# JIKAN

## Surface Nano-Engineering



# CAG-10

## Contact Angle Goniometer

Jikan

The Jikan CAG-10 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.

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.
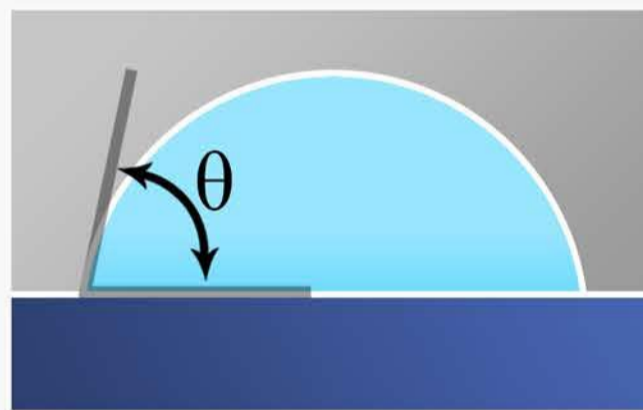


Surface free energy is the work performed to expand the surface. The lower surface free energy leads to a lower wettability and more water repellency.

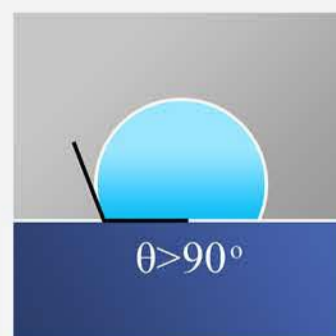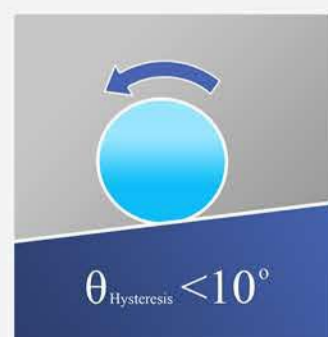Water and oil represent two class of liquids, i.e. polar and non-polar.

Water:
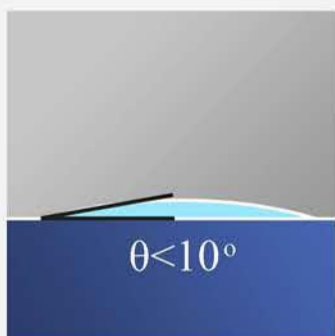
| $\theta < 10°$ | $\theta < 90°$ | $\theta > 90°$ |
|---|---|---|
| Superhydrophilic | Hydrophilic | Hydrophobic |

| $\theta > 150°$ | $\theta_{Hysteresis} < 10°$ |
|---|---|
| Superhydrophobic | |

Oil:
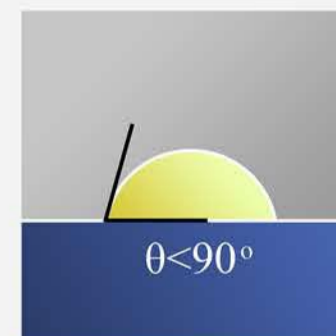
| $\theta < 90°$ |
|---|
| Oleophilic |

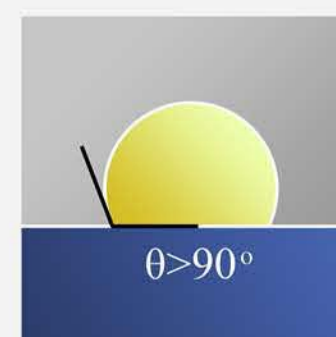| $\theta > 90°$ |
|---|
| Oleophobic |

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.

