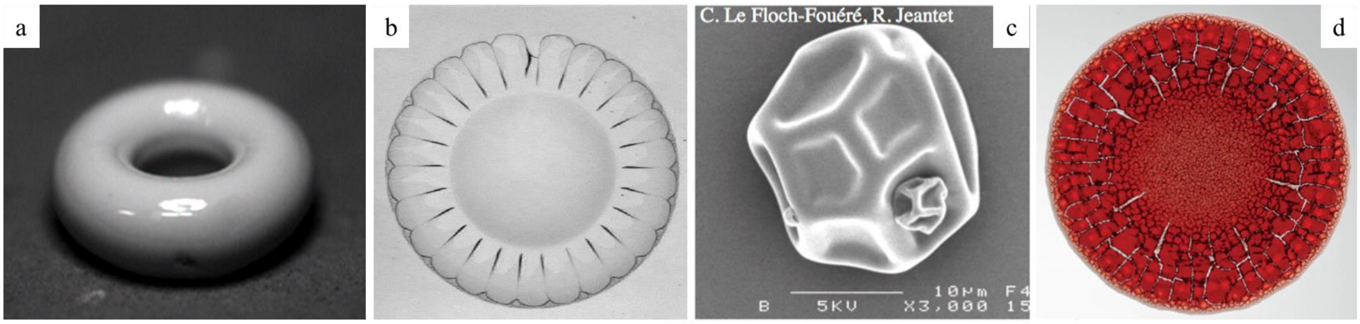
Résumé:

The effects of the evaporation are commonly present in many natural phenomena (drying of tears, desiccation of blood clots resulting from wounds, bacterial films) and everyday life situations such as ink or painting coatings, production of dairy dry ingredients, development of diagnostic techniques, and forensic investigation. The drying of complex fluids (*e.g.* colloidal solutions, suspensions) provides a powerful insight into phenomena that take place on time and length scales not normally accessible and it involves a large number of physical and chemical processes. However, despite the increasing scientific and industrial interests related to this topic, the knowledge of the dynamics of drying remains in its infancy. For instance, understanding the impact of the physico-chemical properties of sample solute (*e.g.* colloids, cells) on the development of drying-induced internal dynamics is still a challenging open question. Furthermore, the influence of such internal flows on the overall sol-gel transition and on the consequent dry morphology in dispersions still requires a systematic investigation.

Currently, the study of the physics of drying involves several groups all around the world and in France too. For example, in the USA the groups of S. Cheng (Virginia Tech) and M. Howard (University of Texas at Austin) have recently published works about the drying-induced stratification in colloidal mixtures. Besides, H. Stone and his collaborators intensively work to optimize a microfluidic approach for the study of diffusiophoresis in emulsions and dispersions. In England, a quite rich community (R. Sear – Surrey University, A. Routh – Cambridge University) focuses its research activity on the evaporation in binary colloidal solutions using both experimental and theoretical approaches. Emerging groups are currently working on the physics of drying in Germany, Netherlands, Italy, and China.

In France, there is a historical scientific community studying the drying mechanisms. Hereafter, some of the current main actors of this dynamic network are listed: i) L. Pauchard (FAST – Fractures in complex fluids), ii) L. Limat (MSC – Evaporation mechanisms at the interface), iii) L. Lanotte, C. Le Floch-Fouéré, R. Jeantet (STLO – Drying of dairy colloidal proteins), iv) D. Laux, (IES – Study of the evaporation by ultrasounds), v) D. Brutin (IUSTI – Blood drying), vi) L. Ramos (L2C – Poroelasticity of gel colloidal beads) and vii) P. Coussot (ENPC – Rheological

behavior of pastes). These groups work on a wide range of topics regarding the evaporation, ranging from the fundamental science to the industrial application, from model colloidal systems to biological suspensions.



Glaring examples of dry samples of colloidal solutions and biological suspensions: a) “donut” structure of a drying dispersion of nanolatex beads (d=30nm); b) crack formation in a sessile droplet of Ludox particles; c) wrinkled dry particle of casein micelles; d) crack patterns in a dry droplet of blood.

Références:

Y. Tang, G. S. Grest and S. Cheng, Stratification in Drying Films Containing Bidisperse Mixtures of Nanoparticles, Langmuir 34, 7161 (2018).

S. Shin, P. B. Warren and H. A. Stone, Cleaning by Surfactant Gradients: Particulate Removal from Porous Materials and the Significance of Rinsing in Laundry Detergency, Physical Review Applied 9, 034012 (2018).

A. Fortini, I. Martín-Fabiani, J. Lesage De La Haye, P.-Y. Dugas, M. Lansalot, F. D’Agosto, E. Bourgeat-Lami, J. L. Keddie, R. P. Sear, Dynamic stratification in drying films of colloidal mixtures, Physical Review Letters 116, 118301 (2016).

C. Le Floch-Fouéré, L. Lanotte, R. Jeantet, L. Pauchard, Solute mechanical properties impact on the drying of dairy and model colloidal systems, Soft Matter,15, 6190-6199 (2019).

C. Allain, L. Limat, Regular Patterns of Cracks Formed by Directional Drying of a Colloidal Suspension, Physical Review Letters, 74, 2981-2984 (1995).

D Brutin, B Sobac, B Loquet, J Sampol, Pattern formation in drying drops of blood, Journal of Fluid Mechanics, 667, 85-95 (2011).