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Film Deposition in the Presence of a Moving Contact Line[1]

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Film deposition experiments are performed in circular glass capillaries of 500 μm diameter. Two surface wettabilities are considered, contact angle $\theta = 30°$ for water on glass and $\theta = 105°$ when a hydrophobic coating is applied. It was observed that the liquid film deposited as the meniscus translates with a velocity U presents a ridge which also moves in the direction of the flow. The ridge is bound by a contact line moving at a velocity U_{CL} as well as a front of velocity U_F, and it translates over the deposited stagnant film. The behavior of the ridge presents striking dissimilarities when the wettability is changed. Both U_{CL} and U_F are approximately twice as large for the non-wetting case at the same capillary number Ca. Classical film deposition theory does not account for the existence of a contact line and it assumes perfect wetting. In contrast, the contact line dynamics fundamentally alter the deposition physics by causing the film to be non-stagnant. As a consequence the non-wetting film is significantly thicker that the Bretherton prediction. Taylor bubbles also form due to the growth of the ridge and are differentiated by wettability, being much shorter and presenting a thicker film in the non-wetting case. The dynamics of the contact line is studied experimentally and a criterion is proposed to explain the occurrence of a shock in the non-wetting film.

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