Drop Shape Analytical System

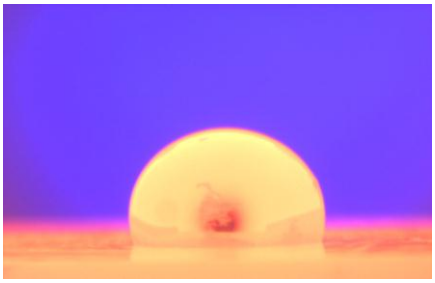
For ultra-high temperature measurement

Model SL200HT

- Interfacial chemical analytical system based on drop shape analysis in extreme conditions

SL200HT series is a drop shape analysis based surface chemical analytical system for extreme conditions such as temperature of 2000℃, specializing in measuring surface tension and contact angle under ultra-high temperature, applied in research of mineral, metallurgy, ceramic, enamel, welding, semi-conductor, glass, alloy and coal and more. The super high temperature furnace, professional optical imaging system and precision adjustable mechanics enable it perfect device for analyzing contact angle between melt and solid or surface/interface tension between melt and air/inert-gas.

Measurement of contact angle / surface tension under ultra-high temperature

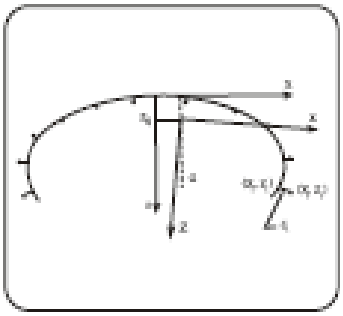


Contact angle, θ, is defined as the angle between tangent of gas-liquid interface and that of solid-liquid interface formed at the three phases' boundary where liquid, vapor and solid intersect.

1. Contact angle measurement: The melted drop is usually shaped into an approximate ellipsoid in 3D due to its gravity, hence we adopt Young-Laplace equation fitting technology（ADSA™）to fit its shape in 2D, and then calculate its contact angle between melted drop and solid..

2. Surface tension measurement for melt under high temperature: For melted sample in high temperature, its surface chemical properties can be characterized by its drop shape profile; hence we here analyze it using Young-Laplace equation fitting method (ADSA™) via sessile drop method; melt volume and surface tension of melt can be calculated then.

Young-Laplace equation and software CAST®3.0



First, single or several dynamic images of drop/bubble are captured for us to analyze its key information like drop shape edge and geometric dimension via sub-pixel image recognition technology; By inputting some important parameters like density, gravitational acceleration, magnification and others, we compare and fit the real drop shape profile with theoretical curve generated by sophisticated mathematical analytical models (such as circle, ellipse, polynomial, spline curve and especially Young-Laplace equation fitting) using least square method; and finally surface tension of liquid-gas, interface tension of liquid-liquid, contact angle of solid-gas/liquid-liquid-solid are calculated.

Our great achievement is: initiating ADSA based Young - Laplace equation fitting method and apply it into analysis of interfacial chemical properties after our 3 decades endeavor.

$$\gamma\left(\frac{1}{R_1}+\frac{1}{R_2}\right)=\Delta\rho\, gz+\frac{2\gamma}{b}$$

Applications

	Product Name	Applications
1	Metallurgy and Smelting plants	Analysis of surface tension and contact angle of melt (e.g. molten steel, liquid aluminum) under high temp. for better wetting and effective ash/slag removal
2	Welding	Analysis of contact angle between solder and welding body and surface tension of soldering flux
3	Alloy	Improve bonding degree between materials by analysis of their surface tension
4	Ceramics and Glass	The gradual change in shape from solid to liquid is observed; analysis of surface tension of melted ceramic and glass
5	Enamel	Analysis of wetting behavior of enamel to strengthen its intensity
6	Coal and Power	Analyzing surface tension of coal for better wetting and effective ash or slag removal
7	Test under extreme high temperature	Analysis of contact angle between melt and solid and dynamic surface tension of melt under different temperatures

International norms and standards

ASTM D 724: Standard Test Method for Surface Wettability of Paper (Angle-of-Contact Method)

