Detecting Surfactant Concentration by Contact Angle Observations

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From first principles of thermodynamics describing the surfactant adsorption at the liquid-vapor and solid-liquid interfaces, one can derive a relationship to estimate the effect of surfactant on wetting of a surface. This is done for a textured surface to find a relationship between contact angle and surfactant concentration. It is shown that by changing topographical indicators such as \( f \) (the solid area fraction under a drop as defined by the Cassie equation) and \( r \) (roughness factor as defined in Wenzel equation), as well as intrinsic contact angle for the solvent, i.e. \( \theta_i \), one can control the level of decrease in contact angle with an increase in surfactant concentration. This level of control can allow one to induce wetting behaviors that result in a gradual change of observed contact angle with surfactant concentration \((C)\), or a sudden change of contact angle with \( C \) (see Fig. 1). The former can be thought as a concentration sensor and the latter can be thought as a switch sensor, e.g. in a microfluidic system. To demonstrate the applicability of this concept, various microtextured surfaces were fabricated using standard photolithographic methods. Solutions of Sodium Dodecyl Sulphate (SDS) in distilled deionized water were used as test liquids. Contact angles were measured by a home-made device. It was found that the manipulation of surface texture can allow predetermined changes in the observed wetting behavior for various surfactant solutions, and this talk will present how this technique can be used to fabricate sensors for determining the surfactant concentration by contact angle observations.

![Figure 1: Predicted behavior of contact angle versus SDS concentration for a microtextured surface; \( r \) and \( f \) values as given on each graph. Contact angle is the minimum of the Cassie and Wenzel contact angles. The surfaces (shown in schematic form in the overlays) could be used as roughly a linear sensor (left), or as a switch (right).](image-url)