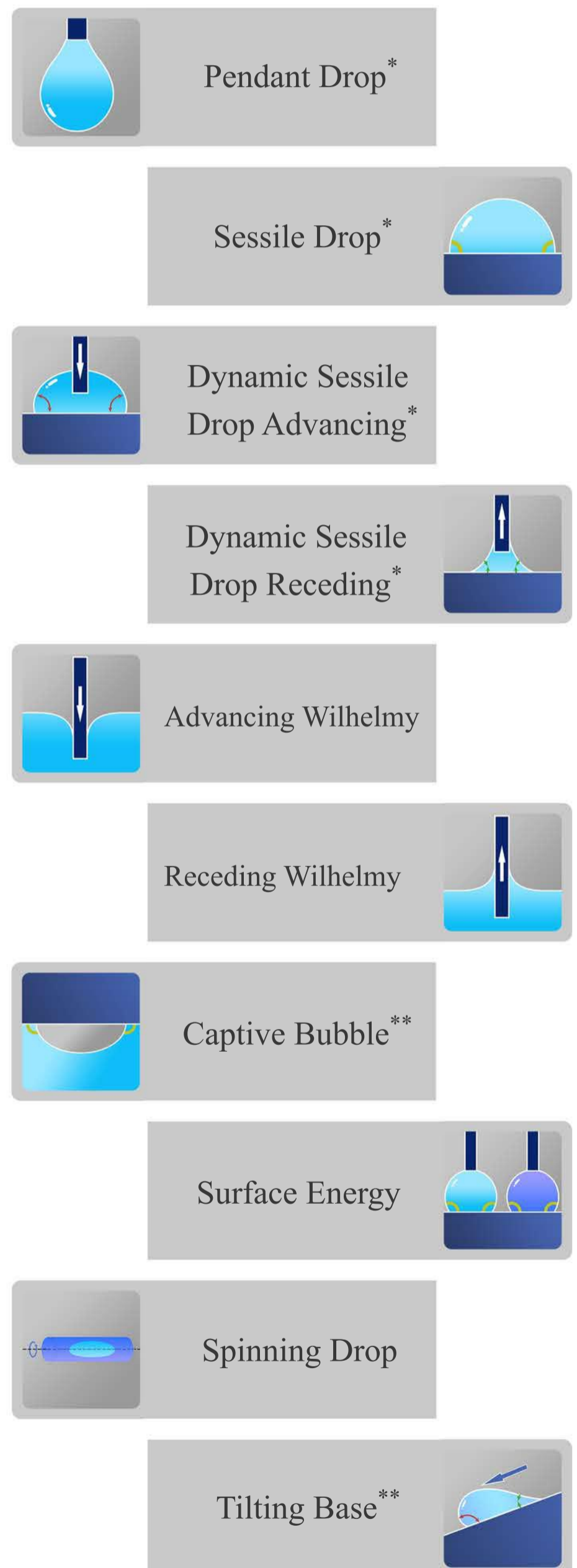In order to measure the contact angle there are two general methods:

