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**Technical Specification : System for Measuring Interfacial Rheology
using Oscillating Drop Technique**

Technical Specifications:

1. Oscillation of Droplet / Bubbles
 - a. Piezoelectric Technology
 - i. Accuracy of Travel Range: Better than 0.01 μm
 - ii. Minimum Oscillation volume: 0.01 μL
 - iii. Frequency: 10 Hz (open loop)
 - b. Camera
 - i. USB 3.0 port
 - ii. Pixel size: better than 4.8 μm per pixel
 - iii. Maximum frame rate: at least 500 fps (full frame); 1000 fps with ROI
 - c. Tele - centric optic with 20x magnification
 - d. Backlight: one cold backlight system with adjustable intensity and very high contrast
 - i. Minimum 10 years of lifetime
 - e. Syringe:
 - i. 1 ml glass borosilicate air-tight syringe
 - f. Strain gauge for 10 Hz (closed-loop) including calibration certificate
 - i. Continuous peak o/p current ± 36 mA
 - ii. Gain 20V/V
 - iii. Gain error $\pm 1\%$
 - g. Software:
 - i. Dynamic display of droplet volume (0.01 μL), area of the drop

- ii. Focus assistance for sharp images
- iii. Digital zoom x9 for steady frames
- iv. Interfacial tension by Young-Laplace algorithm and DS/DE algorithm
- v. Values displayed: volume, area and interfacial tension and their variation with time and frequency
- vi. Curves display: interfacial tension, time and area
- vii. Data results: initial surface tension before oscillation, interfacial tension averaged over whole experiment, frequency, pressure of the experiment, phase shift, algorithm for surface tension ISO 19403, area, phase shift, amplitude, total harmonic distortion, complex dilatational viscoelasticity, E' and E''
- viii. Accuracy of interfacial tension in full frame mode: ± 0.1 mN/m
- ix. Accuracy of area in full frame mode: ± 6 μm^2
- x. Accuracy of complex dilatational viscoelasticity: ± 0.1 mN/m
- xi. Export of data to excel
- xii. Statistical analysis

2. High pressure chamber

- a. Black anodised aluminium
- b. Halar treated aluminium
- c. Dimension 50 mm x 50 mm
- d. Heating
 - i. Resistance heating wire of Nickel-Chromium Alloy surrounding the all the chamber for better homogeneity
 - ii. Temperature control: up to 200°C
 - iii. Accuracy of 0.1°C using PID regulator with auto cooling
 - iv. Temperature colour display
 - v. K-type thermocouple
- e. Viewing Glasses
 - i. Should withstand greater than 10 bar pressure
- f. Over pressure control
 - i. Using back-relief valve
- g. Pressure measurement
 - i. 5 points of calibration included for the pressure sensor

- ii. Up to at least 10 bar
 - iii. Accuracy $\pm 0.25\%$ of full scale
 - iv. Should withstand and be stable at 200 °C
 - h. Inlet and Outlet with manual valve to release the internal pressure
 - i. Should work with low density / high density and high density / low density interfaces
 - j. Should work with captive bubble
 - k. Manual up/down movement of table for adjusting positioning of the chamber
3. Cables
- a. 1 USB cable for camera
 - b. 1 USB cable to control instrument from computer
 - c. 1 power supply cable for power supply; adjustable from 90V to 240V
4. Contact Angle and Surface Tension Measurement:
- a. Automatic dispenser
 - i. Accuracy: $\pm 0.1 \mu\text{L}$
 - ii. Can be used with system syringe, and Hamilton syringe or plastic syringe
 - iii. Fully controlled from computer
 - iv. Supplied with 1 plastic gas tight syringe
 - v. Minimum volume: $0.3 \mu\text{L}$ with needle of 0.8 mm diameter
 - vi. Maximum volume: $20 \mu\text{L}$
 - vii. Dispensing speed: from $0.1 \mu\text{L/s}$ to $20 \mu\text{L/s}$
 - viii. Should allow measurement of advancing and receding contact angle
 - ix. Should allow dynamic measurement and analysis of contact angle versus time, height, volume and area of droplets, independently and simultaneously
 - x. Condition of auto-stop
 - xi. Determination of equilibration time
 - xii. Disposable lines and low dead volume ($4 \mu\text{L}$) lines to be supplied
 - xiii. Can work with interfacial rheology of lower than 0.1 Hz
 - b. Table for automatic deposition of droplet on surface

- i. Automatic movement of table
 - ii. Span of movement at least 120 mm
 - iii. Smart movement of the table (movement depending on the energy of solid-liquid interaction)
 - iv. Maximum height to be set by user
 - c. Temperature control chamber
 - i. Range from RT up to + 90 °C
 - ii. Size 50 mm x 50 mm
 - iii. Walls isolated in temperature
 - iv. Needle input isolated
 - v. 2 glass windows
 - Software for Contact angle determination
 - vi. Sessile drop method using polynomial
 - vii. Manual adjustment of baseline for flat or curved surfaces, etc.
 - d. Range of contact angle from 1 to 180° with accuracy of $\pm 0.1^\circ$ at equilibrium
 - e. Range of surface / interfacial tension from 0.01 to 1000 mN/m with resolution of ± 0.1 mN/m
 - f. Software for Measurement of Surface/Interfacial Tension
 - i. Sessile drop method,
 - ii. Determination of polar and dispersive components of liquids
 - iii. Determination of acid and base components
 - iv. Surface tension versus temperature
 - v. Surface tension measurement by Owens-Wendt, van Oss equation, etc.
 - vi. Critical surface energy by Zisman and modified Zisman equation, Fowks equation, etc.
 - vii. Statistical analysis of data
 - viii. Bibliographic data of surface tension and surface energies of different liquids and surfaces
- 5. Suitable desktops each for Oscillating Drop System and Automatic Drop Dispenser
- 6. Three year warranty from the date of successful installation / commissioning of equipment. (parts, labour and trip)