WHEN SESSILE DROPS ARE NO LONGER SMALL: TRANSITIONS FROM SPHERICAL TO FULLY FLATTENED

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Abstract

Contact angles measurements with sessile liquid drops are widely used to assess wettability. Contact angles can also be measured indirectly from drop dimensions. However, choosing the correct model requires knowledge of the drop shape. Unfortunately, there is no simple means to predict drop shape or the transitions from small and spherical to large and completely flattened. One must generally rely on complex iterative numerical calculations.

In this study, we measured the dimensions and contact angles of sessile drops on a variety of surfaces. With increasing liquid volume, heights of the drops initially rose steeply and then

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gradually tapered to a constant value. The heights of small, undistorted drops as well as the heights of the largest drops were accurately predicted by well-established models. A recently derived expression for meniscus height was used to estimate the heights of intermediate-size drops.

We also identified transition points where gravity began to distort drop shape and ultimately limited drop height. As anticipated, distortion of drops showed a strong dependence on the surface tension and density of the liquid. Somewhat surprisingly, wettability also played an important role. Both the transition height and volume exhibited maxima for contact angles in the vicinity of 90º and tapered off towards the extremes.

Relatively simple closed analytical expressions for estimating these transition points were also derived. Predicted values of the height and volume at the onset of distortion agreed fairly well with the measured ones. Contact angles carefully measured by the tangent method were independent of drop size.