DYNE TESTING

Force Tensiometers

THE COMPLETE RANGE OF
DU NOÜY RING AND WILHELMY PLATE TENSIOMETERS

SIGMA 700/701

SIGMA 702/702ET

SIGMA 703D

BiolinScientific

Force Tensiometers measure surface tension, interfacial tension, critical micelle concentration, dynamic contact angle, surface free energy, powder wettability, sedimentation and density. They are used in research, development and quality control applications.

Applications

Force tensiometers enable precise characterization of a number of material properties. Analysis of surface/interfacial tension and contact angles provides valuable information on the interactions between gas, liquid and solid phases. These interactions play a key role in studying:

· WETTABILITY
· SORPTION
· FORMULATION
· SURFACTANT DEVELOPMENT
· ADHESION

Application examples

Force tensiometry provides information necessary for the control, development and modification of liquid and solid surfaces. A few application examples are given here.

Surfactants and surface tension

Surfactants are utilized in a wide range of products such as detergents, varnishes, inks, paints, food products, adhesives and cosmetic lotions to improve wettability and stabilize emulsions. Force tensiometry is a versatile technique for surfactant development and formulation enabling surface and interfacial tension measurements as well as fully automated critical micelle concentration (CMC) measurement.

Wettability of plates and fibers

Wettability is the ability of a solid surface to maintain contact with a liquid. Some applications such as the development of water repellent materials may require minimizing wettability, while in other cases one may benefit from maximizing it, for instance hair wettability with shampoos. Sigma Force Tensiometers is a convenient method to study dynamic contact angles and wettability of single fibers and plates using the Wilhelmy technique.

Powder wettability

Pigments need to form a stable and homogeneous dispersion with a medium, and thus wettability of pigment powders is of great interest in paint and ink formulation. Attension Sigma 700/701 enables investigation of pigment sorption properties and contact angle determination according to the Washburn equation.

Transformer oil quality control

Oil-water interfacial tension is well-known to correlate with purity and functionality of oils which are used in transformers for cooling, insulation and protection against arcing. Electrical stress and contamination may modify the oil performance and Sigma 702ET is used to control the oil quality according to ASTM D971 standard.

Measurements

Sigma Force Tensiometers can measure:

· SURFACE TENSION
· INTERFACIAL TENSION
· CRITICAL MICELLE CONCENTRATION
· DYNAMIC CONTACT ANGLE
· SURFACE FREE ENERGY
· POWDER WETTABILITY
· SEDIMENTATION
· DENSITY

Key concepts

Surface tension, γ

A molecule in the bulk of a liquid experiences equally attractive forces in all directions, but at the surface there are more attractive forces in the direction of the bulk than away from it. This reduced attraction at the liquid-gas boundary gives rise to the measurable property of surface tension. At the liquid-liquid phase boundary, it is referred to *interfacial tension*.

Contact angle, θ

Contact angle is a measure of the wetting of a solid by a liquid. Interactions between the liquid and solid can be attractive or repulsive. When attracted by the solid, the liquid forms a low contact angles ($\theta < 90°$). If repelled, the contact angles are high ($\theta > 90°$).

Technology

The basic principle of every Sigma measurement is to record and analyse the forces exerted onto a probe or solid sample using a sensitive microbalance.

Surface tension

When a solid touches the surface of a liquid, the liquid tends to be drawn up in a meniscus. This meniscus creates forces on the solid that are correlated to the surface tension. Using probes that completely wet such as a platinum Du Noüy ring or Wilhelmy plate simplifies the calculations and enables Sigma Force Tensiometers to precisely measure surface and interfacial tension.

Correction calculations for rings are made using models from Huh and Mason (Zuidema & Waters can also be available).

Critical Micelle Concentration (CMC) is determined by measuring surface tension of a solution at different concentrations. CMC is the concentration at which the surface tension becomes independant of surfactant concentration.

SURFACE TENSION | *A paper clip maintained at the air-water interface thanks to the surface tension of the liquid while the buoyancy laws would predict otherwise.*

Contact angle

Dynamic contact angles are measured by dipping (advancing contact angle) and withdrawing (receding contact angle) a solid sample into the liquid sample. The forces exerted by the liquid onto the sample are recorded and used to calculate the advancing and receding contact angles. The samples must have uniform size and surface properties (examples: single fiber, sensor plate, metal rod).

By measuring contact angles with different liquids, the *surface free energy* of the solid can be defined.

Powder wettability

A container filled in with powder (or a fiber bundle) is lowered to the liquid level. The instrument monitors the mass change while the liquid wets the powder.

