



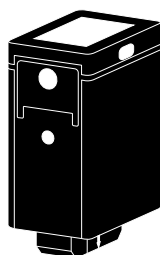
Application Note

Mobile one-click surface energy determination with PCA 200

The surface energy (SFE) is a critical parameter during the production and quality control of surfaces. The SFE and its polar/dispersive parts are highly useful to verify the efficacy of pre-treatment or cleaning processes on solid surfaces. Knowledge of the SFE allows an accurate estimation of the wetting behaviour and adhesive properties of solid surfaces, which is essential for further processing. For a simple quality control of surfaces, test inks are commonly used. However, these test inks are unable to assess the SFE objectively and cannot provide information regarding the polar/dispersive parts of the SFE. Thus, a **quick and reliable** method that can accurately determine the SFE is of high demand. The **PCA 200** Portable Contact Angle Goniometer manufactured by DataPhysics Instruments is the ideal **stand-alone device** for determining the SFE. With **one-click**, the SFE can be determined in just a few seconds with high accuracy. Its compact design is ideal for **non-destructive, quantitative** testing of surfaces of any size. The PCA 200 is the perfect tool for quality control of solid surfaces in production and incoming goods inspection. In this note, we will demonstrate the PCA 200 technique using four different material surfaces.

Measurement device

Portable Contact Angle Goniometer – PCA 200



Measurement method

Optical contact angle and contour analysis systems

Measured quantities

Contact angle
Surface energy

Environmental conditions

25 °C

Samples

Silicon wafer
Plastic
Aluminium
Varnished surface

Industries

Coatings
Pre-treatment or cleaning process on a solid surface

Theory

The PCA 200 Portable Contact Angle Goniometer (Fig. 1), manufactured by DataPhysics Instruments,^[1] is the ideal **hand-held** device for **mobile** measurements of the surface energy of solid surfaces.

It is well established that the surface energy (SFE) of a solid can be determined by contact angle (CA) measurements with at least two different test liquids, for which surface tensions as well as their dispersive and polar parts must be known. The measured CAs as well as the known surface tensions with dispersive and polar parts are then employed in the calculation of the SFE, based on an appropriate theoretical model.^{[2][3][4]} A frequently employed approach is the Owens, Wendt, Rabel, and Kaelble (OWRK) model, which considers the geometric mean of the dispersive and polar parts of the liquid surface tension, and the solid's SFE.

This approach allows to determine the polar and dispersive parts of the solid's SFE from the regression line in a suitable plot (Fig. 2).

Main Features

The PCA 200 Portable Contact Angle Goniometer is the perfect instrument for analysing surfaces in production and quality control processes. By jetting up to two different testing liquids onto the surface to be analysed, it **determines the CAs and SFE within seconds**. In addition to its lightweight design and intuitive user interface, the PCA 200 offers the following key features:



Fig. 1: The PCA 200 Portable Contact Angle Goniometer manufactured by DataPhysics Instruments

- **On-Site Companion**

The PCA 200 is a **cable-free, independent system** with a mini-computer and built-in lithium-ion battery. It has an impressive battery runtime of 6 hours, numerous measurement capabilities, and a **highly portable design and low-weight (820 g)**.

- **Quick and Easy**

The PCA 200 can be **one-hand controlled and accurately positioned even on small samples**. The **live display** clearly shows the test site. By **simply touching** the screen or the measuring button, the **CAs, SFE with dispersive and polar parts, and the image will be displayed in just a few seconds**. The

surface quality of the sample can be highlighted by colour (red/green). An integrated barcode scanner can be used to identify the sample.

- **Reliable**

The PCA 200 is a 'lab-on-the-go' and provides **excellent measurement quality**. It performs optical drop shape analysis and **accurately** determines the surface free energy according to the selected models. It has an **easy-to-use** touch interface and a **web browser interface** for further functionality. It can be connected to a computer to adjust settings, set quality limits, review and organise the measurement data.