ASTM D 5946-2004: Standard Test Method for Corona-Treated Polymer Films Using Water Contact Angle Measurements

ISO 15989: Plastics- Film and sheeting - Measurement of water - contact angle of corona-treated films

Features

1, High-temperature furnace-More professional and safety

→Furnaces of different temperatures (1200℃、1550℃、1750℃and 2200℃) are provided to meet special requirements under different ultra-high temperatures;

→Reachable highest temperature can be up to as high as 2200℃;

→Build in different ports in furnace such as gas connections for operating under different atmospheres like inert gas, vacuum connections for working under vacuum and cooling connections for cooling down the furnace;

→OTP (over-temperature protection) and OCP (over current protection) are provided;

→Multi-layers are designed for thermal insulation.

2, Mechanics-professional and easy to operate

→Mechanics of three-axis precision positioning stages for lens control provide you clearer imaging and more accurate imaging position;

→Lens tilt control and level control of furnace facilitate determining baseline between melt and solid;

→Uniquely designed sampling system with movable sample brackets for loading sample conveniently and easily.

3, Clearer and higher speed vision system

→Advanced drop shape profile lens ensures sharper imaging and clearer drop image edge;

→Continuous zoom industrial lens with magnification of 0.35 - 4.5X enables larger VOA, suitable for samples of varies volumes;

→Lens with long working distance (310mm) effectively protect vision system from high temperature;

→World highest speed camera from Germany can reach 87FPS (WVGA)-340FPS (GIF)

4, World Leading, More Powerful, Automatic and Ergonomic Analytical Software- CAST®3.0

- RealDrop™ method based on ADSA

(1) Wider fields of applications

It can be used to measure surface / interface tension and contact angle by sessile drop method and captive bubble method as well as surface / interface tension of liquid-gas / liquid-liquid by pendant drop method.

(2) Higher measurement accuracy

RealDrop™ method is quite different from select plane based Young-Laplace equation fitting method, which adopts AFLI and 4th generation RealDrop™ technology and achieves higher measurement accuracy without any experience calibration value.

(3) Unique interface tension measuring system of liquid-gas / liquid-liquid with Young-Laplace equation fitting method based on Bashford-Adams table, ADSA™ (Runge-Kutta arithmetic and Realdrop™ method) and capillary pressure method. It can be used for surface tension measurement of medium-high viscosity sample, dynamic surface / interface tension measurement of surfactant, and oscillating drop measurement.

(4) Powerful analytical functions

→Six drop shape states for analysis: sessile drop (liquid/gas, liquid/liquid/gas), pendant drop, captive drop, tilted plate and oscillated drop

→Seven methods to calculate contact angle and nearly 20 kinds of curve-fitting technologies:

-Exclusive methods of θ/2, circle fitting, ellipse fitting, RealDrop™, spline curve-fitting, Young-Laplace equation fitting, curve ruler (tangent method);

-Dynamic / static contact angle measurement

-20 exclusive curve ruler methods, such as circle, spline, Gaussian and power.

→ Twelve surface free energy calculating models, providing you more options to estimate surface free energy and its distributions.

Exclusively provided 12 methods for estimating surface free energy, e.g. Equation of State (Neumann et al.), Good-Girifalco, Owen-Wendt-Rabel, Simple Fowkes, Extended Fowkes, WU method 1-2, Schultz method 1-2, Acid-base (Van OSS & Good), Jhu, and Zizman Plot (critical surface tension) method, can be used to measure free energy and its distribution (dispersive force, polar force and hydrogen bond value, and Lewis acid-base, etc.) of low / high energy solid surface.

→ Unique technology of wetting behavior analysis (WBA / wetting envelopes).

A 2D map of wetting envelope can be constructed by analyzing components of surface free energy with corresponding method (such as OWEN), and a plot produces to show how wettability occurs. It is another way of understanding contact angle, hence degree of wetting from perspective of force existing in the material and between the materials to understand.

→ Unique video recording function. Measurement process can be recorded into AVI format for later use.

(5) Automatic, human-oriented and high-precision function design

→ Standardized windows technology based video capture technology with better compatibility.

