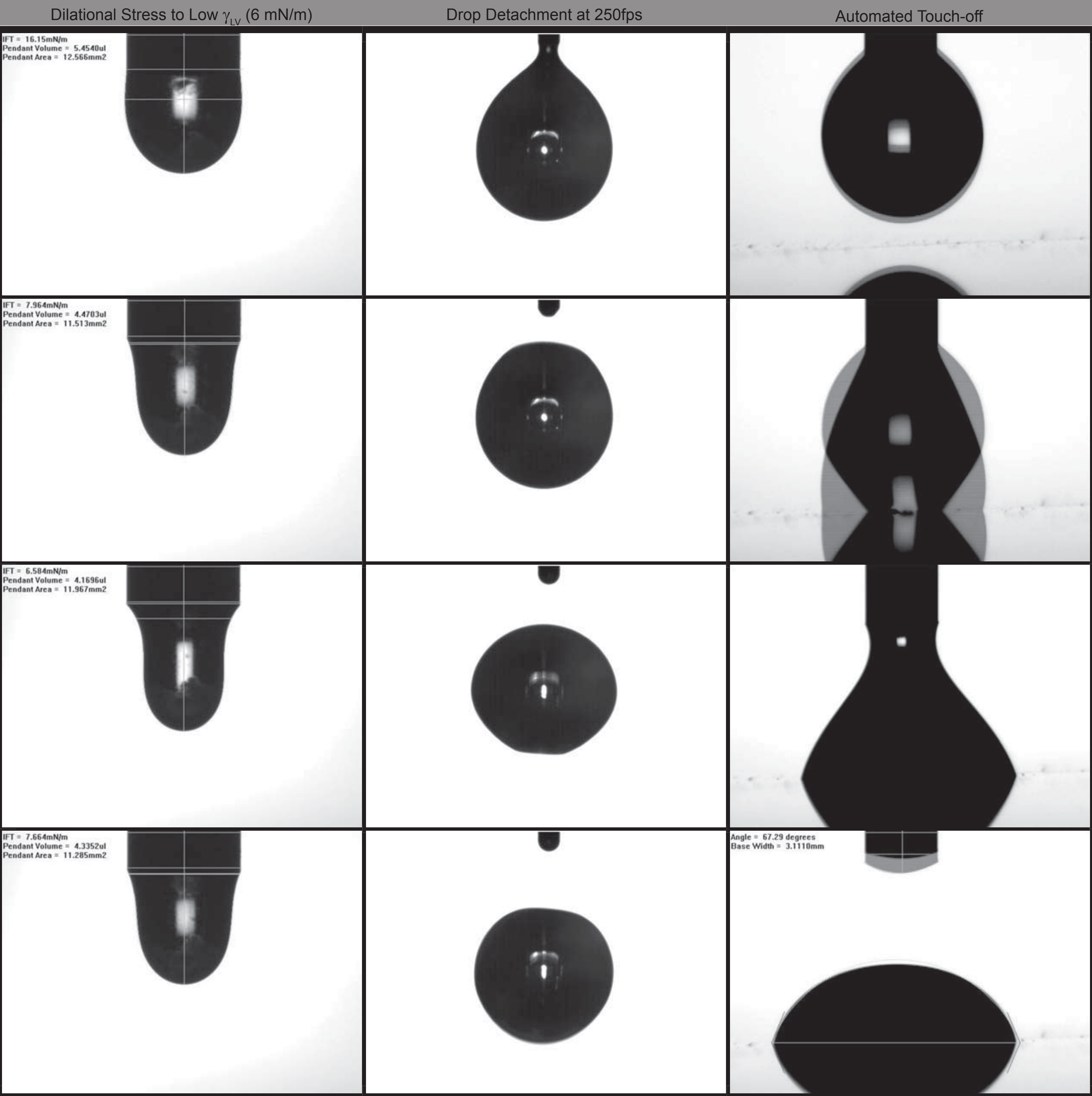
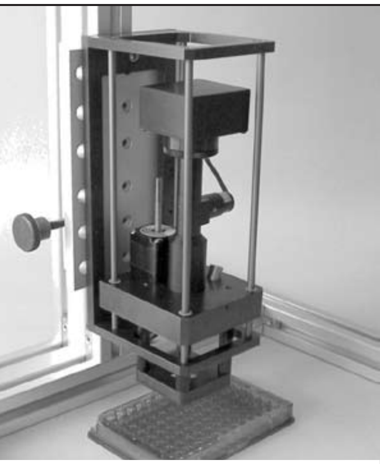
First Ten Ångstroms™