Sedimentation

A sedimentation probe is hung from the Sigma microbalance. The instrument records the mass of the sediment collected in the probe over time. Particles downward movement due to gravity can be studied.

Density

The density probe is pushed through the liquid surface. The forces exerted on the probe are used to calculate the liquid density.

For demonstration videos of those measurements and additional information, please visit the Sigma 700/701 tensiometer webpage at **www.dynetesting.com**

A few of our customers

Universities

MASSACHUSETTS Institute of Technology
University of California, BERKELEY
University of CAMBRIDGE
HARVARD University
University of TORONTO
YALE University
University of BRITISH COLUMBIA
MCGILL University
University of CALIFORNIA, San Diego
SEOUL National University
UPPSALA University
TOHOKU University
Hebrew University of JERUSALEM
STONY BROOK University
University of HELSINKI
DELFT University of Technology
CHALMERS University of Technology
UCL (University College London)
University of BARCELONA
University of AARHUS
Katholieke Universiteit LEUVEN
NANJING University
KTH, ROYAL Institute of Technology

Companies and research institutes

3M
Akzo Nobel
Amgen
Avery Dennison
BASF
Canon
Dow Corning
Eastman Kodak
E. I. Du Pont De Nemours & Company
ExxonMobil
FujiFilm
Hewlett Packard
IBM
INRA
Johnson & Johnson
Lexmark
Medtronic
Monsanto Company
NASA Langley Research Center
Nissan
Nokia
Novo Nordisk
NTT
Omron
Petrobras
Randox laboratories
Rhodia
Ricoh
Rohm and Haas
Samsung
Sandvik
Seksui Chemical
Statoil
VWR International

Product range

Sigma Force Tensiometers are precision instruments with unparalleled ease of use. They all feature high precision microbalance and mechanics, intuitive software and open design for easy access to the different parts of the instrument. All instruments come with Software including all functionalities.

Sigma 700/701 Force Tensiometer

Sigma 700 and Sigma 701 are state-of-the-art force tensiometers able to perform a wide range of measurements and adapt to a great variety of experimental settings. This versatility makes them suitable for research, development, industrial quality control and educational use.

The highly sensitive Sigma 700/701 provides precise surface and interfacial tension measurements (Platinum Du Noüy ring, Platinum Wilhelmy Plate, Platinum rod). It allows fully automatic critical micelle concentration determination. It can also measure dynamic contact angle (small solid sample, fibers etc.), surface free energy, powder wettability, sedimentation and density.

The Sigma 700/701 is computer controlled and operated via the OneAttension Software. It provides unparalleled automation, live measurement capability, multiple measurement options as well as a logical and friendly user interface with no equivalent on the market. Please read the dedicated Software section on page 6 for a complete description.

Sigma 700 allows a microbalance maximum load of 210 g and the Sigma 701 of 5 g. This makes Sigma 700 an instrument of choice for powder wettability as well as for dynamic contact angle measurements with heavy samples. Sigma 701 can measure with improved sensitivity, optimized for dynamic contact angle measurement with a single fiber.

Sigma 700/701 accessories

Probes and related accessories *such as Platinum Du Noüy ring, Platinum Wilhelmy Plate, Platinum rod (for low volume samples), Density probe, Sedimentation probe, calibration tools and ring re-form tool. Temperature and pH probes are also available.*

Sample holders *for plates, fibers and powders.*

Thermostatic vessels *for temperature control of the liquid sample are available (from -20°C up to 200°C). A gas phase temperature controller can also be used for regulation of the air temperature during measurement.*

Automatic liquid dispensers *for fully automated critical micelle concentration measurements.*

Active vibration isolation system and cabinet *to eliminate disturbing vibrations caused by motors, traffic, air conditioning systems, etc.*

Other accessories such as magnetic stirrer and vessels are also available.

For complete accessory descriptions, please visit the Sigma 700/701 product page at www.dynetesting.com

SIGMA 700/701

Sigma 702/702ET Force Tensiometer

Sigma 702 and Sigma 702ET are standalone force tensiometers offering accurate surface and interfacial tension measurements, as well as manual CMC determination (Platinum Du Noüy ring, Platinum Wilhelmy Plate). Density can also be measured.

The open design and convenient control keyboard operations make Sigma 702/702ET extremely easy to use with no need for an external computer.

Results are displayed on a large integrated digital screen. The instrument can be connected to an external PC for additional data storage and simple reporting. Data receiver Software is provided with the instrument. A printer allows direct connection to your Sigma 702/702ET for simple data printing.

Sigma 702 allows precise temperature control via its integrated water-jacket vessel holder which is directly mounted on the motorized sample stage.

