

# Application Report

## Surface free energy measurement on automobiles

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Method:



MobileDrop



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## How effective is hot-wax treatment?

### Abstract

The hot-wax program of mechanical automobile washers is intended to ensure effective and clean drying by hydrophobization. In order to be able to measure this effect contact angle measurements were made on the bodies of two automobiles using the MobileDrop mobile instrument, which is also suitable for the non-destructive testing of large samples. With the new automobile used for the test it was possible to demonstrate a small positive effect of the treatment on the surface free energy and its polar fraction. On a damaged surface an unwanted better wettability by water was observed; this could not be reduced by the hot-wax treatment.

### Method

A combination of cationic surfactants and waxes is used for the hot-wax treatment in the washing program of automobile washing facilities.



Fig. 1: View of the washing process  
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The idea is that the hydrophilic part of the surfactants sticks to the body surface, while the hydrophobic part offers itself for adhesion to the wax, which is also hydrophobic. The wax layer is primarily intended to ensure that the water film breaks up when the blower is used and that the drying process is both uniform and residue-free. Whether such a hydrophobizing effect is actually achieved is one of the classical problems for the contact angle measuring technique – the treatment should have an effect on the surface free energy (SFE), particularly on its polar fraction.

## Experiment and results

Previously problems in solving such tasks were encountered with samples which – as in this case – could not be prepared for the sample table of a laboratory instrument. In recent times the MobileDrop, a mobile mains-independent instrument, has been available for such applications. With its prism arrangement it can be placed on the sample and, thanks to a built-in USB camera, can also be used together with a Notebook.



Fig. 2: Mobile measurement on large samples

This instrument was used to make contact angle measurements on an automobile body in new condition and on a poorly-cared-for one, in each case after a standard automobile wash and also after a hot-wax (HW) treatment described as "gloss care". The test liquids used were water and diiodomethane ( $\text{CH}_2\text{I}_2$ ).

Test liquid	SFT [mN/m]	Dispersive fraction [mN/m]	Polar fraction [mN/m]
Water	72.8	21.8	51
$\text{CH}_2\text{I}_2$	50.8	50.8	0.0

Tab. 1: Surface tension (SFT) of the test liquids with their polar and dispersive fractions

On the intact body a water contact angle of  $78.3^\circ$  was measured before the hot-wax treatment, after the treatment the value increased to  $81.4^\circ$ . The diiodomethane contact angle hardly changed at all. An evaluation by the Owens-Wendt-Rabel-Kaelble method accordingly showed a slight reduction in the surface free energy that primarily resulted from the reduced polar fraction. Thus, the wettability of the surface by water was also reduced as required.

Intact body	KW Water [°]	KW $\text{CH}_2\text{I}_2$ [°]	SFE [mN/m]	Pol. fraction [mN/m]	Disp. fraction [mN/m]
Pre HW treatment	78.3	58.0	36.1	6.4	29.7
Post HW treatment	81.4	58.2	34.8	5.2	29.5

Tab. 2: Wettability before and after hot-wax treatment

In the model with the poorly-cared-for body measurements were only made with water – as in this case the wettability is mainly determined by the increased roughness and only to a lesser degree by the surface free energy, a simple wettability measurement is sufficient. The water contact angle of  $70.2^\circ$  was about  $8^\circ$  lower than with the intact automobile body, which indicates poorer water and dirt-repellant properties. An effect caused by the subsequent wax treatment could not be recognized – the alteration in the water contact angle was no larger than the measuring error resulting from the large degree of inhomogeneity of the surface.

## Summary

Mobile contact angle measurements were made on an "as new" automobile body and a worn one in order to check the influence of the hot-wax program of a automobile washing facility. On the good automobile body it was possible to observe a small reduction in the surface free energy, in particular of its polar fraction. For the poorly-cared-for automobile, whose body surface was clearly less water-repellent before the treatment, the choice of the hot-wax care program is no longer worthwhile.