The standardized design of video capture method with windows multimedia technology enables the compatible of various contact angle meters around the world. Just enjoy the convenience brought by CAST ®3.0.

→Real-time images analysis

It can be used to automatically analyse time-dependent interface tension/contact angle/volume/wetting line, and image is one-to-one correspondence with data for you to conveniently analyse measured value at any time.

→Auto base line detection and curved surface base line correction

Exclusive curve base line based circle- fitting or curve-fitting of unilateral arbitrary curve shapes with easier operation and achieving more accurate result.

→ Dual-Software Triggering Technology for analysis of complicated dynamic/static contact angles.

Unique dual-software triggering technology of CAST®3.0 can not only be applied to measure static contact angle but also advancing / receding contact angle, roll off angle, time-dependent (standard speed is 25 FPS,

and camera with higher speed are optional) contact angle and zero-time contact angle of ultra-water absorption material (e.g. powder, fiber, paper, and artificial periosteum). It is applied more extensively with better measured result.

→More comfortable software user interface:

- New-generation UI. Our software will implement measuring contact angle, surface free energy automatically at the touch of a finger according to wizard. Besides, with our 140-page user manual, you can operate the instrument easily without any professional training.
- Unicode based software interface. Its English user interface can easily be changed between different languages (such as Simplified-Chinese), which makes it more convenient to operate.

→ Full automatic analysis of contact angle, adhesive work and surface free energy:

- Fully automatic. Just press “Measure”, images capture, contact angles calculation, data storage and real-time measured value display will be done without manual operation.
- Manual modification function. Double-click ”Modify”, you can modify measured value by captured image, and software saves the record of operation trace conveniently to avoid errors of automatic measured values.
- Real-time graph. Left/right contact angle, average contact angle, adhesive work, surface free energy based on equation of state method can be real-time displayed without extra calculation.

(6) Powerful database management

→ Most comprehensive liquid database

We provide 300 kinds of liquid with 800 data values of liquid surface tension and its contributions as reference data or for faster analysis of surface free energy of solid.

→ Powerful database management for convenient storage, query, and export of data:

- Access database technology provides you more powerful functions
- Real-time saving and indexing of measured values
- One-to-one correspondence between measured data and image; corresponding drop image is automatically displayed when the data is selected
- Historical data query
- Modification of historical data
- Import and backup of historical data
- Database compression
- Measured data exportable.

→ All measured data can be exported into Excel file and image file into BMP file, which can be easily imported into scientific article and testing report.

USA KINO Industry Co., Ltd.

Technical Specifications

		SL200HT1	SL200HT2	SL200HT3	SL200HT4
					
Subject		～1200℃	～1550℃	～1750℃	～2200℃
High Temp. Furnace	Temp. Range	Ambient Temp.～1200℃	Ambient Temp.～1550℃	Ambient Temp.～1750℃	Ambient Temp.～2200℃
	Long-Term Operation Temp.	～1000℃	～1450℃	～1650℃	～2000℃
	Temp. Limited under Vacuum Atmosphere	1000℃	1200℃	1500℃	1800℃
	Thermocouple	K-type	S-type	B-type	infrared measurement/Tungsten rhenium
	Temp. Control Accuracy	±0.2%（full range）			
	Temp. Resolution	±1℃ for temp. above 1000 degree and ±0.1℃ for 1000 degree below			
	Protective Circuit	OTP(over-temperature protection) and OCP(over current protection)			

