SFA 2000 & μSFA

SurForce LLC

A sophisticated research instrument for directly measuring static and dynamic forces between surfaces (inorganic, organic, metal, oxide, polymer, glasses, biological, etc.) and for studying interfacial and thin film phenomena at the molecular level. Modular design allows for expansion with numerous attachments and customized upgrades (see page 3).

The SFA 2000 Basic System

designed by Jacob Israelachvili

APPLICATIONS

Research areas and types of interactions that can be directly measured *

- Dispersion science – "colloidal" forces between surfaces in liquids and controlled vapors
- Adhesion science – long-range colloidal forces and short-range adhesion forces
- Surface chemistry – surface and electrochemical interactions between dissimilar materials
- Detergency, food research – forces between surfactant and lipid monolayers and bilayers
- Biomaterials and biosurfaces – forces between protein and polymer-coated surfaces
- Biomedical interactions – ligand-receptor, protein and model biomembrane interactions
- Tribology – friction, lubrication and wear of smooth or rough surfaces, thin film rheology
- Powder technology – capillary effects and surface deformations during interactions
- Materials research – mechanical and failure properties of metal and oxide surfaces and films

** This list is not exhaustive; contact us for your specific needs.*

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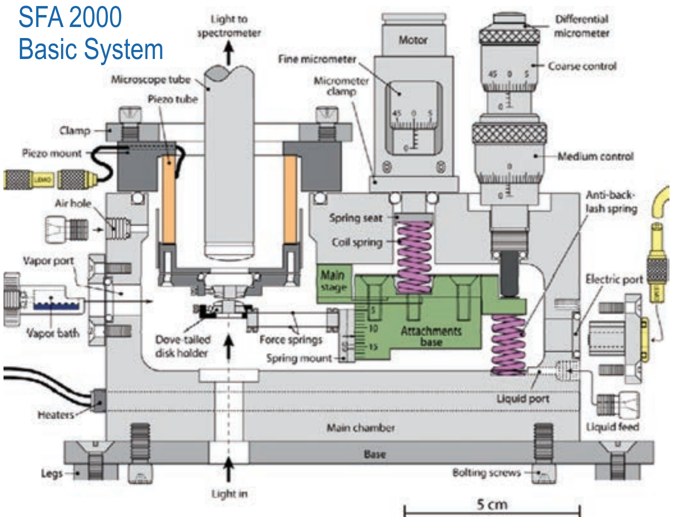
GENERAL DESCRIPTION

The SFA measures forces between two surfaces in vapors or liquids with a sensitivity of a few nN and a distance resolution of 1Å (0.1 nm). It can also measure the refractive index of the medium between the surfaces, adsorption isotherms, capillary condensation, surface deformations arising from surface forces, dynamic interactions such as viscoelastic and frictional forces, thin film rheology, and other time-dependent phenomena in real time at the molecular (nano-) scale. The molecularly smooth surfaces of hard materials such as mica, silica, sapphire, polymers, serve as suitable substrate surfaces in most measurements; these can also be coated with thick or thin layers of surfactants, lipids, polymers, metals, metal oxides, proteins and other biomolecules.

HOW IT WORKS

The figure below is a schematic drawing of the SFA 2000 configured with the Piezoelectric Top Mount (attached to the exterior of the Main Chamber and hosts the top surface) and the Main Translation Stage Bottom Mount (resides inside the Main Chamber and hosts the bottom surface) ready for use. For both the SFA 2000 and µSFA, the shapes of the interacting surfaces, the absolute separation between them, and the thickness of any adsorbed layer on the surfaces, are measured (to within 0.1 nm) by analyzing the optical interference fringes (known as FECO fringes) produced when white light passes through the two surfaces. The distance between the surfaces is controlled by a four-stage mechanism of increasing sensitivity from millimeters to ångstroms. Using the SFA 2000, dynamic measurements are conducted with surfaces in motion (vertically, horizontally, or in any direction in 3D space) using one of the attachments described in the following pages, while for the µSFA dynamic measurements are conducted with the surfaces in vertical motion. The µSFA retains the same normal force measurement capability as the SFA 2000 but in a compact form factor for use in typical laboratory microscopes thereby enabling SFA *and* fluorescence studies, for example.

SFA 2000 Basic System



SFA Control Box

USES

The SFA technique is routinely used to characterize and quantify various types of interactions between surfaces in liquids and vapors (see references on page 4). Static interactions include van der Waals and electrostatic forces, forces due to solvent structure (solvation and hydration forces), capillary forces, hydrophobic interactions, polymer-mediated steric and depletion forces, surfactant monolayers and lipid bilayers, adhesion and bio-specific receptor/ligand or other “lock-and-key” type binding interactions. Dynamic and time-dependent interactions include the viscosity of liquids in ultra-thin films (nano-rheology), slow relaxations of liquids, and polymers in confined geometries, and surface deformations during the approach, separation and lateral sliding of two surfaces. More recent applications have included food technology, the friction of clutches, how geckos run on walls and ceilings, the bioadhesion of mussels, joint biolubrication.

