KYOWA
Leading to answers

DropMaster

Microscopic Contact Angle Meter

Contact Angle & Surface Free Energy

MCA-4

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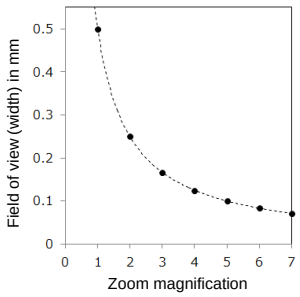
Wetting behavior in nanotechnology

Due to technological development, the design patterns on silicon wafers and glass panels have become increasingly miniaturized. Therefore, we developed our Microscopic Contact Angle Meter MCA to support the increasing demand for studying the wettability of nanoscale areas.
With the development of a unique capillary with an inner diameter of only 5 µm, it is possible to generate droplets with a volume as low as 10 pL on micro-areas within the width of 100 µm. In addition, using high-quality optical components assures the precise measurement of contact angles even at high magnifications.
The top-view camera monitors the surface of the solid substrate and the capillary's tip. That allows depositing tiny droplets with pinpoint accuracy onto small microelectronic components, micro-grooved surfaces, or single fibers.
The sophisticated technology of our MCA-4 offers reliable measurements of contact angles with high reproducibility.

The width of the field of view depending on the zoom magnification



Features

- Automatic recognition of drop deposition by FAMAS analysis software
- The top view camera allows for the deposition of droplets with pinpoint accuracy and observation of the spreading of micro-droplets
- The high magnification lens and a 12-fold zoom provide a field of view from approximately 75 x 56 µm to 910 x 680 µm
- Fine adjustable micro stage in x-, y- and z-axis for exact positioning
- Fast image capture system with max. 2,700 fps allows accurate measurements of even quick evaporating picoliter droplets
- Droplet calibration standard bearing three sets of one full circle for calibration and three droplet silhouettes of 5°, 60°, and 108° for periodic inspection of measurement accuracy

Applications

- Miniaturized patterns on silicon wafers, OLED panels, electronic components, printed circuit boards, etc.
- Wettability of thin wire materials such as single fibers, hairs, filaments, etc.
- Defined locations on the surface of tiny samples
- Inks at a small droplet volume (emitted from an ink-jet head)
- Other or micro-structured areas where conventional methods and droplet volume are not applicable

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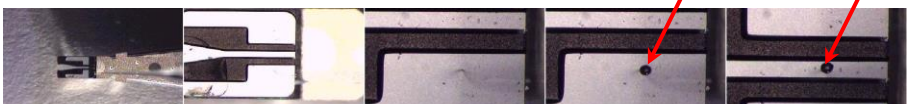
Measurement

The MCA-4 utilizes a precise electric micro-injector system and a high-quality optical system for accurate contact angle measurements of micro-droplets on small surface areas of only 100 x 100µm.
The unique capillaries with three different inner diameters allow micro-droplets to be dispensed from about 10pl to 1nL with high reproducibility.
This state-of-the-art system has an additional top-view camera that enables not only the pinpoint accuracy of droplet deposition but also the observation of the three-phase line and the spreading of tiny droplets on solid surfaces.

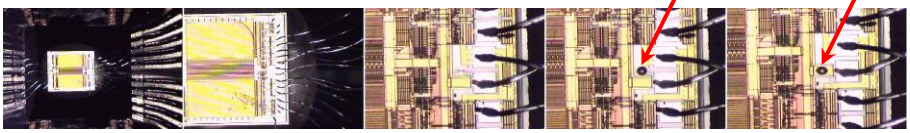
■Hard drive read-write head

Droplets observed with the top-view-camera



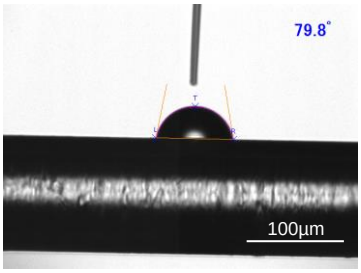
■ROM circuit

Droplets observed with the top-view-camera



■Example of Measurement

Contact angle measurement of a water droplet on a human hair.



■Example of Observation

Observation of the wetting condition inside cells of an OLED panel concerning homogeneous three-phase lines of water droplets.

