An All-around Contact Angle Measuring System

(as presented at Pittcon® 2000)

Surface Electro Optics

Contact angle measurement is a well-known technique, which is being used to control adhesion, surface treatments, and polymer film modification. The wetting of solid substrates by liquids is a basic element in many natural and commercial processes.

Contact angle is a simple, rapid and sensitive method of measuring the wettability of a solid surface. Computer controlled contact angle analyzer makes it easy to measure not only static contact angle but also dynamic contact angles and surface energies.

Also the surface tension of liquid medium can be easily measured by analyzing a pendant drop shape.

Equipment

The instrument, the "SEO 300A", has a continuous frame grabber which is capable of digitizing frame at VGA resolution. The resolution of CCD camera is 768*576, NTSC. We used a 6.4 fold zooming lens and a special optical light source that was decided to an experiment. These images are fed into a buffer set aside in Windows ™, main memory to maximum 30 images/sec. Using a light sensor, images are captured automatically by the computer when a drop is to be observed.

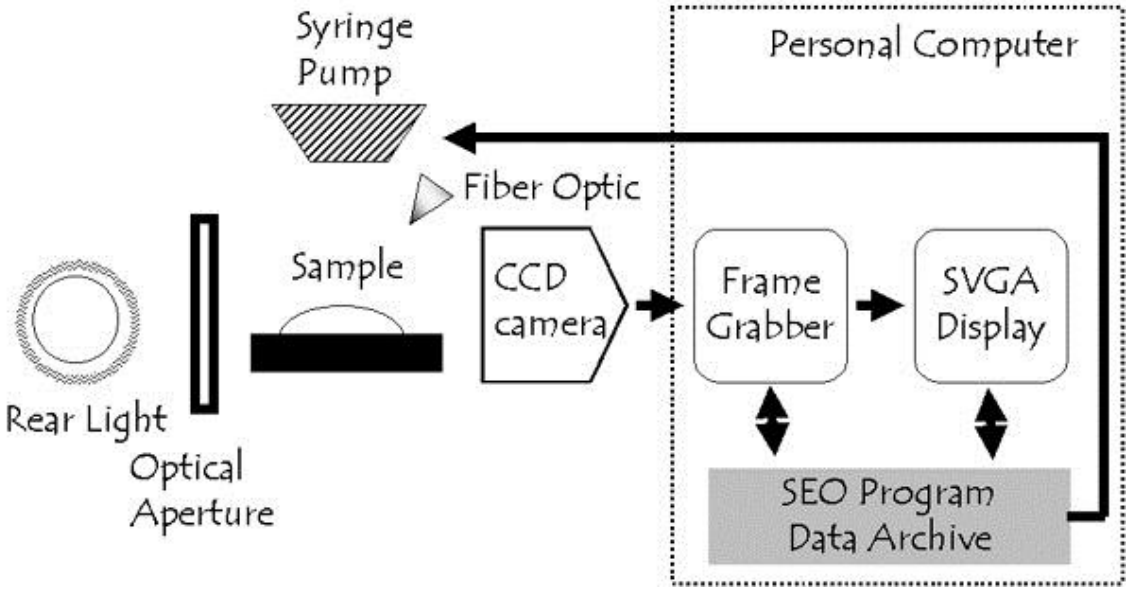
A typical measurement is performed as follows (1) for better clear image; setup the experiment of fluid dispensing, lighting, mode, focus and program. (2) begin the experiment, start the stepping motor and capture of the continuous images. You can find a tendency through a contact angle changes. (3) Finally, graph the resulting data or export database for further analysis (like a surface energy or a work of adhesion)

To summarize, User can analysis any images which had performed. The movie is stored and treated like a database which has a image, left contact angle, right contact angle, mean contact angle, captured time.

The continuous capturing system so relies on the computer' performance that SEO offers a highly efficient computer system.

Data is digitized by the frame grabber as a 24-gray scale that allow fine measurements. Over 90 degree contact angle, which is hard to image analysis, SEO gives a fully automatic analysis of any degrees that is remarkably easy and convenient. We can go without unessential effort.

Figure 1 shows the captured images flows and hardware configuration.



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Application

In this paper will illustrate typical application of the system. All photos were taken with SEO300A and analyzed its program.

Contact angle

Contact angle is the angle between the tangent to the drop's profile and the tangent to the surface, at the point of meeting between the vapor, the liquid and the solid (see Figure 2). Contact angle is an index of the wettability of solid surface. A lower contact angle means that the hydrophilic and high-energy surface. But a higher contact angle means that the hydrophobic and low-energy surface.

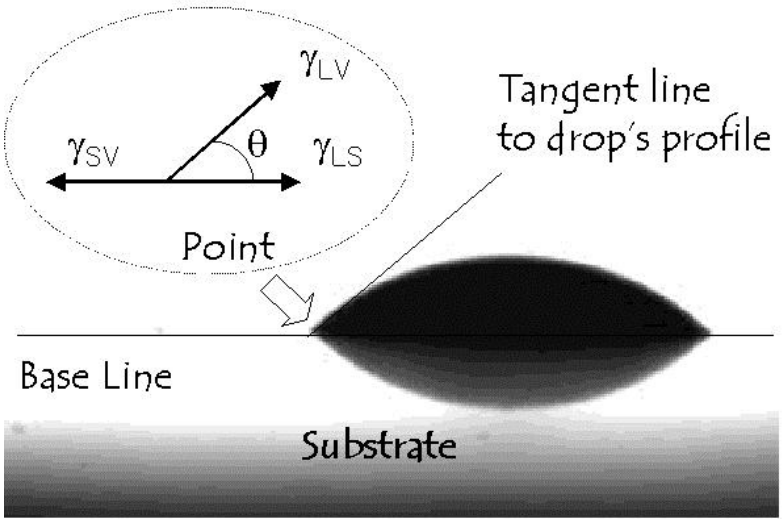

Figure 2. Contact angle measurement (this image captured SEO300A)

The graph shown in Figure 3 shows the contact angle for a drop of paint placed on a steel surface. The time resolution in this movie was 0.33 seconds. After the paint drop is dispensed, contact angle decreased little by little. So we can understand the effect of an annex to include in the paint. SEO300A automatically analyzing sequenced images and treated as a database.

