

Surface Nano-Engineering



CAG-20^{PE}

Contact Angle Goniometer

A spin off from



Jikan CAG-20 is a drop shape analyzer. By placing drops on test samples and taking images, the CAG-10 calculates the wettability and surface free energy of the solid surface.

What is contact angle?

Consider the system shown below, consists of liquid, solid and gas phases. The intersection of solid, liquid and gas phases is called the contact line. The angle formed between the liquid-solid and liquid-gas interfaces is called the contact angle.



If the contact line moves during the measurement, the contact angle is dynamic contact angle. Otherwise, the angle is static contact angle.

On an ideal surface (smooth and homogeneous), the static and dynamic contact angles are equal.

On a real surface, the contact angle varies from a maximum (advancing) to a minimum (receding). The difference between advancing and receding contact angles is called the contact angle hysteresis.

Contact angle hysteresis determines the required force to shed a drop from the surface. Therefore, lower contact angle hysteresis signifies easier drop detachment.

Surface free energy is the work performed to expand the surface. The lower surface free energy leads to a lower wettability and more water repellency.

Surface Classification

Water and oil represent two class of liquids, i.e. polar and non-polar.

Water:



Hydrophobic



Superhydrophilic



Hydrophilic



$\theta_{\text{receding}} < 10^\circ$



$\theta > 150^\circ$

Superhydrophobic

Oil:



Oleophilic



Oleophobic

Engineered Surfaces Application

Superhydrophobic surfaces are self-cleaning as water drops easily bead up and roll off on these surfaces. As drop rolls off, it collects dust and dirt and carries them out. The superhydrophobic surfaces have various applications, e.g. drag reduction, corrosion inhibition, and heat transfer enhancement.

Superhydrophilic surface have applications in medical implants for biocompatibility improvement, anti-fog and anti-fouling applications and so on.

Oleophobicity has a wide application in self-cleaning paints, materials, glass and clothing.

Direct vs Indirect

In order to measure the contact angle there are two general methods:

Indirect methods find the contact angle by measuring the force (e.g. the Wilhelmy Plate method). Direct methods find the contact angle from the image (e.g. the Sessile drop method).

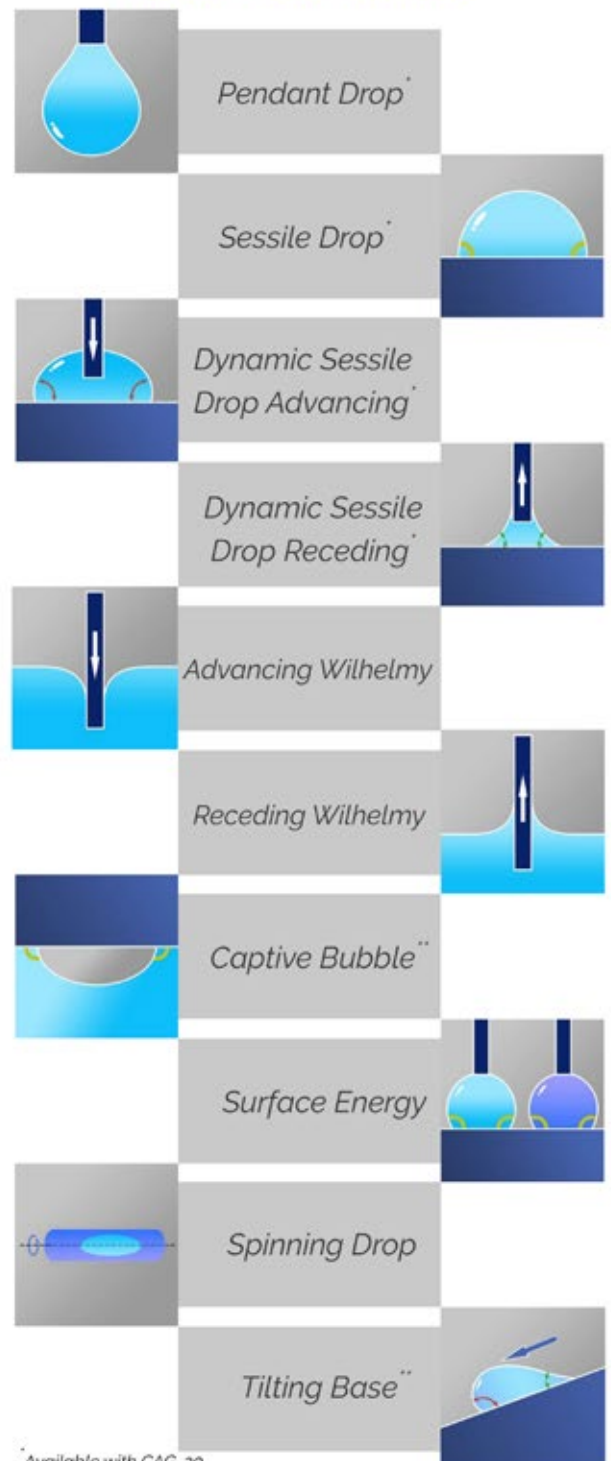
The direct methods are more common as they have higher precision and require less volume of liquid.

