Coating with colloids via a moving contact line.

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Coating a solid with colloids is a great technical challenge that has many possible applications: control of optical properties of a glass, control of surface properties, nanotechnologies etc… Very often, the process involves an advancing moving contact line, i. e. a wetting front that leaves behind him a thin film progressively evaporating. The possible interaction between the wetting process and the colloid dynamics has received up to now very little attention.

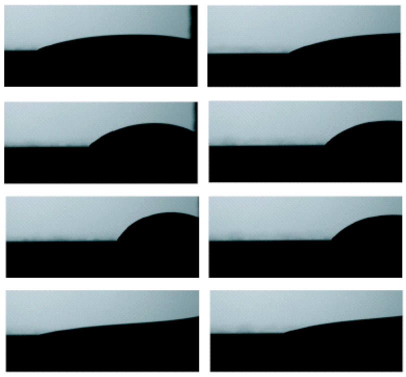

Figure*: A drop of colloids is pushed (here from right to left) over a solid surface at constant speed. In practice, the right side of the drop is maintained fixed by a Teflon wall, while the substrate is moving from left to right. A stick-slip motion of the contact line is observed.*

Most of available knowledge concerns what happens near a quasi-static receding contact line, as for instance that involved near a progressively drying coffee drop. It is known that the contact line behaves as a singularity for the evaporation process, which increases the colloid concentration very near the contact line. This leads to the well known dark annular deposit around a drying drop, and also to a possible stick-slip behaviour of the contact line that remains pinned on this deposit before suddenly sliding.

In contrast with this, we have investigated a more complex situation: what happens near an advancing dynamic contact line? A typical experiment is reproduced on the figure. A drop of colloid is pushed at constant speed over a solid, and we have observed what happens at the advancing liquid front. Depending on the contact line mean velocity and on the colloid concentration, different behaviours are observed. At high enough concentration or low enough velocity, a stick-slip motion of the contact line takes place with oscillations of both the contact line position and the dynamic contact angle. This effect induces irregularities of the colloid deposition, followed by transmission electron microscopy. We have explored these phenomena by careful experiments combined with simple physical modelling, and obtained the laws governing the stick-slip appearance and its properties.