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.
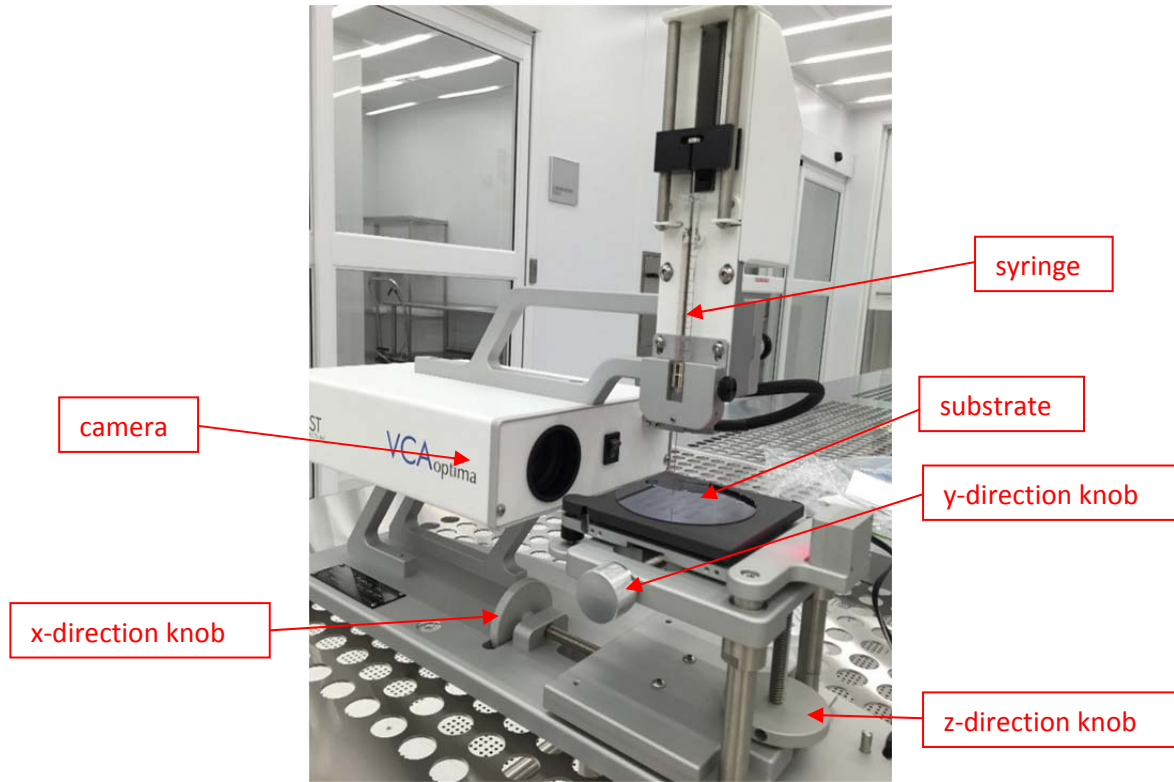

Figure 1 Contact Angle Measurement tool

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

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.
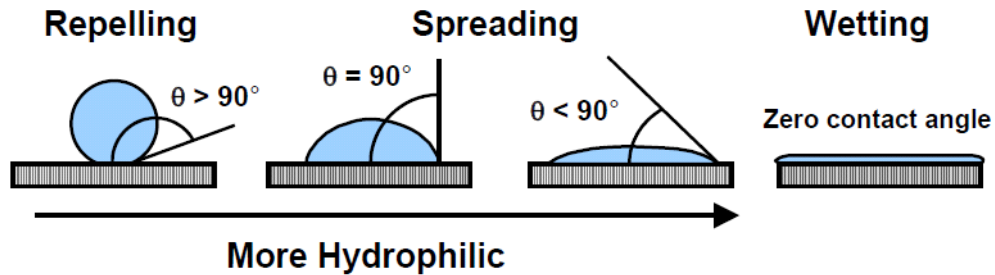

Figure 2. Contact angles and hydrophilicity.

