Dissolution Droplets on a Substrate with Concentric Rings Engraved

José Manuel Encarnación Escobar, Erik Dietrich, Pengyu Lv, Harold Zandvliet, Xuehua Zhang, Steve Arscott and Detlef Lohse .
Physics of Fluids, Faculty of Science and Technology, University of Twente

THE study of the behavior of oil drops dissolving on patterned surfaces will be addressed. For this first approach, a substrate prepared at the Institut d'Electronique, de Microélectronique et de Nanotechnologie of the University of Lille with concentric rings patterned on the surface was used. The experiments described are done with the aim of better understanding the pinning and jumping effect of the droplet caused by this micro structures during the dissolution of oil droplets. Our results will be compared with the results and theory proposed by Debuisson et al. in the Institut d'Electronique, de Microélectronique et de Nanotechnologie of the University of Lille on their work "Wetting on smooth micropatterned defects" in which they address a very similar problem. According to that work it is possible to predict the depinning angle of a drying drop as a function of the geometry of the defect and the receding contact angle that we would find on a flat surface of the same material. The jump from one ring to another happens fast but is not an immediate change between both situations and on oil dissolving drops it is possible to observe the dynamics of this process showing a behavior similar to the one addressed in the works by Sbragaglia et al. and Peters et al. in their papers on the breakdown of superhydrophobicity. In our experiments, as in those works, we want to approach the dynamics of contact lines and angles.

When a drop is deposited on top of a group of concentric rings we observe, experimentally, the self centering and later the jumping mode between ring and ring when the effective receding angle is achieved. This jumping mode is, however, not really a jump but a relatively slow zipping process. The behavior is very different when a sessile dissolving drop placed on top of a flat substrate presents the jumping mode. In that case every point of the contact line moves almost simultaneously towards the center of the drop to achieve a higher contact angle. Typically, one of the points of the contact line gets pinned in some defect or more rough point avoiding the jump and making the center of the drop move towards it. On the other hand, when the drop is sitting on the concentric rings, the situation changes. Now there is not a relatively strong pining point. Instead, all the contact line is preferably pined and we found a weak pinning point which first detaches the ring and starts the transition to the following ring. This transition can happen faster or slower motivated, as it may be, by a sort of propierties like the geometry of the defects, the dissolving velocity, the wetting properties, the properties of the liquids and their mixtures and hence the mass transfer mechanisms.

The aim of the future experiments is to understand the physics behind that process and their influence on the lifetimes or potential applications like microparticle focusing, self-assembly or manipulation of micro- or even nano-sized objects. For the measurements both a contact angle meter and a confocal microscope will be used for side and top views respectively and for 3D imaging.