Surface Science Instruments with Real Vision™

Product Line



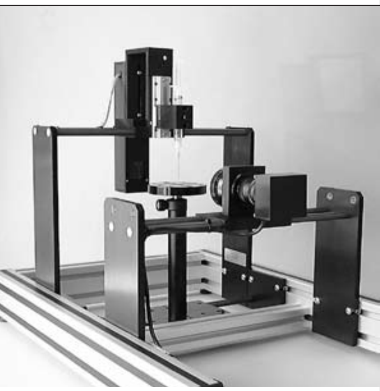
FTA1000 A Class

Special Purpose Dispense and Measurement Heads

□ compact, modular, self-contained instruments
□ mix-and-match controller, pumps, and heads
□ heads can be located remotely on robotics
□ provide contact angles and / or precision dispense
□ all use small microscopes and cameras to verify dispense

□ precision dispense of high-value picoliter and nanoliter drops
□ jetting of heated polymers and solders
□ top view contact angles for wells and low-angle surfaces
□ classic side view contact angles

□ OEM friendly (incorporate into your system)
□ self-contained microprocessor: no host computer required
□ built-in LCD and keypad
□ supports local VGA, touchscreen, keyboard, mouse
□ browser interface over Ethernet LAN or Internet



FTA1000 B Class

Economical Drop Shape Instruments

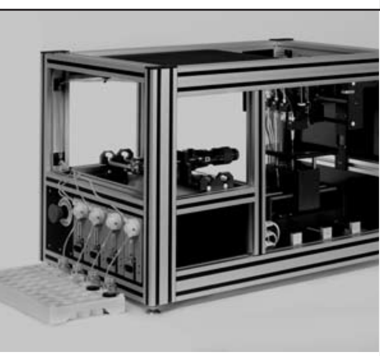
□ expandable, upgradeable instruments
□ contact angle and surface tension measurements

□ user-swappable modules for entire electronics chain
□ plug and play determination of options present
□ excellent for QA and factory floor use
□ some systems can be powered by laptop

To design your instrument:
1 choose stage and / or chamber
2 choose camera + microscope + backlight combination
3 choose dispense pump + tip Z control

□ 36 page catalog available to explain all options, or
□ let your distributor or FTA recommend a configuration
□ pre-configured *student* edition in stock for immediate delivery

□ Vista® compatible when Firewire camera chosen
□ can use most FTA200 stages and chambers
□ instrument tilt stage available



FTA1000 C Class

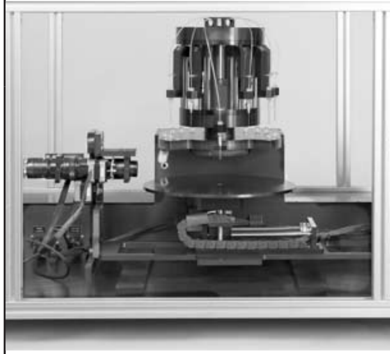
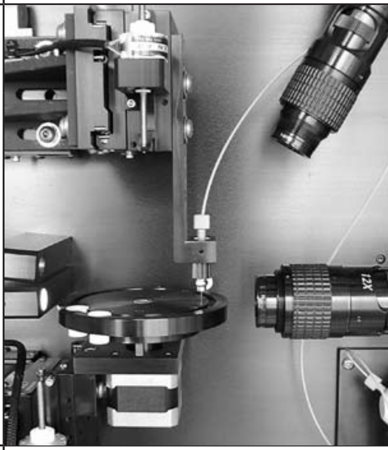
General Purpose Laboratory Drop Shape Instruments

