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Surfactant Self-Assembly on Substrates and the Dewetting Process

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Abstract – Dewetting is a phenomenon in which a thin film of a liquid on a substrate ruptures and forms droplets. The morphology produced by dewetting can be controlled by the solution properties, temperature and substrate wetting and it can be used as template for nanoparticle organization [1]. Diluted surfactant solution deposited on distinct surfaces form different types of patterns after drying process, which suggests that the dewetting process behavior is not intrinsic to the surfactant but is dependent on the interaction between the surfactant and the underlying solid substrate.

Dewetting phenomena produces interesting surface patterns that may impart new properties to solid surfaces. In this work, we study the patterns formed by surfactant molecules on substrates as a consequence of dewetting during water evaporation from initially diluted solutions.

Results of electron scanning microscopy show different trends for cationic and anionic surfactants deposited on mica surface. SDS on mica forms long stripes (Figure 1A), which branch out of the edge due to fingering instability that is a consequence of surface tension gradient in the vicinity of the three-phase-line (Marangoni effect). The same feature of branching is also observed by non-contact AFM that shows SDS dewetting patterns composed by layers with even thickness (6nm), indicating the formation of SDS bilayer structure on surface.

DTAB dries on mica forming stripes with high degree of order (Figure 1B). There are two main populations of stripes that are intercalated: in the first one the length ranges from 45 to 65μm, while the second has length from 8 to 16μm. This image also shows that some long stripes break into circular structures due Raleigh instability. The formation of this type of dewetting pattern can be result of the tree-phase-line slip-stick motion, i.e., fast receding alternated with "pinning". [2]

DTAB and SDS dried on carbon-coated parlodion film were analyzed by transmission electron microscopy. SDS spreads on surface and forms smooth, flat layers (Figure 1C). DTAB shows the formation of holes, result of the film instability, that grow and coalesce forming a polygonal network of liquid rims (Figure 1D).

In summary, the dewetting patterns formed by the surfactant molecules are dependent on surfactant-substrate interaction and a number of interesting morphologies are obtained that can be used to template complex micro and nanostructures.

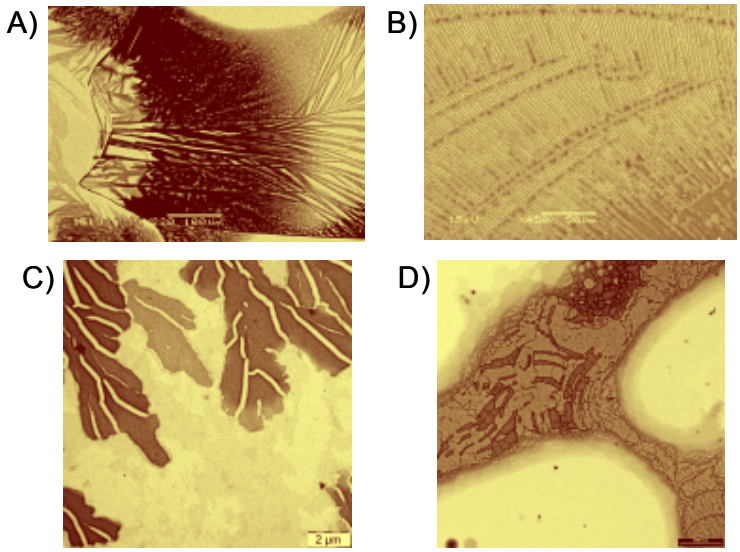

Figure 1: Micrographs of surfactant dried on substrates: A) SEM image of SDS on mica; B) SEM image of DTAB on mica; C) TEM image of SDS on carbon; D) TEM image of DTAB on carbon. All surfactant solution (2mM) was dried at 20ºC and at 50%RH.

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