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.
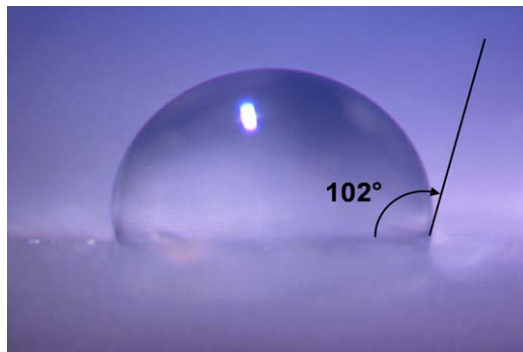

Figure 3: Contact angle of water droplet measured on a silicon substrate.

Operating Procedure

The equipment manual can be found on the computer desktop.

A. Preparation

- Reserve and logon this tool in FOM before operating. Logoff it when you finish.

- 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.
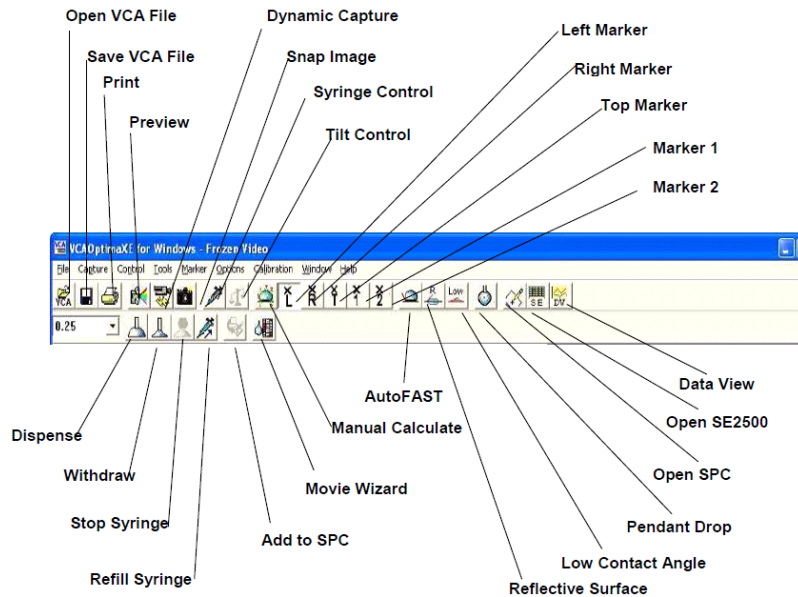

Figure 4: Software interface.

B. Measurement

- Lower the sample stage.

- Place sample onto stage and raise upward until the sample is below the needle.

- Adjust the contrast of the live video if necessary, as shown in Figure 5.

- Slowly twist the knob on the top of the syringe until the water just peeks through the needle. Then set the "'droplet size" to 3-5 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. 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.
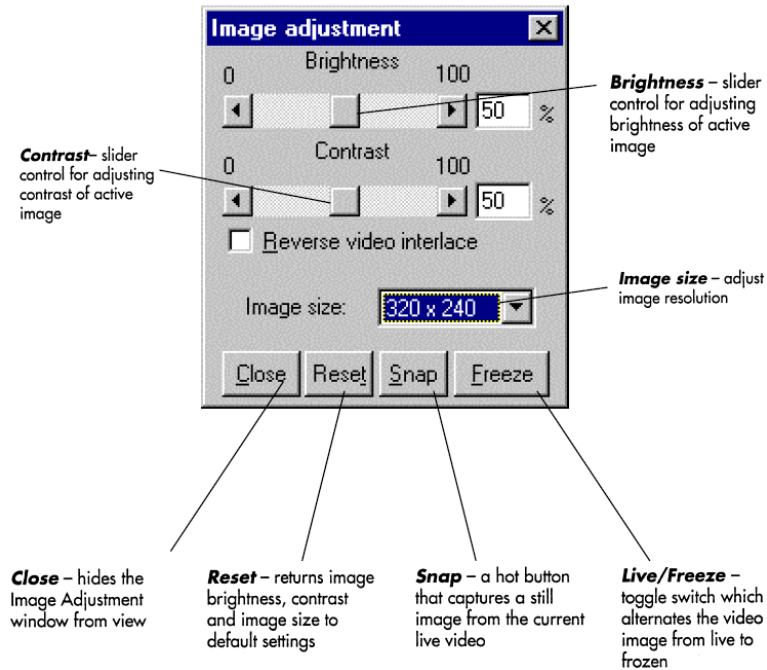
Image adjustment