SFA 2000

SurForce LLC

MAIN FEATURES AND ATTACHMENTS

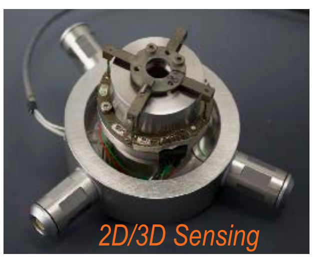
For anyone who wants to accurately measure the forces or any type of “interaction” between two material surfaces at any given separation in air, vapor or liquid, including their local geometry (shape) and deformations, the SFA stands unrivalled as to directness of measurement and visualization, unambiguous (sub-ångstrom) accuracy, and stability to thermal drift. Unlike some surface force-measuring instruments, such as scanning probe microscopes and pin-on-disk tribometers, the SFA 2000, especially when used with FECO optics, measures forces between surfaces at precisely known surface separations, providing the local surface geometry (shape), directly at the point of interaction. A number of capabilities that appeared as accessories in earlier models (such as the SFA 3) are now part of the SFA 2000, and new attachments allow for various dynamic measurements to be made, for example, of friction, lubrication and viscoelastic forces over a large range of speeds or shear rates. Some of these capabilities are illustrated below:

FRICTION SENSOR/ACTUATOR ASSEMBLIES

For friction and lubrication studies

1D Sense & Actuation

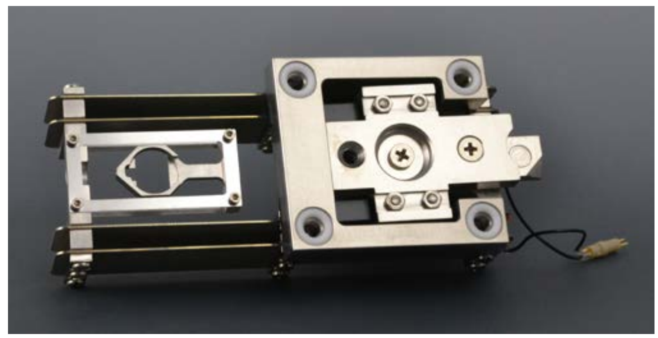
3D Sense & Actuation



2D/3D Sensing

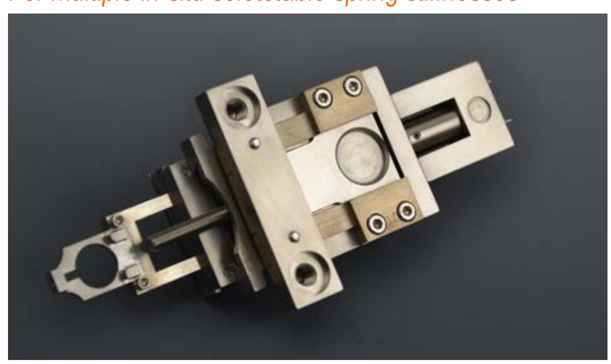
PIEZOELECTRIC BIMORPH SLIDER (1D & 2D)

For high-speed shearing of thin films



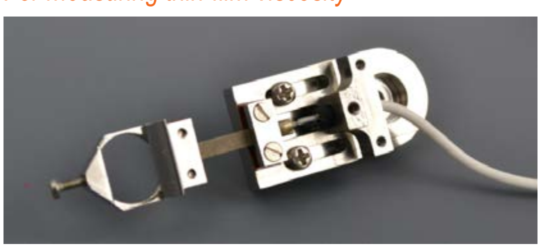
VARIABLE MAIN STAGE SPRING

For multiple in-situ seletctable spring stiffnesses



BIMORPH VIBRATOR

For measuring thin-film viscosity



CUSTOM ATTACHMENTS

Designed for your specifc research

OTHER ATTACHMENTS INCLUDE:

(1) Variable Stiffness Force-Measuring stage, (2) Constant Force-Measuring Balance, (3) Attachments for moving and detecting forces in 3D, (4) High-Speed Friction attachment (pin-on-disk type), (5) Attachments for applying electric or magnetic fields, (6) Short Working Distance for in-situ fluorescence & FRAP measurements (FL-SFA), (7) Attachment for electrochemical studies (EC-SFA), (8) Under-Water Mounts for biological surfaces