Sigma 702ET is specifically designed for oil-water interfacial tension measurements in line with the ASTM D971 standard. The embedded Software provided with the Sigma 702ET is specifically designed for oil-water measurements.

Accessories include a thermostatic vessel (already included with Sigma 702), a thermometer and a gas phase temperature controller to control sample temperature. Glass vessels, Platinum Du Noüy ring, Platinum Wilhelmy Plate, Density probe, calibration tools and ring re-form tool are also available.

For complete accessory descriptions, please visit the Sigma 702/702ET product page at www.dynetesting.com

Sigma 703D Force Tensiometer

Sigma 703D is a simple standalone and robust digital force tensiometer for accurate measurement of surface and interfacial tension (Platinum Du Noüy ring, Platinum Wilhelmy Plate). Manual CMC measurements can also be conducted.

The open design and convenient control keyboard operations make Sigma 703D extremely easy to use with no need for an external computer. Measurements are displayed in real-time on the large digital screen integrated into the instrument and can be transferred to a computer using the Data receiver software.

Equipped with a manual sample stage, Sigma 703D is meant for easy and quick standalone operations.

Accessories include a thermostatic vessel, a thermometer and a gas phase temperature controller to control sample temperature. Glass vessels, Platinum Du Noüy ring, Platinum Wilhelmy Plate, Density probe, calibration tools and ring re-form tool are also available. A printer allows direct connection to your Sigma 703D for simple data printing.

For complete accessory descriptions, please visit the Sigma 703D product page at www.dynetesting.com

SIGMA 702/702ET

SIGMA 703D

OneAttension Software

The OneAttension Software provides unrivalled performance and ease of use to all computer controlled Attension tensiometers. It features:

Recipe manager: *default recipes include pre-defined experimental parameters for standard measurements, saving time at start-up. The user can decide to create custom recipes to match his/her needs. Recipes can be stored for further use for quick and repeatable operations.*

Live analysis: *the measurement data is plotted and analyzed in real time enabling easy monitoring of results (deeper analysis can be performed off line when required).*

Best-in-class user interface: *the simple and logical Software inter-face allows efficient and convenient operations, leading to easy familiarization and time savings.*

Flexible data handling: *any groups of data points can be selected, plotted and analyzed. Data can be assigned to any axis and be transformed into logarithmic scale.*

Data export: *measurement results are exported to an Excel, CSV or other file formats in a few clicks.*

User manager: *set the desired level of privacy on experiment recipes and measurement results.*

Flexible software platform: *easy implementation of customized features and functionalities.*

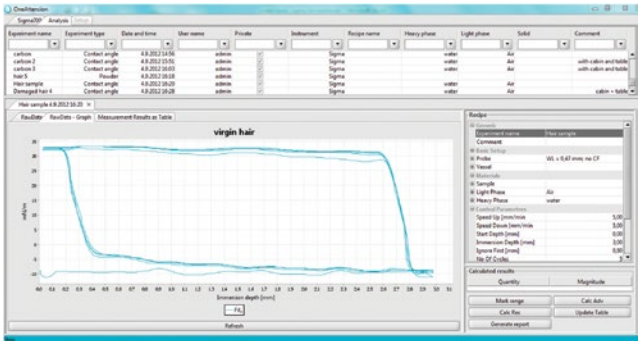
OneAttension for Sigma 700/701 Force Tensiometers:

Programmable and automated operations: *immersions and withdrawal cycle(s) of probes and samples are programmable. Experimental parameters such as the used liquid and solid, temperature or sample concentration (during CMC measurement) can also be controlled. Automation prevents user dependant variation. Carrying out long measurements without operator intervention saves time and free the user to concentrate on other tasks.*

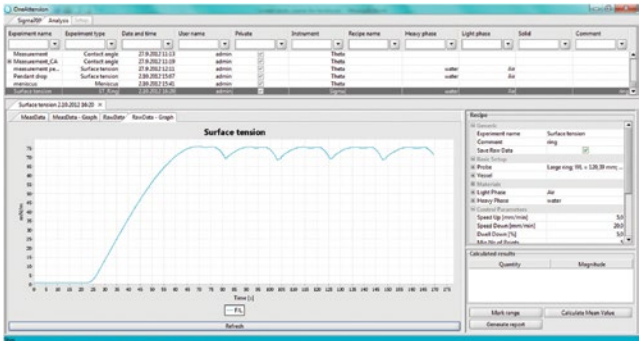
Performance: *when measuring surface tension, all data points are recorded enabling full understanding of the phenomena. The mass curve is also displayed and saved together with the surface tension values for additional insight.*

Ease of use: *simple step-by-step protocols make data recording and analysis extremely easy and logical.*