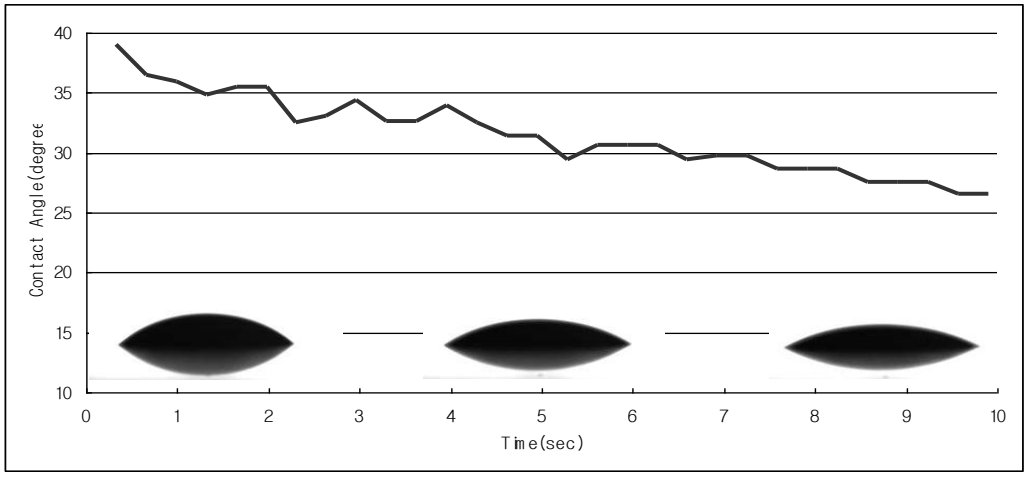

Figure 3. Contact angle changes (this image captured SEO300A)

Surface tension

Surface tension can be measured from a drop's shape (see Figure 4). Given the fluid density and two measurements of the drop's shape(S_W/S_E), a look up table provides the surface tension. SEO300 series use the Bashforth-Adams technique of measuring surface tension. It gives almost exact value of water-based liquid.

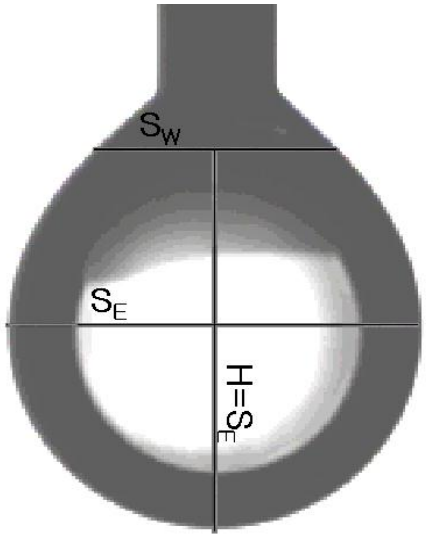

Figure 4. Pendant drop surface tension measurement (this image captured SEO300A)

To characterize of an unknown liquid, surface tension was measured by sequenced time. Surface tension result is sensitive to dimensional change. So the region of similar surface tension is the correct value of surface tension in Figure 5.

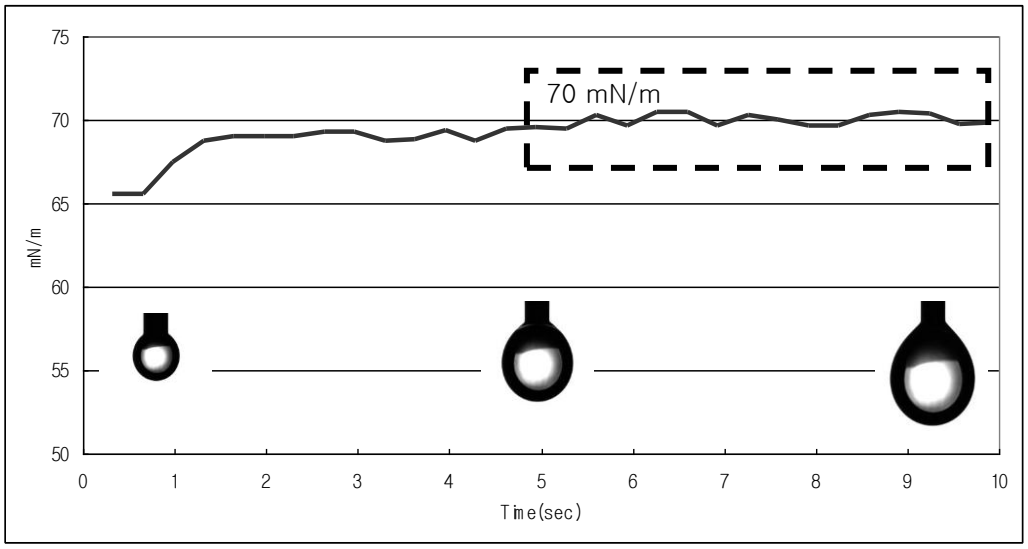

Figure 5. Optimized surface tension measurement (this image captured SEO300A)

Reference

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