Minicolloque n° MMB16 X Oral ☐ ~~Poster~~

Evaporation and deposition of colloidal suspensions driven by local infrared laser heating

Nicolas-Alexandre GOY[a], and Jean-Pierre DELVILLE[a], Ulysse DELABRE[a*]

a. Univ. Bordeaux, CNRS, LOMA, UMR 5798, F-33405 Talence, France

* email : ulysse.delabre@u-bordeaux.fr

Controlling the self-assembly of particles on surfaces is essential to design new patterned and functional materials. Standard methods are often based on bottom-up approaches like the "coffee ring effect" resulting from the solvent evaporation of a sessile drop [1]. However, such methods are limited to a few patterning geometries : lines or rings typically. The goal of our study is to get rid of these limitations by proposing a new versatile and contactless method that allows to control dynamically the deposition of micro/nano-sized particles. We use an infrared (λ = 1480nm) laser beam to locally induce thermal gradients inside water drops deposited on glass slide and make use of Marangoni flows. Contrary to the classical coffee ring effect, the Marangoni recirculation transports the suspended particles and concentrate them at the laser spot region (*fig.1-a*). We analyze experimentally the dependence of the spatial extent of recirculation flows and deposit size as a function of the laser parameters and solvent composition (*fig.1-b*). We also investigate the temperature rise profile due to laser heating by Infrared thermography (*fig.1-c*). To model our results, we quantify analytically the size of the recirculating flow with respect to the temperature rise extent. As a consequence, we show that it is possible to shape the final deposit by using masks to shape the laser beam exposure (*fig.1-d*), which opens the route towards controlled 2D deposition. Finally, we show that using highly concentrated solutions [2], more complex 3D deposition/structure can be achieved and tunable (*fig.1-e*).

[1] R.G. Larson, AIChE Journal 2014 Vol. 60, No. 5
[2] F.Giorgiutti-Dauphiné & L.Pauchard, Eur. Phys. J. E (2018) 41 : 32

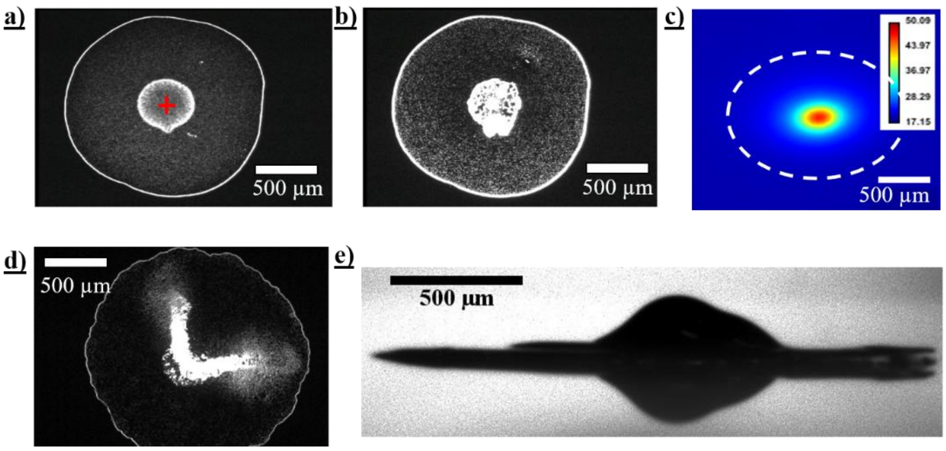

Figure 1 : ***a)*** Local infrared laser heating (indicated by a red cross) at the center of a 0,1µL water drop deposited on a glass slide (laser beam waist = 10 µm). Particles are 1µm diameter long and at 0,1% weight fraction. ***b)*** Deposit of a) after complete drying. ***c)*** Infrared thermography of a heated drop (contact line indicated by a dotted circle). Colorbar indicates the temperature (°C). ***d)*** Pattern deposition using a mask with « L » shape (2mm). ***e)*** Side view of the final structure built from the evaporation of a 0,5µL drop of Ludox TM-50 (Sillica 25 nm diameter beads at 40% weight fraction) under laser radiation. All scale bars = 500µm