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.
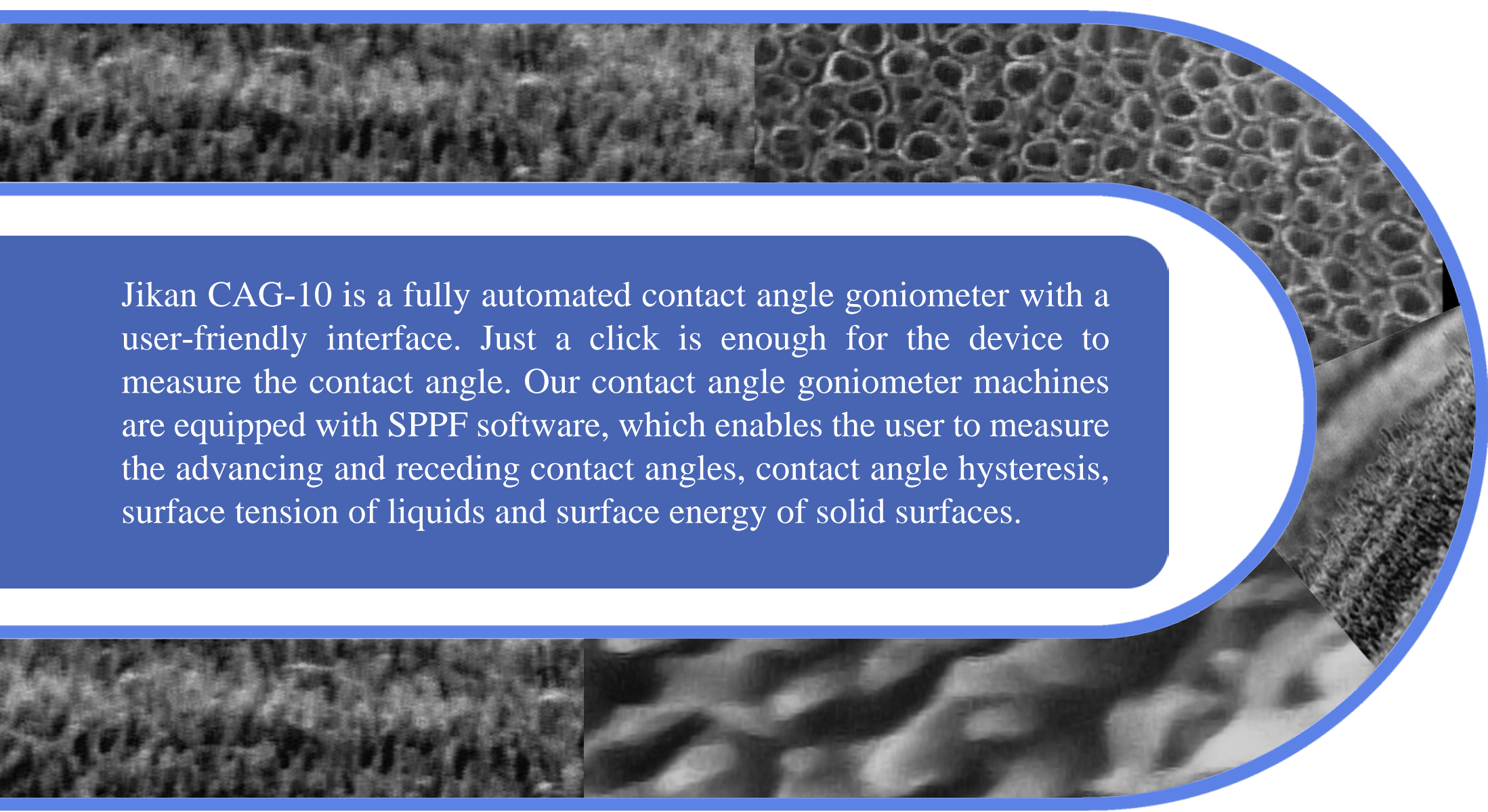
In the sessile drop method, the droplet is firstly injected on a horizontal sample, the injection continues and contact angle is measured during the contact line motion (advancing contact angle). The reverse procedure is used to measure the receding contact angle. For a smooth and homogeneous surface, 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.

Pendant Drop[*]

Sessile Drop[*]

Dynamic Sessile Drop Advancing[*]

Dynamic Sessile Drop Receding[*]

Advancing Wilhelmy

Receding Wilhelmy

Captive Bubble[**]

Surface Energy

Spinning Drop

Tilting Base[**]

[*] Available with CAG-10

[**] Available with CAG-10 upon request

Jikan CAG-10 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 SPPF 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.