The sessile drop method and the tilting plate method are the main two methods to measure dynamic contact angles.

In the sessile drop method, the droplet is firstly injected on a horizontal sample, the injection continues and contact angle is measured during the contact line motion (advancing contact angle). The reverse procedure is used to measure the receding contact angle. For a smooth and homogeneous surface, the surface free energy could be calculated by the equation of state, through the sessile drop method.

In the tilting plate method, after the drop is formed on the surface, the stage (with the sample) starts to tilt. As soon as the drop starts to slide on the tilted surface, maximum (advancing) and minimum (receding) contact angles are recorded.

Measurement Methods



* Available with CAG-20
** Available with CAG-20 upon request

Jikan CAG-20 is a fully automated contact angle goniometer with a user-friendly interface. Just a click is enough for the device to measure the contact angle. Our contact angle goniometer machines are equipped with Jikan Assistant software, which enables the user to measure the advancing and receding contact angles, contact angle hysteresis, surface tension of liquids and surface energy of solid surfaces.

Features



Mechanical Advantages

Authentic design of Jikan CAG-20 with stainless-steel body minimizes the mechanical vibrations and produces accurate results.

Camera Back to Front Tilt

This feature enables the user to see the reflection of drop and measure the contact angle accurately. The reflection is also needed to automatically detect the contact points. The tilt is engineered so that it does not produce any error

Adjustable stage

Z axis movement of camera and sample holder ables you to test samples with 0-30 mm heights. The camera and the sample holder heights can be adjusted by a single click. Also you can perform the pendant drop test easily using this functions.

Stage Level

To test uneven samples, stage level enables the user to find a horizontal spot on the sample using this feature.

Dispatchable Syringes

The syringe could easily be dispatched from the system so the fill-in, discharge and probable washing process could be easily done. The syringe and its holder can be completely replaced with other size syringes by the user.

Injecting System

The injection system is designed to produce continuous injection of liquids with flow rates as low as 200 nl/s, and with no vibrations. The minimum attainable liquid volume with the standard injection system is 2.5 nl. This range is more than enough for measuring advancing and receding contact angles. The injection system is modular to simplify the repair or change with other systems we offer to meet your needs. The range and flow can be customized for specific applications.



Imaging System

To have an accurate contact angle measurement, a sharp droplet image is needed. Jikan CAG-20 utilizes a wide range of customized lens and camera for regular or specific applications. Using CAG-20, you will be able to measure the static and dynamic contact angles using sessile drop method, (or tilt plate method by installing the proper add-on); surface tension and interfacial tension using pendant drop method; and surface free energy using OWRK and Wu methods in accordance with ISO 19403.

Imaging module includes camera and lighting system. Appropriate lighting not only lowers the noise and optical errors, but also creates sharp, clear and ideal image for processing by the software.

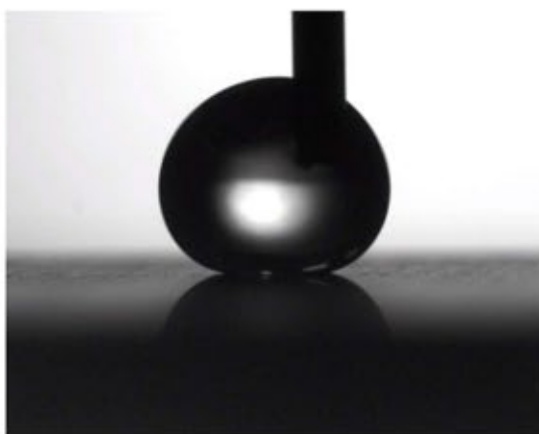
Lighting System

You are able to adjust lighting intensity of Jikan CAG-20 by the software, "Jikan Assistant". You can adjust the illumination without making any changes into camera setup, and achieve the best images. The device uses a 450 nm light source in order to minimize the light diffraction, reduce the generated heat, and increase the resolution according to Bragg's law and Abbe diffraction limit. The shape of light source, helps illuminating the drop more evenly, and reduces the noise due to any environmental lights.