Brightness
0   100
[slider] 50 %

Brightness – slider control for adjusting brightness of active image

Contrast
0   100
[slider] 50 %

Contrast – slider control for adjusting contrast of active image

☐ Reverse video interlace

Image size: 320 x 240 ▼

Image size – adjust image resolution

Close Reset Snap Freeze

Close – hides the Image Adjustment window from view

Reset – returns image brightness, contrast and image size to default settings

Snap – a hot button that captures a still image from the current live video

Live/Freeze – toggle switch which alternates the video image from live to frozen

Figure 5: Brightness and contrast adjustment.

Syringe Control

Syringe level =   ?   %

Trigger
Delay 3.0 Sec
Trigger

Speed Medium ▼
Syringe size
1000ul ▼

Droplet
☐ Continuous
Size:
5.00 ul
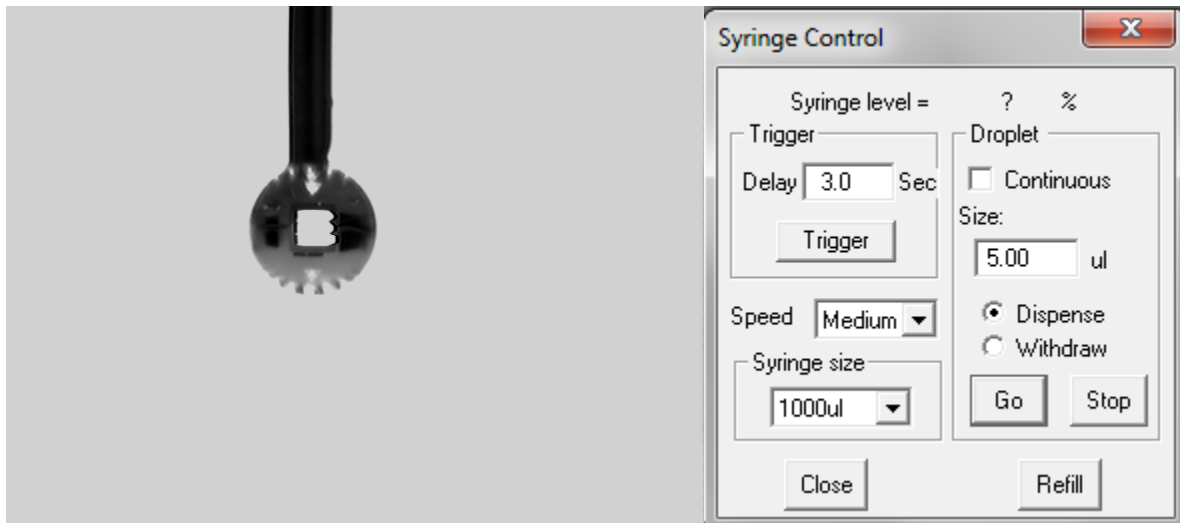
○ Dispense
○ Withdraw
Go   Stop

Close   Refill

Figure 6: Dispense a drop of liquid.

Figure 7: Transfer the drop to the sample surface.

C. Analysis

- Click the AUTOFAST ICON to freeze the image and 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.
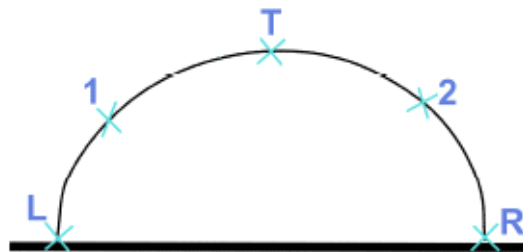

Figure 8. Manual fit of the droplet boundary.