## The device consists of:

- Vibration free, accurate and reliable injection system
- Adjustable camera and sample holder
- Computer-controlled injection system
- Levelable sample holder
- Changeable camera back to front angle
- High speed, noise-free, advanced imaging system
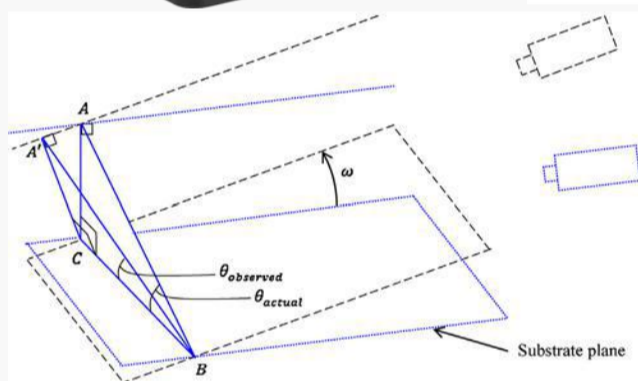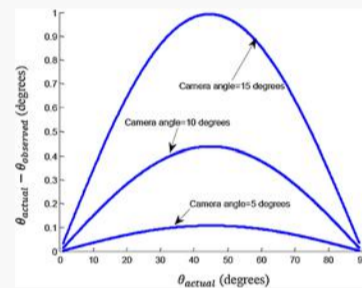- Changeable syringes
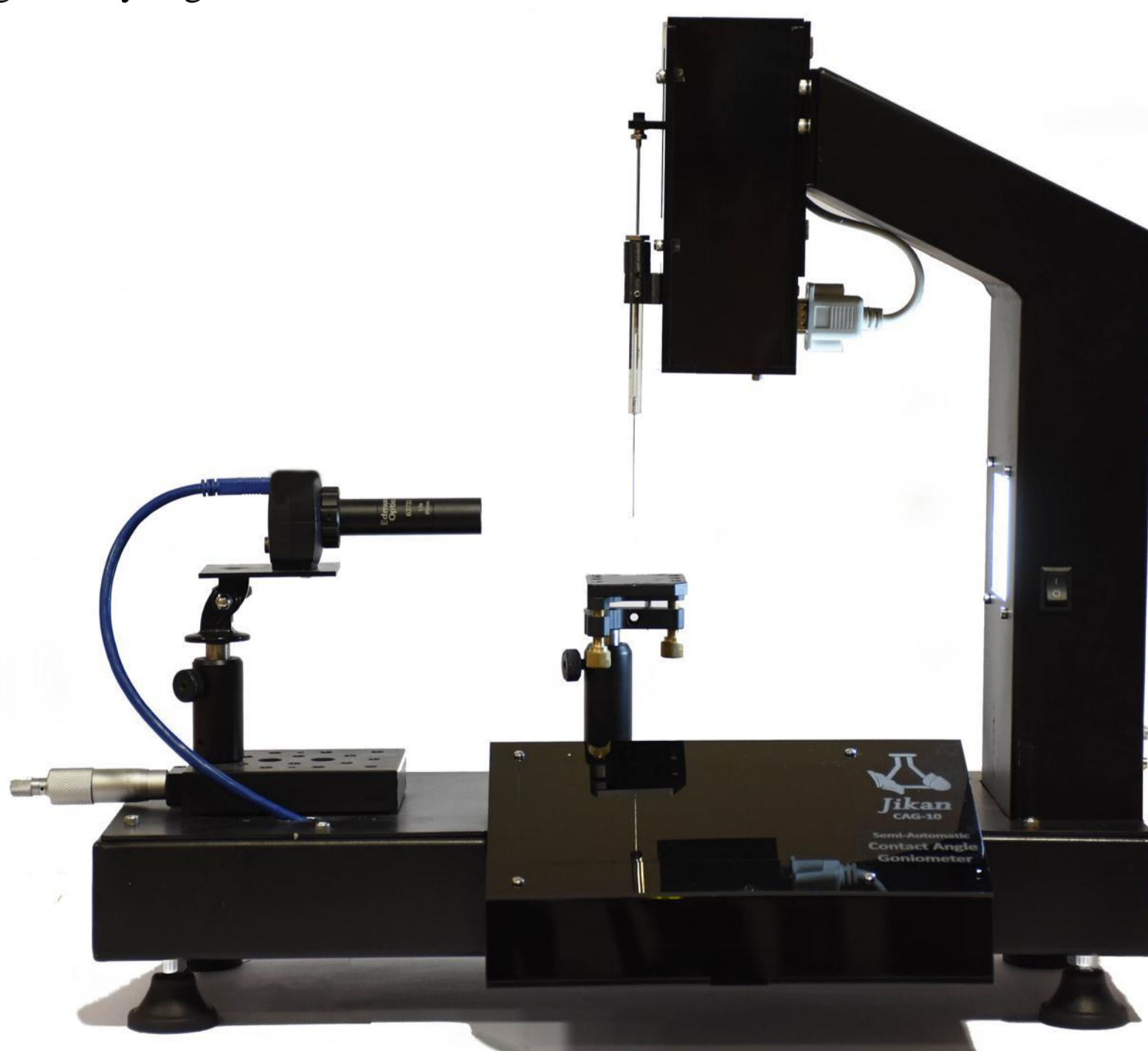
## Mechanical Advantages:

Authentic design of Jikan CAG-10 with stainless-steel body, minimizes the mechanical vibrations and produces accurate results.