Camera

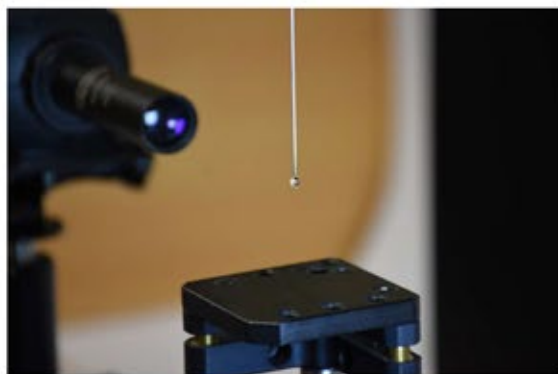
The Jikan CAG-20 camera is equipped with a global shutter, which is necessary for better imaging of moving objects which users may encounter during dynamic contact angle and surface tension measurements.

Camera sends a maximum of 60 fps through its USB 3.0 cable which perfectly satisfies the needs. The pixel size of the camera is less than 6 μm which enables the software to accurately locate the contact point automatically. The manual mode is also available for noisy images where the software is unable to accurately find the contact points. The live image processing enables the user to have the results as fast as possible. The field of view of imaging system enables the user to perform all kinds of test without needing to change the lens or injection syringe. Although, the lens, camera, and injection syringe are all exchangeable for customized tests.



Minimizing perspective error

The lens used on CAG-20 has a fixed zooming, which benefits the user to extract dimensional data of the image and calibrate the system. The telecentricity of the lens eradicates the effect of perspective and gives the user a precise image, especially for dynamic measurements.



Jikan Assistant

The Jikan Assistant performs three major tasks: hardware control, automatic image brightness adjustments and image processing, to make a unique and easy experience for the user to measure the desired properties.

Image processing

User can choose from polynomial fit, circle fit, ADSA to measure the contact angle. The contact points can be found automatically or user can pick them manually. The live processing is added to evaluate the results as fast as possible. For a comprehensive data analysis off-line process can be performed as well.

Hardware control

Using hardware control, the user can adjust the height of sample stage and camera at different elevation rates. The injection rate can be adjusted to the recommended values for static and dynamics measurements as well as surface tension analysis. User can also monitor and record the pressure, temperature and relative humidity within the software.



Results appearance & data analysis

The collective data are shown in table and graph forms, along with the live analysis. Also the data, image and video can be saved separately and you can re-analyze them anytime you demand.

Imaging adjustments

You can choose the frame rate, exposure time, image resolution and illumination to obtain better results.

Environmental Chamber

for adjusting the temperature and humidity from -30°C to $+90^{\circ}\text{C}$, and 0% to 100% accordingly.

Captive Bubble Chamber

for measuring the Young, advancing and receding contact angle of bubbles, instead of drops.

Tilt Plate Stage

for measuring the advancing and receding contact angles using tilt plate method.

Modules



Technical Data

Measuring Range Inaccuracy	0° - 180° ±0.1°
Camera System	Progressive CMOS Sensor Global Shutter Up to 150fps Optical Frame Rate 1024×1280 Pixels Pixel Size: 5.0 μm×5.0 μm USB 3.0 Video Sequences
Optics	±1mm Working Distance Tolerance
Camera Back To Front Tilt	±10°
Lighting System	450nm Wavelength No Heat LED
Camera Positioning Sample Holder Positioning	Motorized X & Z Direction Move(Optional Y Direction) Motorized Y & Z Direction Move (Optional X Direction)
Position Adjustment Stroke Accuracy	2.5 cm ±100 μm
Dispenser	Automatic Dispenser Nanoliter Resolution
Hardware Control	PC via Jikan Assistanst 7" Touch Control Pad
Jikan Assistant Software	Contact Angle, Surface Tension & Surface Free Energy Measurement Module Included
Computer Requirements	OS: Windows 8.1, 10 (32-bit & 64-bit) CPU: Intel Corei3 @ 1.3 GHz or Higher RAM: 2 GB or Higher Disk Space: 2 Gb
Input Power Supply	USB 3.0 110/220 V, 50 W, AC
Size Weight	55 cm × 30 cm × 50 cm 15 Kg



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