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Application note 22

Dynamic Contact Angle Measurements on curved surfaces by using the Bridge-Function

Task

The wettability of liquids on surfaces is easily determined by measuring advancing and receding contact angles as the surface is not wetted before. The measurement becomes more complicated if the surface is already wetted or in reality stored in a liquid (for example contact lenses). For this application the so called “Bridge-Function” has been developed. With this software module it is possible to examine the wettability of these surfaces. It is part of the DataPhysics SCA 23 software and can be used in combination with a contact angle measuring device of the OCA-Series.

Method

The curved synthetic surface to be examined is located in the glass cuvette GC 10 filled with water. For the measurement with the Bridge-Function a gas bubble was produced which is held on the synthetic surface by the dosing syringe. When the gas bubble touches the surface it begins to unwet it while building an inverse liquid bridge.

For the measurement of advancing and receding contact angles an automated dynamic contact angle measurement was started. The volume of the gas bubble has been increased at first and reduced afterwards. The growing gas bubble unwets the surface while the wetting of the surfaces starts again with the decrease of the gas bubble volume. The process was recorded with the video function of the OCA system and can be analysed later on.

At the beginning of the analyses the baseline of the system has to be defined. The manually fit of the baseline has the benefit that nearly any surface profile can be analyzed. To determine the contact angle a “region of interest” (ROI) has to be chosen within its range the contact points of the gas bubble with the surface is located. The software automatically detects the shape of the contour and calculates the contact angle of the gas bubble with the surface regarding to the bubble volume. The measured contact angles will be determined fully automatically and transferred into the result window.

The advancing and receding contact angles can be examined with this method and will give information about the wettability of the surface.

Results

For this application note an air bubble is pressed on the inner site of a pipette tip, simulating the normal use of a pipette. Figures 1 and 2 are showing the expanding (Fig. 1) and the decreasing air bubble (Fig. 2) in contact with the surface.

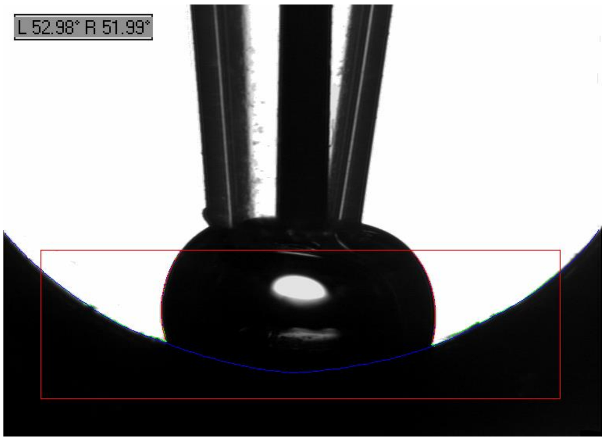

Figure 1: The growing gas bubble unwets the inner site of the curved synthetic surface, shown incl. the ROI and the contact angle analyses.

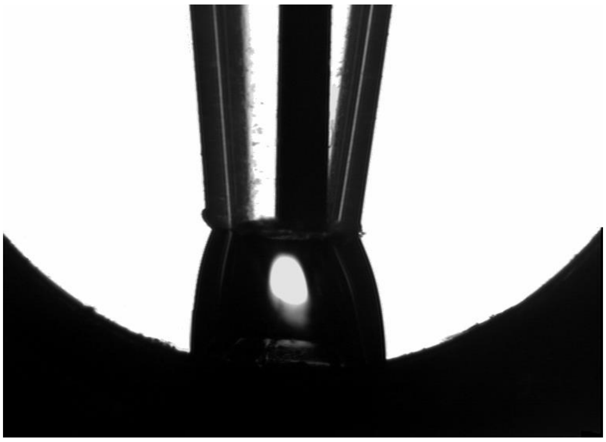

Figure 2: The decreasing bubble results in a new wetting of the surface.

Resulting by the increase and decrease of the air bubble volume the determined mean contact angles between air bubble and surface are shown in figure 3. Because of inhomogeneities at the surface the contact angle jumps from time to time which is seen especially at the beginning and at the end of the measurements, because the small area of contact at this times.

When you correlate the contact angle (Fig. 3) with the base diameter of the air bubble on the surface (Fig. 4) it is easily seen that the air bubble increases at the beginning of the measurement. When the contact angle reaches a value about 55-57° it gets constant and the base diameter of the contact increases very slow. The determined contact angle is the receding contact angle of the liquid, which is mainly caused by the hydrophilic part of the surface because this share tries to bind the liquid on the already wetted areas.

At data point 150 the increase of the air bubble volume stops and the air is pulled into the syringe again. The bubble decreases in volume and the liquid starts to wet the surface again. It is shown that the base diameter does not change at first while the contact angle rises caused by the loss of volume of the air bubble. This effect is mainly caused by the hydrophobic parts of the surface which prevent the surface of being wetted again. After some time the bubble can not hold its dimension and the wetting of the surface begins. At this point the advancing contact angle can be determined. At all following points the advancing contact angle is overlaid with shape changes caused by the decreasing volume of the air bubble.

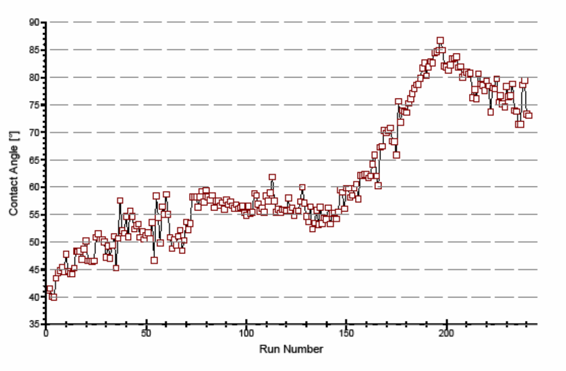

Figure 3: Mean contact angle while increasing and decreasing of the air bubble

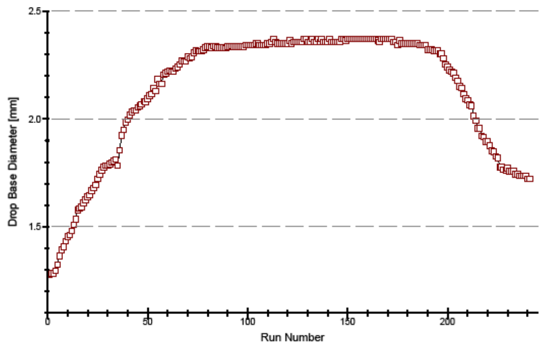

Figure 4: Base diameter of the contact area between air bubble and surface

Afterwards the contact angle does not stay at constant value but decreases instead while the contact area / base diameter decreases too caused by the volume loss of the air bubble, which is easily seen in figure 4.

Summary

With a contact angle measuring device of the DataPhysics OCA-Series the increase of an air bubble on the inner site of a pipette tip can be examined. By the use of the analytic tool, the Bridge-function, the single images recorded can be analyzed. The advancing and receding contact angles of the liquid on the surface can be determined whit this method.

The Bridge-Function is a new method which allows examining the wettability on prewetted surfaces. The method is especially developed for applications containing the analysis of swelling surfaces or surfaces stored in liquids or used in a liquid environment.