Compatibility: *OneAttension is also compatible with older Atten-sion Force Tensiometers such as Sigma 70. Contact your closest Attension representative to upgrade your Software.*



OneAttension software:
contact angle measurement



OneAttension software:
easy and powerful data handling and plotting

Available measurement methods:

Surface tension
Surface tension measurement with ring, plate or rod

CMC
Critical micelle concentration measurement

DCA
Dynamic contact angle measurement (advancing/receding)

Powder wettability
Wettability of a powder by the Washburn method

Density
Liquid density measurement

Sedimentation
Measure sedimentation kinetics

Specifications

The main specifications of Sigma Force Tensiometers are listed in the table below. For all additional questions, please contact your nearest Attension representative which can be found from our website www.dynetesting.com

	SIGMA 700	SIGMA 701	SIGMA 702	SIGMA 702ET	SIGMA 703D
Available Measurements					
Surface tension	•	•	•	•	•
Interfacial tension	•	•	•	•	•
Critical micelle concentration	Automatic	Automatic	Manual	Manual	Manual
Dynamic contact angle	•	•	–	–	–
Surface free energy Powder	•	•	–	–	–
wettability	•	•	–	–	–
Density	•	•	•	•	•
Sedimentation	•	•	–	–	–
Balance Specifications					
Measuring range (mN/m)	1...2000	1...1000	1...1000	1...1000	1...1000
Displayed resolution (mN/m)	0.001	0.001	0.01	0.01	0.01
Density range (g/cm³)	0...2.2	0...2.2	0...2.2	0...2.2	0...2.2
Density resolution (g/cm³)	0.0001	0.0001	0.0001	0.0001	0.0001
Maximum load (g) Weighing	210	5	5	5	5
resolution (mg) Force	0.01	0.005	0.01	0.01	0.01
resolution (µN) Contact	0.1	0.05	0.1	0.1	0.1
angle range Contact angle	0...180°	0...180°	–	–	–
resolution Calibration &	0.01°	0.01°	–	–	–
locking	Automatic	Manual	Manual	Manual	Manual
Measuring Unit Specifications					
Sample stage	Motorized	Motorized	Motorized	Motorized	Manual
Sample stage speed (mm/min)	0.01...500	0.01...500	0.01...500	0.01...500	–
Stage movement range (mm)	0...75	0...75	0...75	0...75	–
Stage positioning resolution (µm)	0.016	0.016	0.26	0.26	–
Dimensions (cm)	L 33.3 * W 24.4 * H	L 33.3 * W 24.4 * H	L 33.3 * W 24.4 * H	L 33.3 * W 24.4 * H	L 27.5 * W 15.5 * H
Weight (kg)	18.3	17	10.7	10.7	3.2
Power supply (VAC)	85...264	85...264	85...264	85...264	100...240
Power consumption (W)	13	13	13	13	7
Frequency (Hz)	47...440	47...440	47...440	47...440	50...60
Common Accessories					
Temperature control mechanism	Range of water bath accessories	Range of water bath accessories	Built-in thermo-static vessel for water bath	Thermo-static vessel for water bath	Range of water bath accessories
Temperature control range (°C)	-20...+200	-20...+200	-10...+100	-10...+100	-10...+100
Stirrer	•	•	–	–	–
Software					
	OneAttension	OneAttension	Data receiver	Data receiver	Data receiver
System requirements					
Recommended system requirements	1 GHZ processor, 1 GB RAM, 40 GB hard disk drive (20 GB free), 1 USB port Accessories such as water bath and liquid dispenser may require a free RS-232 port Windows 7				
Operating system requirements	& 8 (32 or 64 bit), Windows Vista (32 bit), Windows XP SP3 (32 bit)				

•: available –: not available/not applicable

Services

Attension offers a range of services to assist you throughout the lifecycle of your instrument:

Pre-testing: *Attension can conduct pre-studies to ensure the most suitable instrument is selected for your application.*

Installation and user training: *installation and user training can be performed at your site. Additional training can be provided at anytime at your research location or at any one of our Attension Laboratories.*

Maintenance and repairs: *Attension understands the importance of your research and we are committed to insuring that your instrument is running at its optimal performance level. With an Attension service plan you can be proactive and choose when your service takes place. This will insure your laboratory runs at its peak efficiency and the investment in your instrument will be maximized by extending its lifetime. Separate repair services are also available.*

Other Attension Tensiometers

Optical Tensiometers for static contact angle, dynamic contact angle, surface free energy and surface/interfacial tension measurements. Attension Theta Optical Tensiometers can also measure interfacial rheology.

For more information on Attension Tensiometers please contact your Attension representative or read the product brochures available from our website **www.dynetesting.com**

Availability

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