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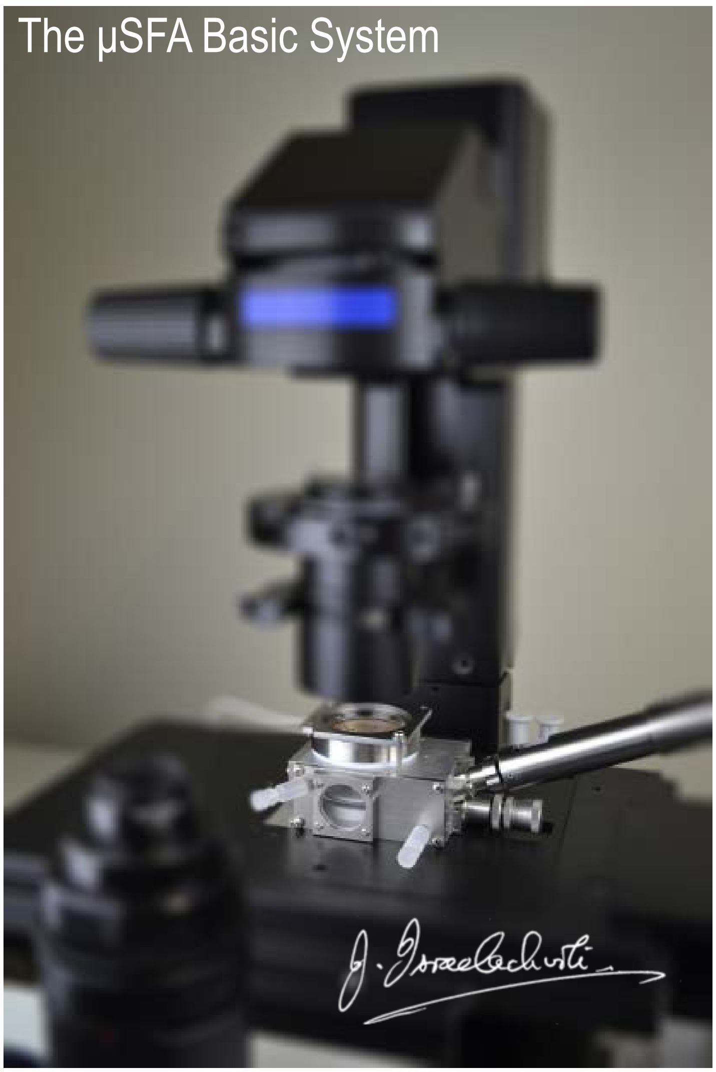
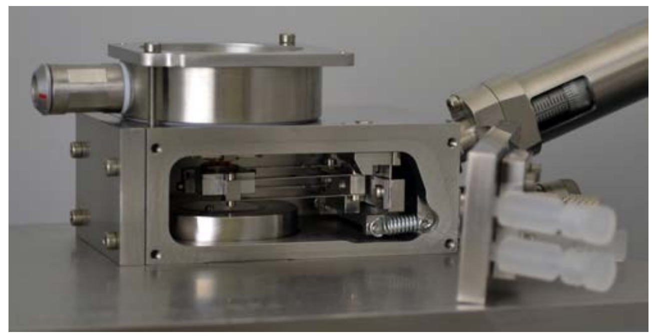
MAIN FEATURES AND ATTACHMENTS

The microscope-ready SFA, or µSFA, is intended to be used in common upright or inverted laboratory microscopes. Instead of an external white-light source, the microscope itself provides the broad-band white-light (tungsten source, 75W minimum) as well as the light collection and redirection to a side exit port for external guiding to a spectrometer to generate the FECO (Fringes of Equal Chromatic Order) measure of the inter-surface separation and *contact geometry*. This allows common modern microscopy, such as fluorescence imaging, to be done with the SFA. The µSFA supports large diameter, short focal-length objectives (< 36MM diameter and working distance > 11MM). The µSFA, like the SFA 2000, especially when used with FECO optics, measures forces between surfaces at *precisely* known surface separations, providing the local *surface geometry* (shape), directly at the point of interaction. The µSFA uses the same SFA disks and surfaces as the SFA2000 and can be used in an SFA2000 optical setup without modification.



designed by Jacob Israelachvili



Corrosion resistant 316 Stainless Steel with ports for filling and emptying, temperature monitoring (thermister) and chamber heating (100W).

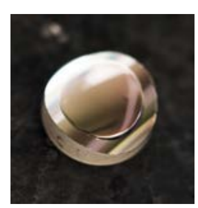
Can also be used in an SFA2000 Optical Setup

SFA ACCESSORIES

Mica Cutting Stage & Miniature Hot Plate

PRE-MADE DISKS

Silica surface (variable roughness), for ease-of-use/functionalization



FUTURE ATTACHMENTS TO INCLUDE:

(1) 1D Bimorph Slider, (2) 1D Friction Device, (3) Attachment for electrochemical studies (EC-µSFA), and (4) Under-Water Mounts for biological surfaces.

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SFA LITERATURE

SurForce LLC

THE SFA AND FECO OPTICAL TECHNIQUE AND INTERFACING WITH OTHER TECHNIQUES

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