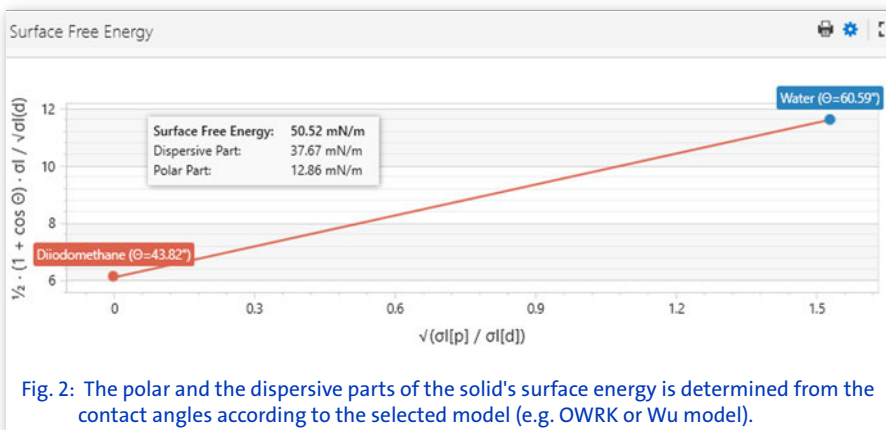


Fig. 2: The polar and the dispersive parts of the solid's surface energy is determined from the contact angles according to the selected model (e.g. OWRK or Wu model).

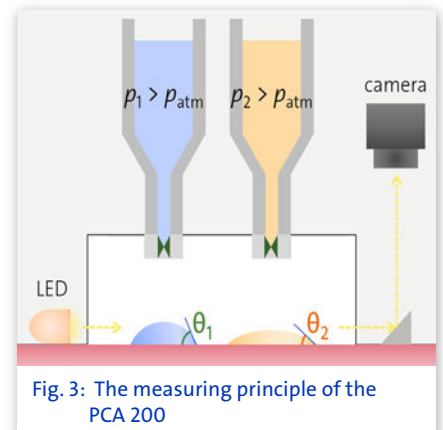


Fig. 3: The measuring principle of the PCA 200

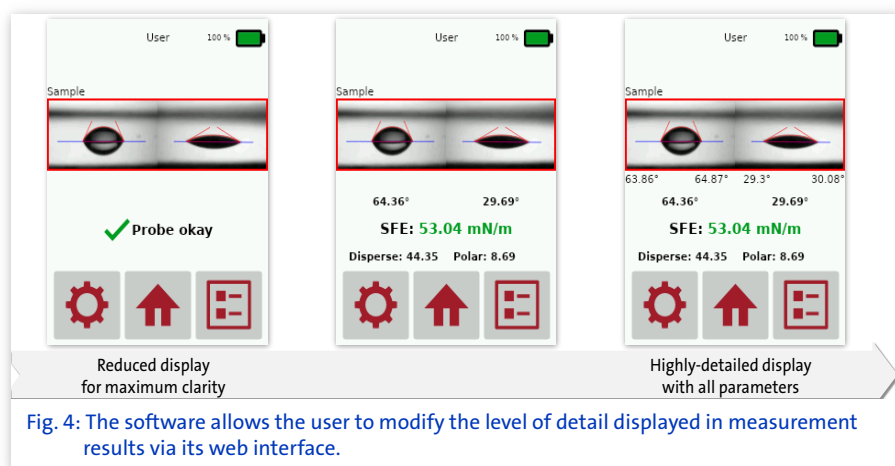


Fig. 4: The software allows the user to modify the level of detail displayed in measurement results via its web interface.

Experiment

The PCA 200 initiates and performs a **fully automatic** measurement protocol, as illustrated in the diagram below, **without requiring any manual inputs**.

Step 1: Liquid dosing

The device employs a pressure-based dosing system, whereby both test liquids are simultaneously dosed onto the sample (Fig. 3).

Step 2: Recording the drop image

This is achieved by utilising an optical system incorporating a prism, which enables the camera to capture a profile image of both drops situated upon the sample surface (Fig. 3).

Step 3: Contact angle evaluation

In the image of the drop profile, the software identifies the contours of the drop and the line representing the substrate, and fits the contours with a suitable model. Subsequently, the CAs are determined based on the aforementioned fits.

Step 4: Calculation of surface energy

Following the measurement of the contact angles, the SFE is calculated in accordance with the selected model (OWRK or the Wu model amongst others).

Step 5: Display of result output

The results are displayed on the device display just within a few seconds, with the desired level of detail (Fig. 4).

Results & Discussion

In this application note, a variety of samples were employed for analysis, including silicon wafers, plastic cards, aluminium plates and varnished surfaces. To ensure the reliability and comparability of the results obtained by the PCA 200 technique to tests with the test inks method, the test area of all samples was treated in the same manner and measured within the same time range.

As depicted in Fig. 5, the PCA 200 technique provides not only the SFE but also additional information on the dispersive and polar parts. This offers further insight into the distinguishing characteristics of the samples. Additionally, it can determine the SFE of different materials sensitively. In strong contrast, the test inks method can only provide SFE values for the samples without the dispersive and polar parts. This is due to the fact that the test inks method does not take

into account the interfacial energy between the solid and liquid phases. It is also the reason why the SFE values obtained with PCA 200 based contact angle analysis are more accurate than those measured with the test inks method.