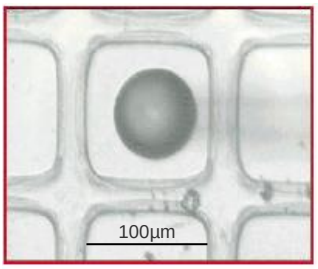


Image showing a homogeneous three-phase line

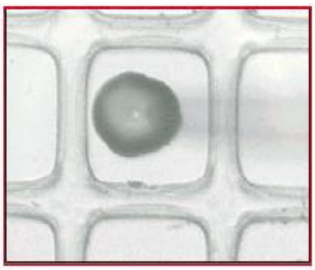
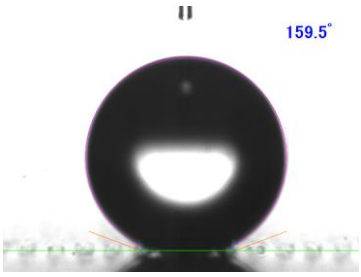
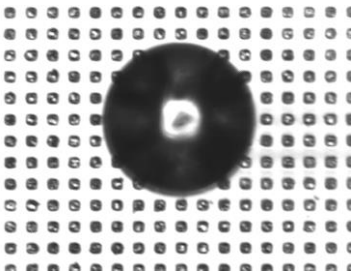


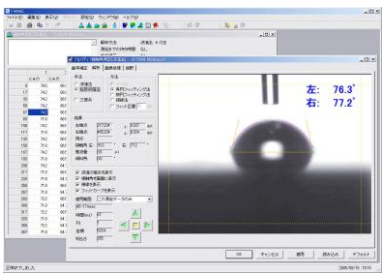
Image showing an inhomogeneous three-phase line

■Contact angle measurement and top-view observation of a 1.7nL water droplet on a superhydrophobic pillar surface





Analysis System FAMAS



■Measurement of Contact Angles

The analysis software FAMAS enables highly reliable measurements of contact angles using different methods such as θ/2 (height-width), tangent, curve fittings, and Young-Laplace.
The focusing aid with an index graph and the value displayed on the image screen help operators achieve perfect focus. In addition, the black-and-white threshold level used to determine the binary image before and after measurement helps to optimize droplet analysis.
The spreadsheet-like table displays measured results for easy reference and comparison, and a movie converter converts measurement data images to MPEG or AVI movie formats.

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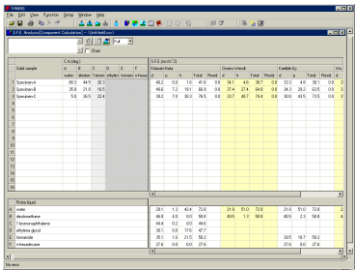

■Analysis of Surface Free Energy of Solids

Solid surface free energies and their polar and dispersive components are analyzed using contact angle measurements with different probe liquids.

The software provides theories from authors such as Geometric mean, Harmonic mean, OWRK, acid-base, Interaction analysis (Work of Adhesion, Interfacial Free Energy), Young-Dupré, and Zisman plot.

An optional kit with five probe liquids and a set of needles is available to quickly start measurements of surface free energies according to the desired theory.

Specifications

	MCA-4	
Camera system	USB 3.0 CMOS camera with:	400 fps at 640x480 pixels 500 fps at 640x400 pixels 1000 fps at 640x200 pixels 2700 fps at 640x64 pixels
Optical system	Primary magnification (PMAG): Field of view:	5.3 to 64 times (manual focus with a 12-fold zoom lens) 75 x 56 µm to 910 x 680 µm ±5%
Measuring methods	Sessile drop	
Analysis methods	Contact angle: Surface free energy of solids:	θ/2 (height-width), Tangent, Curve fitting (ellipse, circle), Young-Laplace OWRK, Owens-Wendt, Kaelble-Uy, Kitazaki-Hata, Wu, acid-base, Zisman
Measuring range	0 to 180 ° (depending on the sample and environmental conditions)	
Display resolution	0.01 °	
Accuracy[1)]	0.05 °	
Sample stage size (WxD)	50 x 25mm	
Stage travel range	X-axis: Y-axis: Z-axis:	25 mm by manual micrometer 25 mm by manual micrometer 15 mm by manual micrometer
Approximately droplet size	Diameter: Volume:	above 40 µm 10 pl to 1 nL
Measuring temperature	Standard: Option:	Ambient Jacket type temperature-controlled (+10 to +60 °C)
Dimensions (WxDxH)	Main instrument: Controller rack: Installation area:	550 x 620 x 700 mm 420 x 320 x 323 mm 1000 x 650 x 720 mm
Approximately weight	Main instrument: Controller rack:	50.0 kg 15.0 kg
Utilities	Clean, dry, and oil-free pressurized air or N_2 gas at 0.4 to 0.7 MPa	
Power supply	AC 100 to 240 V, 5.0 A, 50/60 Hz	
Operating environment	Temperature: +10 to +35 °C, humidity: 30 to 80 %RH (non-condensing) Positioned away from sources of electrical noise and vibration	

[1)] Accuracy is the repeatability in terms of standard deviation based on the manufacturer's calibration standard.

Standard Components

- The main instrument is composed of horizontal & vertical camera assembly, LED light source, manual micro-positioning sample stage, micro-manipulator, micro-dispenser system, and control box
- Analysis software FAMAS
- Standard accessories: 2 sets of capillaries (25 pcs. each)
  1 droplet calibration standard for calibration and periodic inspections