□ top-of-the-line general purpose laboratory instrument
□ very wide range of modules available
□ all modules user-installable
□ variety of additional stages and chambers planned for future

To design your instrument:
1 choose stage and / or chamber
2 choose camera + microscope + backlight combination
3 choose dispense pump + tip Z control
steps 1-3 just like a B frame...
4 optionally add an autosampler
5 optionally add a lookdown camera for locating drop on sample

□ 1 and 4 pump options
□ heated syringes possible

□ all the flexibility of the B frame and more
□ designed to be run by automation *one-click* scripts
□ autosampler can support tip changer
□ fixed mag, detented mag, and autozoom microscope options
□ can interface to external hosts for robotic sample handler control

DCA-100 Contact Angle Tensiometer	□ economical force balance tensiometer □ meets ASTM and DIN measurement standards □ choice of 100µg or 1µg sensitivities □ 100µg is robust and satisfactory for ring and plate IFT □ 1µg provides sensitivity for 10µm fiber contact angles □ advancing / receding contact angles by Wilhelmy immersion □ calculates surface energies from contact angles □ surface and interfacial tensions: liquid-vapor or liquid-liquid □ ring or plate methods □ critical micelle determination □ temperature probe for liquid □ density measurement □ disposable paper plates for liquid-vapor surface tension □ rod method for liquid-vapor surface tension	
FTA2000 Wafer Analyzer	□ 300mm wafer capable platter □ can handle smaller wafers □ can handle rectangular samples that fit within 300mm circle □ contact angle and surface tension analysis □ platter and camera tilt through 90° for receding angle analysis □ 6 tip, 17 liquid vial, autosampler □ tip changer option available □ fully enclosed □ clean room compatible □ temperature stabilized to 40C □ autofocus, autozoom microscope □ adjustable lookdown angle □ script programmable for unattended operation □ macros to automate drop formation and baseline determination □ host computer interface to coordinate sample loading □ SECS interface available	
FTA4000 Small Drop Contact Angle Analyzer	□ piezo-electric jetting for picoliter drops □ jetted volumes down to 20 picoliters □ can also form classical pendant drops up to µl volumes □ automated touch-off for classical drops □ dip-and-sip for low volume pump prime □ two camera design: horizontal analytical and lookdown locator □ zoom microscopes on both axes □ all optics mount on single surface plate for stability □ two halogen illuminators adjustable for best image contrast □ enclosed cabinet for stability □ X-Y-Z-θ automated specimen stage □ special analysis software for rapid absorption work	
Legacy Instruments	The following instruments have been replaced by the FTA1000: FTA125, FTA135, FTA136, FTA137, FTA188, FTA200 If you need one of these units, say to match a setup at another facility, they can be obtained by special order. There will be a lead time and the price will reflect a custom order charge.	

Useful Formulas

Young's Equation
Contact angle of liquid on surface
Also, the force balance on a spherical sessile drop

$\gamma_{SV} - \gamma_{SL} = \gamma_{LV} \cos\theta$

γ_{SV} = solid vapor IFT (aka *surface energy* of solid)
γ_{SL} = solid liquid IFT (IFT = interfacial tension)
γ_{LV} = liquid vapor IFT (aka *surface tension* of liquid)
θ = contact angle of drop (angle in liquid at three-phase line)

Laplace Pressure across Curved Surface

$\Delta P = \gamma_{LV} (1/R_1 + 1/R_2)$

ΔP = $\perp$ pressure differential across interface
R_1, R_2 = principal radii of curvature of interface at $\perp$ point
for sphere, $R_1 = R_2$ = radius of sphere

Spherical Drop Geometry

$\theta = 2 \arctan(2h / d)$

h = height of drop
d = diameter of drop's wetted surface on solid
θ = contact angle of drop