Additionally, the PCA 200 technique is capable of obtaining the SFE with a single click, whereas the test inks are applied in a stepwise manner. In comparison to the test inks method, as illustrated in Fig. 6, the **PCA 200 technique needs much smaller test area and shorter time for data collection**. As the test inks method relies on visual assessment of whether the inks contracts or not, it is inherently subjective and lacks reproducibility. In sharp contrast, the **PCA 200** technique utilises contact angle analysis, thereby ensuring **objective measurement and high reproducibility**.

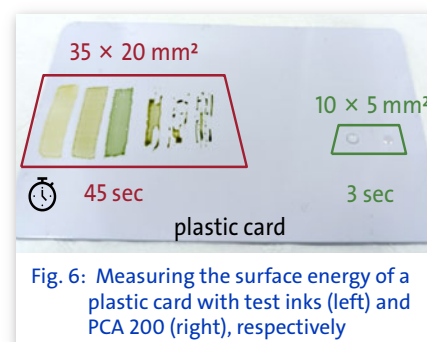


Fig. 6: Measuring the surface energy of a plastic card with test inks (left) and PCA 200 (right), respectively

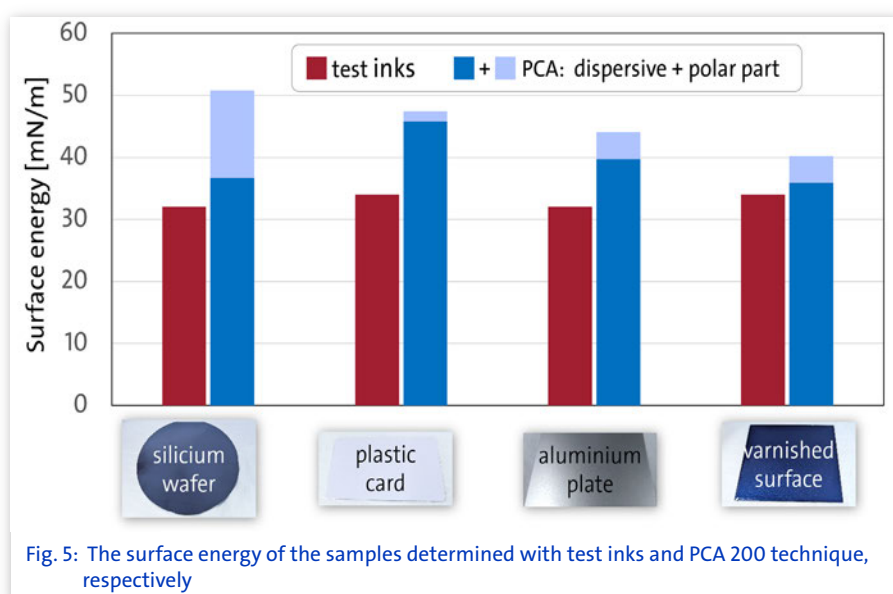


Fig. 5: The surface energy of the samples determined with test inks and PCA 200 technique, respectively

Summary

The PCA 200 Portable Contact Angle Goniometer is the ideal hand-held device for determining the contact angles and the surface energy of solid surfaces. Not only does it provide surface energy, but it also offers the dispersive and polar parts, which is essential for studying the wetting behaviour and adhesive properties of solid surfaces for further processing. The PCA 200 is a highly reproducible, quantitative measurement device that guarantees a high level of accuracy. Its compact, space-saving design makes it the top choice for non-destructive testing of surfaces of any size. It is the perfect tool for quality control of solid surfaces in production and incoming goods inspection.

Reference

- [1] <https://www.dataphysics-instruments.com/products/pca200/>
- [2] Kaelble, H., J. Dispersion-Polar Surface Tension Properties of Organic Solids. *Adhesion*, **1970**, *2*, 66-81.
- [3] Owens, D., Wendt, R. Estimation of the Surface Free Energy of Polymers. *J. Appl. Polym. Sci.*, **1969**, *13*, 1741-1747.
- [4] Rabel, W. Einige Aspekte der Benetzungstheorie und ihre Anwendung auf die Untersuchung und Veränderung der Oberflächeneigenschaften von Polymeren. *Farbe und Lack*, **1971**, *77*, 10.

We will find a tailor-made solution for your surface science use case and will be pleased to provide you with an obligation-free quotation for the system that fits your needs. For more information please contact us.

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