## Stage Level:

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

## 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 in contact angle results.

## Adjustable Stage:

In order to achieve maximum flexibility, Jikan CAG-10 stage has the ability to adjust in vertical and horizontal directions. This enables the user to test samples with maximum size of 25×60×150 mm.
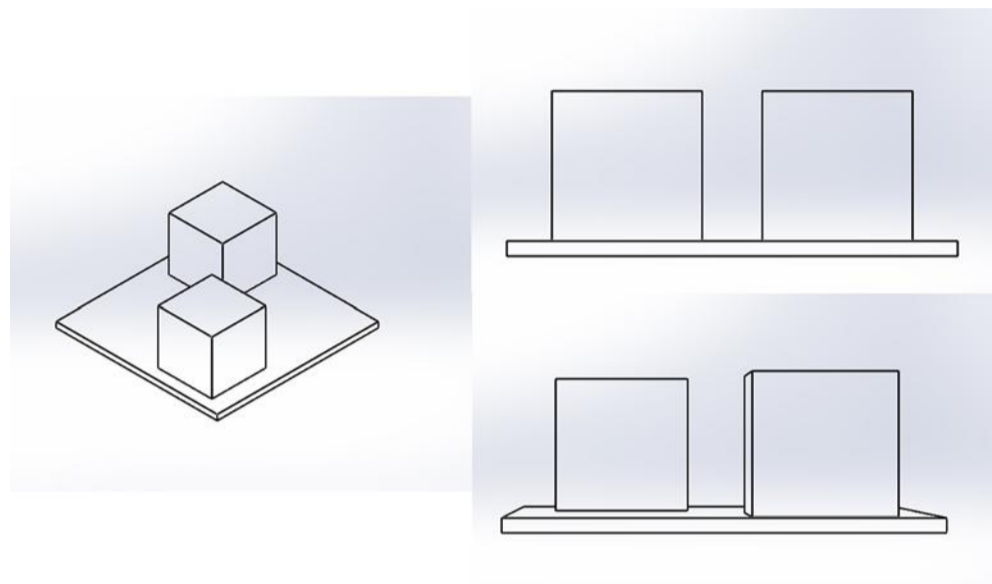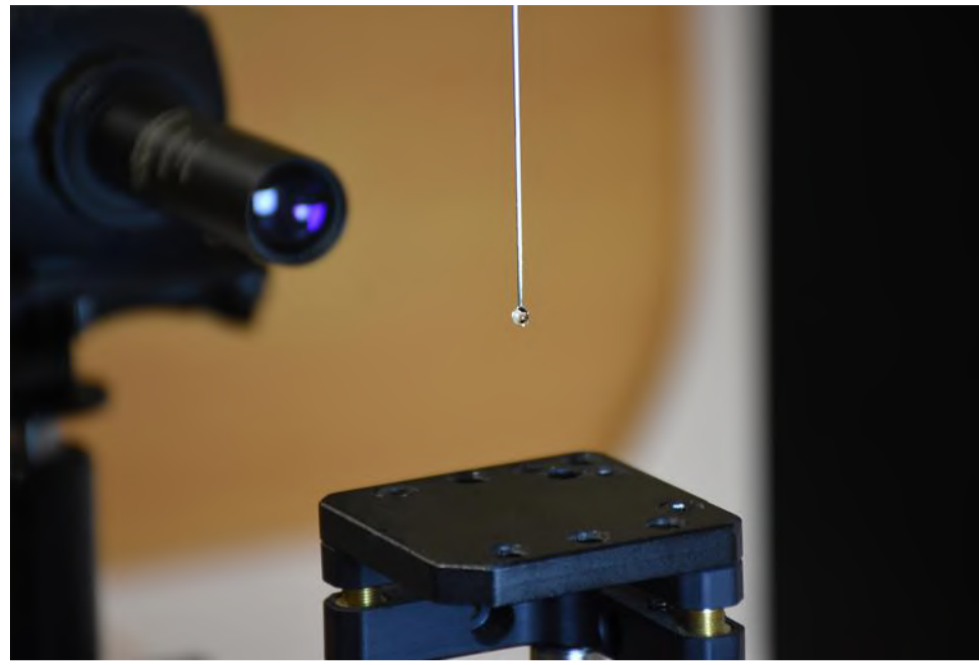
## Injecting System:

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.

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.