Laplace-Young Equation
IFT of liquid-vapor (γ_{LV}) or liquid-liquid (γ_{LL}) interface

$mgh = \Delta P = \gamma_{LV} (1/R_1 + 1/R_2)$

m = density differential across interface
g = acceleration of gravity
h = vertical position with drop, measured from apex

Force on Wilhelmy Plate

$F = L \gamma_{LV} \cos\theta$

F = force on plate
L = wetted perimeter length

Force - Mass (Weight) Relationship

F = mg

F = force (in Newtons) measured by balance
m = mass (in kilograms)
g = acceleration of gravity, nominally $9.8 m/s^2$
e.g. 1 gram mass $\rightarrow$ 9.8 milli Newton force

Basic Statistics

$\mu = \Sigma x_i / n$
$\sigma = \sqrt{\{ 1/(n-1)\ \Sigma(x_i - \mu)^2 \}}$
$COV = \sigma / \mu$

n = number of items
i = index of item (for summations)
x_i = value of i^{th} item
μ = mean value (aka *average*) of set
σ = standard deviation of set
COV = coefficient of variance

Hook's Law and Dilational Stress

$\tau = G \gamma$
$\tau(t) = G(t)\ \gamma(t)$
$G' = \tau_0 \cos(\phi) / \gamma_0$
$G'' = \tau_0 \sin(\phi) / \gamma_0$
$\eta' = G'' / \omega$
$\eta'' = G' / \omega$

τ = stress, or force per unit area
$\tau(t)$ = time varying stress, typically $\tau_0 \sin(\omega t)$
G, G(t) = elastic modulus
γ = strain, relative change in length (or shape)
$\gamma(t)$ = time varying strain, typically $\gamma_0 \sin(\omega t + \phi)$
G' = in-phase *elastic* modulus
G'' = out-of-phase *viscous* modulus
η' = dynamic viscosity
η'' = dynamic elasticity

Wetting Tension
Characterizes solid surface by RHS of Young's equation:

$WT = \gamma_{LV} \cos\theta$

Note this varies from $-\gamma_{LV}$ (at 180°) to $+\gamma_{LV}$ (at 0°)

Zisman's Critical Wetting Tension

Critical Wetting Tension (CWT) is defined as intersection of IFT-cos θ plot line with cos 0° (IFT on X axis, cos θ on Y). IFT at this point is CWT. Experimentally it is found CWT $\approx \gamma_{SV}$.

Girifalco-Good-Fowkes-Young Rule
Uses the combining rule $\gamma_{SL} = (\sqrt{\gamma_{SV}} - \sqrt{\gamma_{LV}})^2$

$1 + \cos\theta = 2\sqrt{(\gamma_{SV} / \gamma_{LV})} - \pi / \gamma_{LV}$

π = spreading pressure (often ≈ 0)

Owens-Wendt Geometric Mean Mean

$(1 + \cos\theta)\ \gamma_{LV} = 2\sqrt{(\gamma^D_{SV}\ \gamma^D_{LV})} + 2\sqrt{(\gamma^P_{SV}\ \gamma^P_{LV})}$

D superscript indicates dispersive and P polar component

Wu's Harmonic Mean Rule

$(1 + \cos\theta)\ \gamma_{LV} = 4\{\gamma^D_{SV}\gamma^D_{LV} / (\gamma^D_{SV} + \gamma^D_{LV}) + \gamma^P_{SV}\gamma^P_{LV} / (\gamma^P_{SV} + \gamma^P_{LV})\}$

Lewis Acid / Base Rule

$(1 + \cos\theta)\ \gamma_{LV} = 2\sqrt{(\gamma^D_{SV}\ \gamma^D_{LV})} + 2\sqrt{(\gamma^A_{SV}\ \gamma^B_{LV})} + 2\sqrt{(\gamma^B_{SV}\ \gamma^A_{LV})}$

A superscript indicates acid and B base component

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