	Heater Material	Electric resistance wire	Platinum-rhodium wire	MoSi2 (protective gas is needed)	Graphite carbon tube (protective gas is needed)
	Sample tube material	Al_2O_3 with mullite preservation layer		l_2O_3 with mullite preservation layer	l_2O_3 with graphite felt preservation layer, insulating layer and cooling layer
	ID and Length of Sample Tube	Φ40mm*350mm			
	Maximum Sample Size	Φ6×8			
	Built-in Ports (accessories should be separate purchased)	inert-gas connections, vacuumizing connections (10^{-4}pa in general) and cooling connections			
	Power(KW)	2.KW/220V/50HZ	3.5.KW/220V/50HZ	3.5.KW/220V/50HZ	15.KW/380V/50HZ
	Cooling System (accessories should be separate purchased)	Circulating water			
	Level Adjustment Mechanics	Integral adjustment with sample brackets			
	Sampling Method	Movable sample brackets for conveniently sampling and loading, and corundum or Zr-Cr-Corundum sample stage for temp. below 1750℃			
Optical Vision System	XY-Axis	Manual, travel range: 50mm, accuracy 0.1mm;			
	Z-Axis	Manual, travel range: 25mm, accuracy 0.01mm;			
	Tilting of Camera Lens	Tilting stage with micrometer			
	Lens	Continuous zoom industrial lens of 6.5X			
	Cameras	High speed camera from Germany, WVGA format, 87(WVGA)-340(GIF)FPS			

	Light Source	brightness-adjustable background light
Software	✓ 5 drop shape state: Pendant drop , Sessile drop (liquid/gas, liquid/liquid/gas), Captive drop , Tilted Plate , and Oscillating drop.	
	✓ 7 methods to calculate contact angles: θ/2 (WH), circle fitting , ellipse fitting , RealDrop™ , curve ruler (tangent fitting), Spline curve-fitting , and Young-Laplace equation fitting (ADSA-P™), etc. ✓ surface tension calculation: 4th generation Young-Laplace equation fitting tech	
	✓ Data acquisition: combination of full-automatic measured values with manual modification. Just press "Measure", the software will complete the whole process of capturing, finding edge, finding sensitive spots, fitting the curve, calculating contact angle values, and displaying the calculation results without manual participation so as to reduce the effect of human factors.	
	✓ Contact angle measuring technology: mathematical model fitting and real-drop contour measurement solves the problem of measurement of asymmetric drop shape or drop without apex.	
	✓ Automatic curved surface base line modification: modification of upper convex surface, lower concave surface, and roughness of surface.	
	✓ Dynamic/static contact angle measurement: measuring advancing / receding contact angle and tilting & roll off contact angle.	
	✓ Image capture methods: single / continuous capturing with 25 FPS. Higher speed of 60 FPS, 100 FPS, or 1,000 FPS are optional available.	
	✓ Unique dual-software triggering technology: measurement of first-time-point contact angle for analyzing powder, paper and other hygroscopic materials; whole-process shooting of small degree contact angle measurement.	
	✓ Calculation and comparison of left and right contact angle values and calculation of their average values.	
	✓ Automatically generated curve graph: real-time observation of contact angle changes.	
	✓ Powerful database management : one-to-one correspondence of data and drop images; backup, compression, and export to EXCEL files; measured values and curve-fitting results can all be saved into exported pictures, visually and clearly.	
	✓ Video recording: recording visual images in AVI format and also for PPT file	
	✓ 12 kinds of surface energy estimation models: Exclusively providing 12 methods for estimating surface free energy, e.g. Equation of State (Neumann et al.), Good-Girifalco, Owen-Wendt-Rabel, Simple Fowkes, Extended Fowkes, WU method 1-2, Schultz method 1-2, Acid-base (Van OSS & Good), Jhu, Zhang, and Zizman Plot (critical surface tension) method, for measurement of free energy and its distribution (dispersive force, polar force and hydrogen	

	bond value, and Lewis acid-base, etc.) of low/high free energy solid surfaces.	
	✓ wetting behavior analysis (WBA -Wettability Envelopes)	
	✓ Drop volume analysis ✓ Auto detection of baseline	
General Specifications	**Measuring range of contact angles**	0 °＜θ＜180 °
	Resolution	0.01 °
	Accuracy	±1° (θ/2 method) / ±0.1 °circle fitting method
	Measuring range of interfacial tension	0.001-4000mN/m
	Measuring resolution of interfacial tension	0.001mN/m
	Measuring methods of interfacial tension	Young-Laplace equation fitting technology（4th generation）
	Dimension and weight	300Wx650Lx600Hmm 23-30kg
	Power supply	AC220V or 380V 50/60HZ

Special Statements

1.The above production pictures and technical specifications are subject to change without notice, and the latest confirmed product information shall prevail.