## The imaging system:

Imaging system plays a crucial role in the contact angle measurement, so the components of the system are selected with the highest quality models and brands. The camera is a 60 fps (optical) with a USB 3.0 connection for maximum speed of data transfer. The field of view completely covers the droplet area with a great accuracy. Jikan CAG-10 imaging system employs advanced imaging of the droplet which minimizes the perspective errors.





A hypothetical image of two identical cubes.
Up: imaged with telecentric lens.
Down: imaged with conventional zoom lens. The perspective error due to the separation of the cubes would lead to incorrect measurements.

## Lighting system:

Proper lighting is a necessity to achieve an appropriate image of the droplet. Jikan CAG-10 uses a 450 nm lighting system to minimize the errors caused by ray diffraction. The intensity of the light is also easily adjustable by the user through the software.
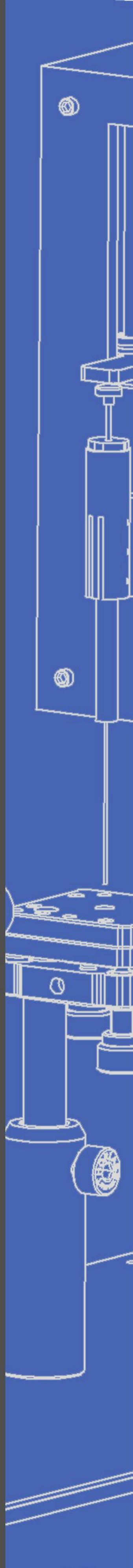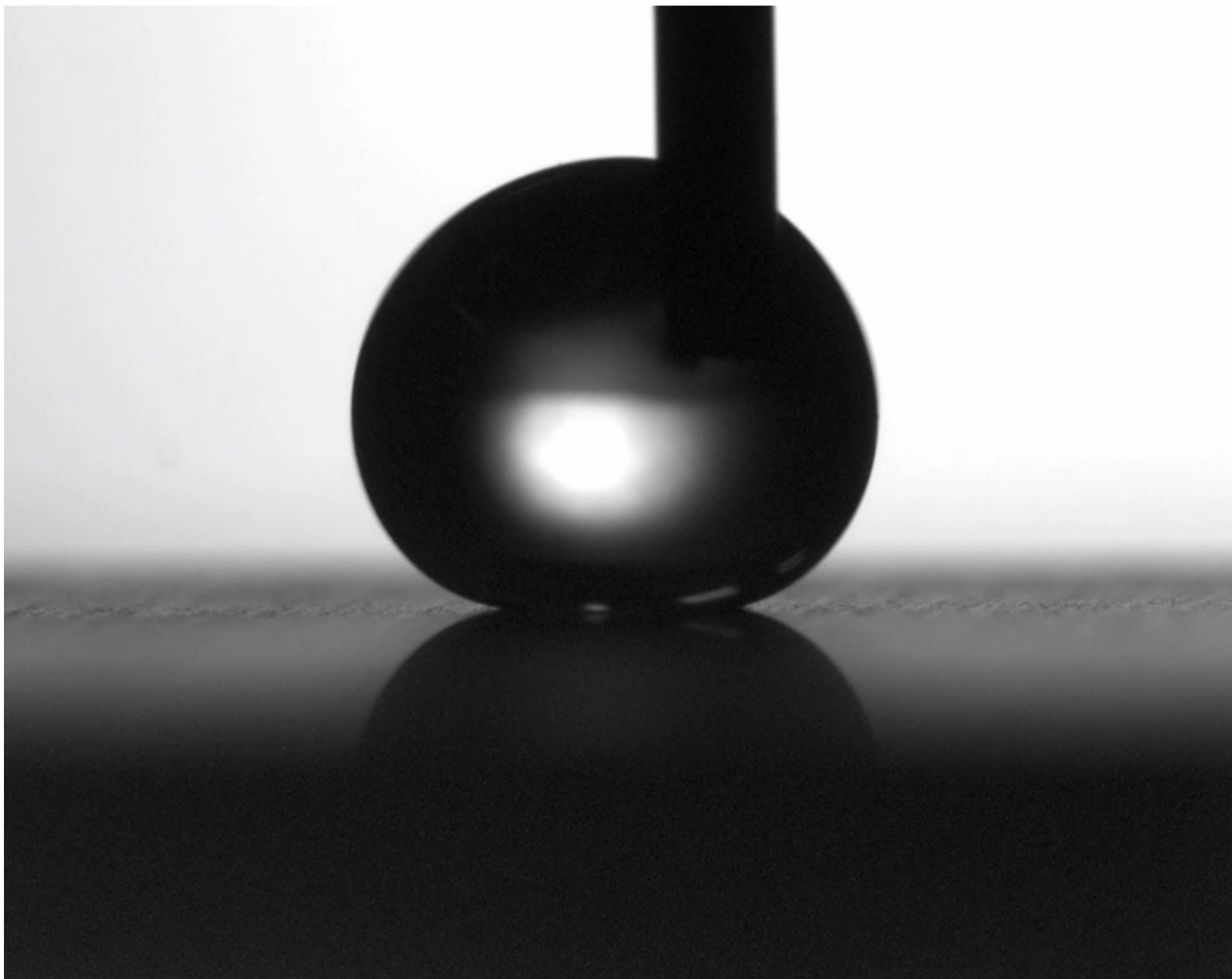
**Image processing software:**

