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Investigation of partially dewetting flow at Re∼O(100) and Ca∼O(0.01) HYOUNGSOO KIM, CHRISTIAN POELMA, JERRY WESTERWEEL, Delft University of Technology — We study a free surface flow problem with moving contact lines at a Reynolds number Re∼O(100) and a capillary number Ca∼O(0.01). This problem corresponds to the flow in an immersion drop applied in a liquid-immersion lithography machine; so-called a shear-driven confined liquid layer. At a certain critical condition, droplet break-up occurs. We quantitatively investigate this free surface flow problem by means of shadowgraphy measurement and tomographic PIV. For increasing shear rates, we observe four successive regimes at the rear end of the liquid layer. These regimes are identified based on the shape of the elongated tail and denoted as oval, corner, cusp, and pearling. Interestingly, the same qualitative behavior is also observed in a different geometry in the Stokes flow regime (Podgorski et al. 2001). Moreover, additional quantitative similarities are found by evaluating analytical results for sliding drops, based on Stokes flow: the Cox-Voinov model, the three-dimensional lubrication model and a self-similar flow pattern. Surprisingly enough, these results match with the observations even for the present intermediate Reynolds number free surface flow. To understand the underlying mechanism behind this agreement, we have performed a scale analysis based on the momentum equations. Finally, we present the flow structure in this problem is expressed in terms of the results of the lubrication equation.

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