- 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 software menu bar.

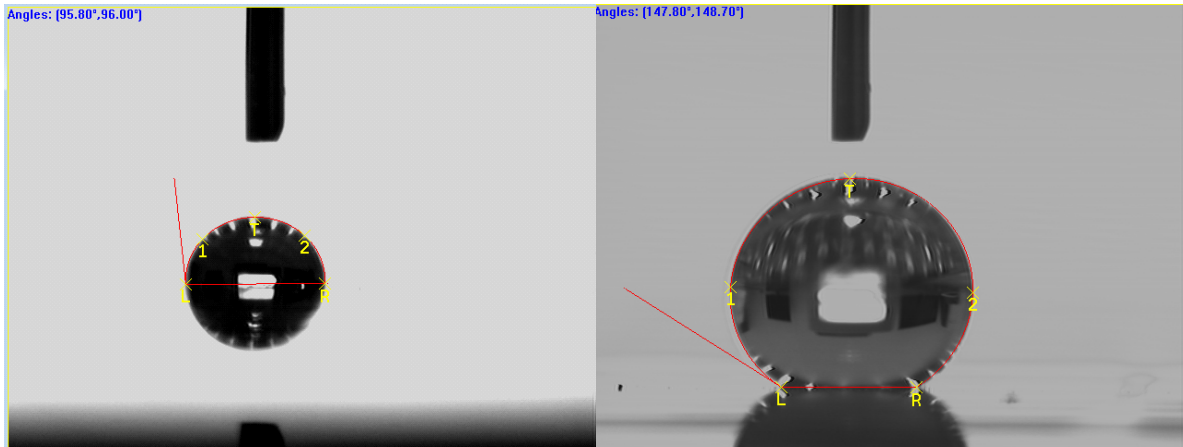- Go to File menu and Export image to store on your memory stick.

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. You need to input the measured contact angle and 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.
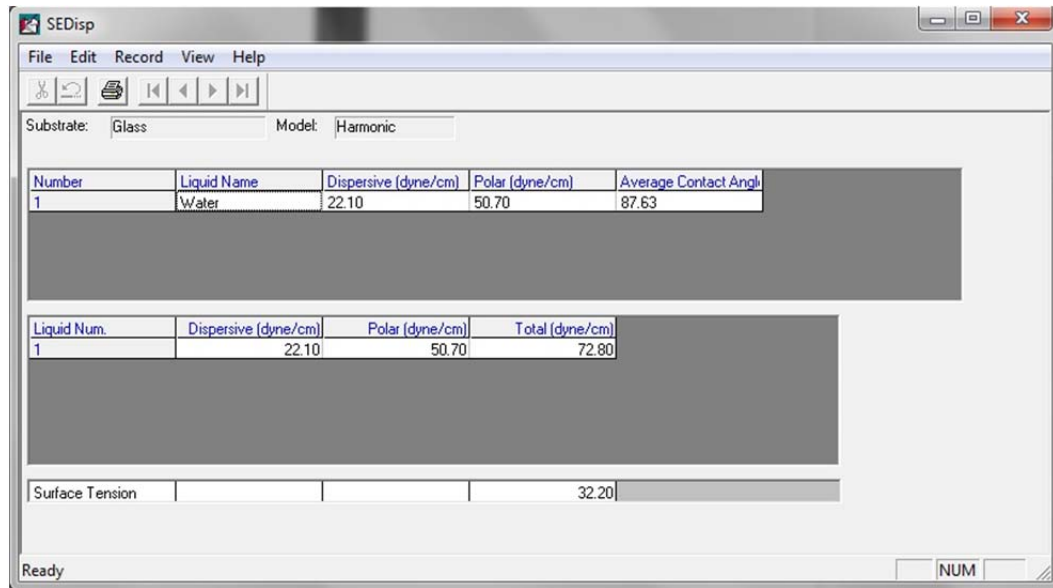
Figure 11: SE2500 for surface energy calculation.