Jikan CAG-10's Image processing software is completely automatic and needs no additional data for measurement. The software implements both Young-Laplace, and polynomial curve fittings. Surface energy algorithm is based on equation of state and contact angle values. The image processing software employs advanced and unique image processing algorithms with the sub-pixel resolution to find the actual contact point with minimum error.
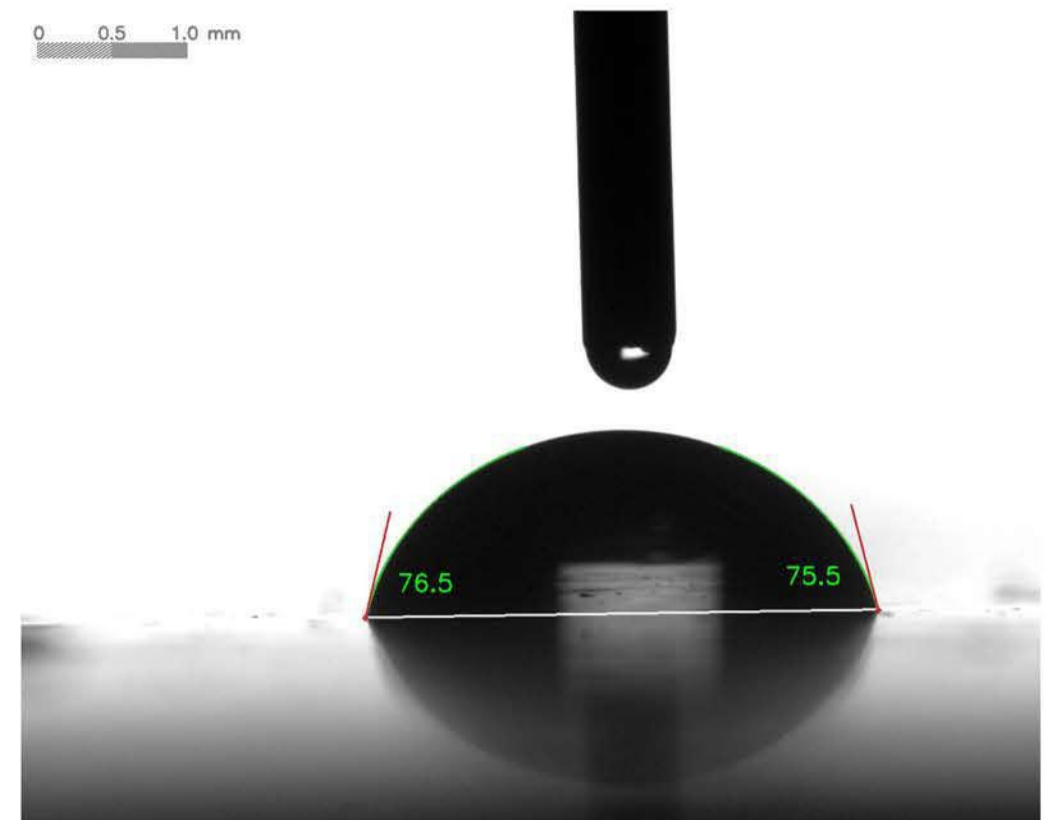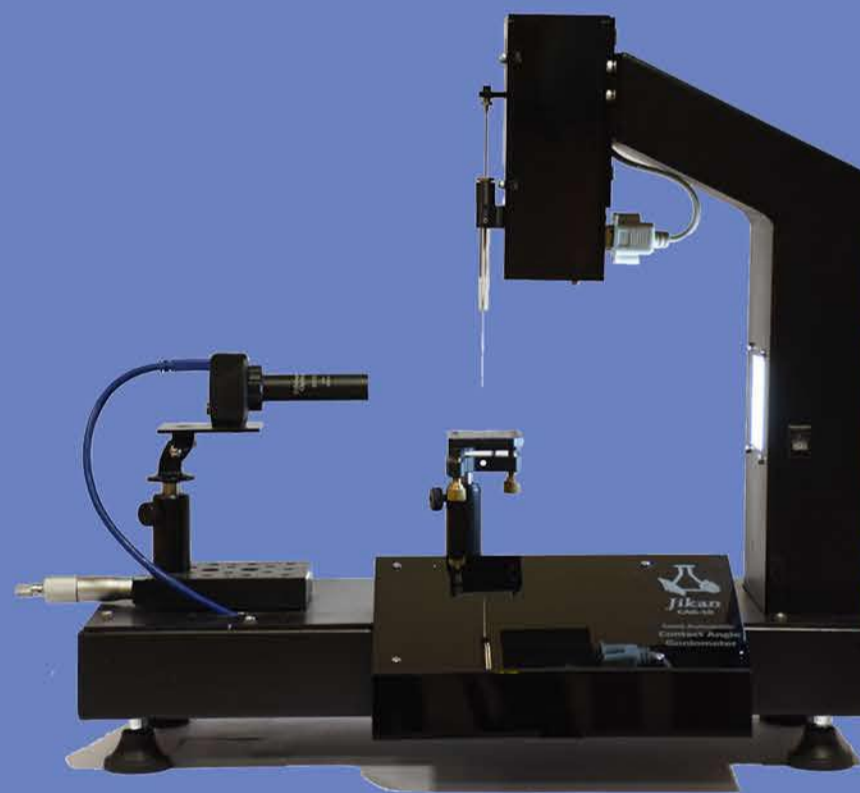


