VCA-Optima XE Contact Angle Measurement

Introduction

The VCA Optima Contact Angle Measurement system (Figure 1) incorporates lightweight design, easy assembly, and the latest Windows standards and user-friendly software to create a contact angle instrument that is accurate and easy to use. VCA-optima is suitable for research or quality control in R&D and process engineering. The system integrates contact angle and surface energy evaluation with computer imaging technology to create an easy to use tool that provides accurate, objective results.

![Figure 1 Contact Angle Measurement tool](image)

Features and Specifications

- Measuring range: 0-180 degree
- Repeatability: ±1 degree
- Accuracy: ±0.5 degree
- Magnification: 35:1
- Sample/specimen stage sizes: 3.5” x 3.5” / W6.5” x L9” x H2.5”
- Dosing: 150-500 Droplets
- Motorized syringe
Precaution:

- To avoid liquid contamination, the installed syringe is for DI water only. If you need other liquid, please contact the staff.

Working Principle

Wettability determines the quality of the contact between a liquid and its limiting surface. Wettability is also described in terms of hydrophilicity or hydrophobicity. Hydrophilicity is a characteristic of materials exhibiting an affinity for water and hydrophobicity is the opposite concept. Hydrophilic materials have the ability to form hydrogen-bonds with water. The hydrophilic character of a surface can be represented by the contact angle between a liquid and a solid substrate when the liquid is either stationary or slowly moving across the surface. Figure 2 shows how the contact angle and droplet shape changes depending on the degree of hydrophilicity.

![Figure 2. Contact angles and hydrophilicity.](image.png)

The micropipette is filled with de-ionized water, and placed within a plastic holder. The droplet is dispensed manually at the tip, as the stage raises the sample surface into contact with the liquid. Upon creating the droplet on the surface of the sample, the VCA software program, as shown in Figure 3, captures the image on a CCD camera. The angles will be measured by utilizing the software. The process needs to be repeated for different locations on the sample.

![Figure 3: Contact angle of water droplet measured on a silicon substrate.](image.png)

Operating Procedure

The equipment manual can be found on the computer desktop.

A. Preparation
• Reserve and logon this tool in NUcore before operating.
• Turn on the CCD camera with the switch on the back of the box.
• On the computer desktop, double click the shortcut of VCA-OPTIMA™ for Windows to open the software. The software interface is shown in Figure 4.
• A live video image of the needle will appear in the upper left hand corner of the screen.

![Software interface.](image)

**Figure 4: Software interface.**

**B. Measurement**

• Lower the sample stage.
• Place sample onto stage and raise upward until the sample is below the needle.
• If necessary, adjust the contrast of the live video, as shown in Figure 5.
• Slowly twist the knob on the top of the syringe until the water just peeks through the needle. Click ‘syringe control’ in the Graphical Menu Bar. Then set the “droplet size” to 1-5 ul, as shown in Figure 6.
• Align the test spot under the syringe needle by using x and y-direction knobs shown in Figure 1. Dispense a drop of liquid by clicking ‘Go’ in syringe control in Figure 6. Bring the stage up slowly by adjusting z-direction knob shown in Figure 1 until the drop transfers to the sample, as shown in Figure 7. Do not hit the sample surface with the syringe needle.
• Lower the stage to have a better view on the camera. If necessary, center the drop in field of view using the horizontal stage adjustment.
• Click the ‘snap image’ in Graphical Menu Bar to capture the image.
Figure 5: Brightness and contrast adjustment.

Figure 6: Dispense a drop of liquid.
C. Analysis

- Click the AUTOFAST ICON to calculate the contact angle. Two numbers will be displayed; these are the left and right contact angles.

- Sometimes auto-calculation using AUTOFAST ICON is not accurate, so manual calculation is necessary. To calculate manually, use the mouse to place five markers around the droplet. Markers are placed around the droplet by selecting the symbol and dragging it to the correct position, as shown in Figure 8.

![Figure 8. Manual fit of the droplet boundary.](image)

- Select the Manual Calculate ICON from the Graphical Menu Bar to calculate the contact angle. This will create a curve fit and tangent line on the image. Two numbers will be displayed in the left hand corner of the screen; these are the left and right contact angles, as shown in Figure 9.

- For contact angles less than 15°, select LOW CONTACT ANGLE from the Graphical Menu Bar.

- Go to File menu and Export image image with the contact angle values.

- To protect the computer from virus attack, please don’t directly connect your USB drive to the computer to copy the data. Instead, create a folder in the ‘NUFAB_data_contact angle (R)’ web disk on desktop, name it with your netID, and save your file there. Your data can be immediately
found in the web disk ‘NUFAB_data (R)/contact angle’ on the desktop of the log in/off computer. There you can email it, upload it to box or copy it to a USB.

Figure 9. Contact angle of DI water on different substrates.

• If you want to calculate the surface energy, click “SE2500” shown in Figure 4. You will see the table as shown in Figure 10. Here you may choose the desired substrate and liquid. Note that, the surface energy calculation requires two liquids. Please select two from the liquid list.

• You need to measure four contact angles with each liquid. Click the ‘Add Contact Angle Data’ in Figure 10 as you measure. The values will be automatically entered in the form. The average and standard deviation will be calculated automatically.

Figure 10: Data input of SE2500 for surface energy calculation.

• There are 3 models for calculation, Geometric-Mean Method, Harmonic Mean Method, and Acid-Base Theory. After you click “Calculate”, the result will be shown as in Figure 11.
- Log off in NUcore

Figure 11: SE2500 for surface energy calculation.