EVAPORATION OF A COMPLEX FLUID DROP ON A REACTIVE SUBSTRATE

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Laboratory, CNES

TEAM(S) : LIQ@INT

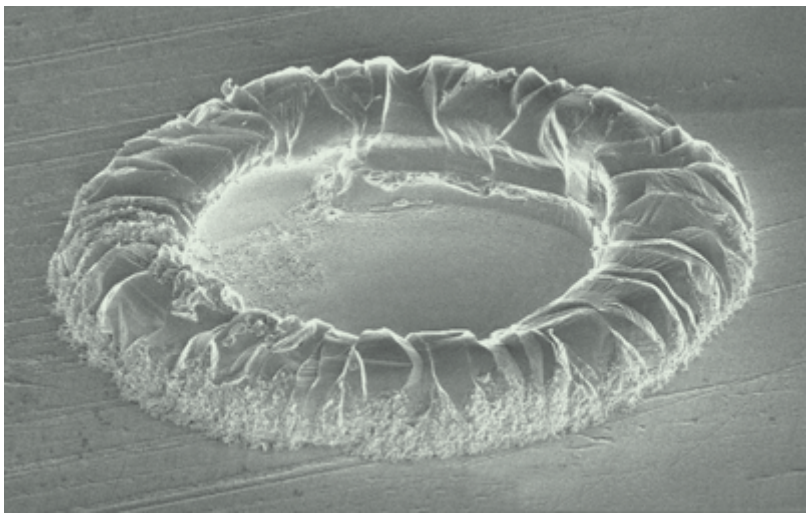
CONTACT(S) : COLOMBANI Jean
PIRAT Christophe

CONTACT(S) DETAILS: jean.colombani[at]univ-lyon1.fr / Tel. 0472448570
christophe.pirat[at]univ-lyon1.fr / Tel. 0472432796

KEYWORD(S) : evaporation / dissolution / crystallization

SCIENTIFIC CONTEXT :

As is common in everyday life, evaporation of a drop of non-pure liquid on an inert substrate leads to the formation of a stain. Its morphology appears to be extremely variable and can take the shape of a sombrero, a spiral, an eye, an igloo, etc. In the most common cases, during the evaporation of a drop of coffee, blood, milk or ink for example, the final stain is a ring. We have shown recently that this coffee-ring effect can surprisingly occur with pure water as well, provided the drop is deposited on a soluble substrate, for example a salt or sugar crystal. In these conditions, the peripheral deposit, stemming from the dissolved substrate, has the rare and original shape of a hollow rim (see figure).



stain left by a water drop on a salt crystal

MISSIONS :

The PhD student will investigate experimentally the evaporation of drops on a soluble substrate in two novel configurations. First, he/she will study the evaporation of a drop of colloidal suspensions on a salt substrate. Preliminary experiments have shown that new unexpected deposit morphologies tend to appear. The PhD student will benefit from the expertise of our research group regarding colloids, and will study the role of their nature, size, concentration, and surface charge on the final deposit of the salt-colloid mixture. Besides, the PhD student will use the micro-fabrication platform of our institute to etch salt crystals, in order to constrain the shape of the drop and provoke the growth of new forms of deposit. Indeed, the crystalline growth-wetting coupling is a particularly fertile configuration for generating solids with novel and controlled shapes. As we carry out the majority of our experiments in the microgravity environment of the parabolic flights of the A310 Airbus of Novespace, the PhD student will participate in several parabolic flight campaigns during the thesis, including the campaign preparation, the flights, and the data analysis.

OUTLOOKS :

We are seeking for this thesis funded by CNES and UCBL a candidate trained in physics or mechanics.

BIBLIOGRAPHY :

[1] Mailleur, Pirat, Pierre-Louis and Colombani, Hollow rims from water drop evaporation on salt substrates, Phys. Rev. Lett., 121, 214501 (2018).

[2] Mailleur, Colombani, Pirat, Rivière, Vodolazskaya, Flow reversal inside a drop evaporating on a soluble substrate, Phys. Rev. Fluids, 7, 093605 (2022).

[3] Mailleur, Pirat, Simon, Fulcrand, Colombani, Ring shells obtained from pure water drops evaporating on a soluble substrate, Coll. Surf. A, 651, 129724 (2022).

published on 04/02/2026