## Tilt Plate Stage

This stage enables the user to measure the advancing and receding contact angles using tilt plate method.

## Captive Bubble Chamber

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



## Environmental Chamber

This chamber allows the user to adjust the temperature and humidity from −30°C to +90°C, and 0% to 100% accordingly. The chamber is able to do the standard thermocycle tests to evaluate the durability of superhydrophobic, icephobic or any other coatings.

# Technical Data

| | |
|---|---|
| **Measuring Range** | 0–180° |
| **Inaccuracy** | ± 0.1° |
| **Camera System** | • Pixel Depth: 10-bit<br>• Progressive Scan CMOS Sensor<br>• Frame Rate: 60fps Optical<br>• 1280×1024 Pixels<br>• Global shutter<br>• Video Sequences<br>• USB 3<br>• Pixel size: 5.3 × 5.3 μm |
| **Optics** | • Telecentric lens<br>• ±1mm working distance tolerance<br>• LED light source |
| **Sample Stage** | Movable in z direction (optional x, y directions) |
| **Display** | • LCD<br>• 7", 800 × 480<br>• Capacitive touch |
| **Input/Output** | USB 3, HDMI |
| **Power Supply** | 220 – 240 V, 50 W,  AC |
| **Computer requirements** | • OS: Windows 7, 8, 8.1, 10 (32-bit and 64-bit)<br>• CPU: Intel Core-2 Duo @ 1.3 GHz or higher<br>• RAM: 1 GB or higher<br>• Disk space: 1 GB |
| **Dispenser** | • Automatic<br>• nano-liter resolution |

Jikan Surface Nano-Engineering Company is a knowledge-based company based in Tehran, Iran. Jikan was established as a spin-off from SNE Research Center, University of Tehran. In Jikan, we manufacture world-class measurment instruments and perform top-notch research in the field of surface nano-engineering. Jikan is also a service provider and is well-known for its accurate, customizable, and quick services. We are in the process of developing new standards and protocols for our products and procedures, to secure our share both in domestic and international markets.

**Jikan**

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