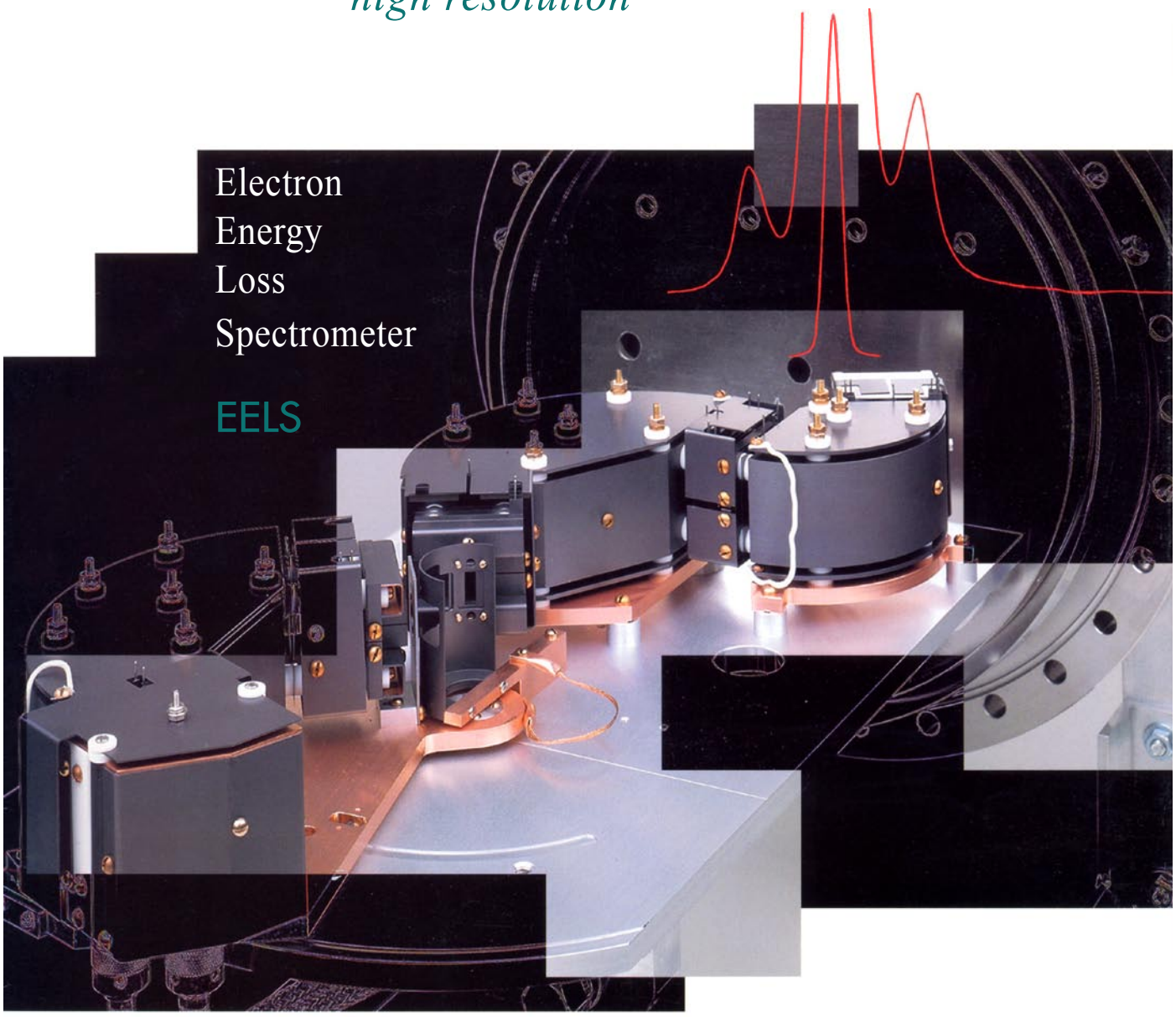
Model LK2000

high resolution



LK
TECHNOLOGIES

Model LK2000

Electron Energy Loss Spectrometer

INTRODUCTION

High-resolution electron energy loss spectroscopy (EELS) is a powerful surface analytical technique which provides unique vibrational analysis of metal and semiconductor surfaces in a high-vacuum environment. Insulators and polymer films may also be analyzed under suitable conditions. EELS readily provides important information on:

- adsorbate vibrational frequencies
- molecular structure of adsorbates (decomposition, polymerization)
- bond strengths at surfaces
- adsorption geometry—surface bonding sites
- surface chemistry (oxide formation, reduction, intermediates, etc.)
- overtone and combination vibrational bands
- surface acoustic and optical phonons

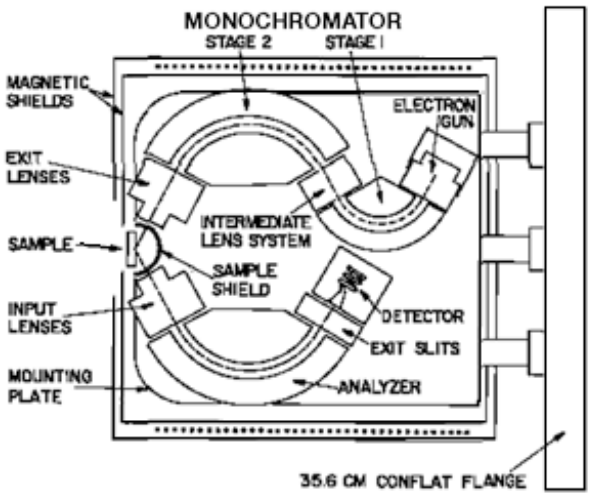
Importantly, ELLS affords higher surface sensitivity and wider spectral range than infrared spectroscopy. For example, a spectral range of 200-5000 cm^{-1} can be scanned in a few minutes, and less than 10^{-3} monolayers of adsorbed CO may be detected. In contrast to IR spectroscopy, EELS is not limited by strict dipole selection rules, which often hinder observation of important modes and adsorbates. In ELLS, both long-range dipole and short-range "impact" scattering mechanisms are operable and may be effectively studied as a function of scattering angle and impact energy. For example, molecular adsorbates which exhibit weak dipole activity can be detected in the impact scattering regime. Information obtained from EELS ideally complements data obtained with Auger, ESCA, LEED, SIMS, STM and other surface probes, and offers ease of interpretation for the experimentalist.

THE LK2000 SPECTROMETER

Since its commercial introduction in 1986 the LK2000 high-resolution EELS spectrometer has gained international recognition as the proven performance leader in its field. This reputation is based on our commitment to reliability, customer satisfaction and continued instrument improvement. The patented electron optics and innovative computer control of the LK2000 have been major factors in making EELS, once regarded as a precision technique of the specialist, the "workhorse" of the surface scientist for vibrational spectroscopy. The LK2000 has seen widespread use in industrial and academic laboratories worldwide. It has been successfully applied to a diverse range of problems, including hydrocarbon chemisorption (catalysis) on metals, analysis of silicon wafer cleaning techniques, characterization of polymer films, C_{60} films studies, and innumerable others.

Features

- Resolution at 3 meV (FWHM) and below
- Double-pass monochromator
- Superior monochromatic current and count rates
- Very low spectral background free of "ghost" peaks
- Primary beam energy variable from 0-240 eV
- Ease in day-to-day operation
- Available with fixed or rotatable analyzer
- Dual magnetic shielding standard
- Low-noise, high-stability power supply
- Computer controlled electronics with auto-tuning software
- Complete UHV systems available



Schematic of the LK2000-14

The LK2000 features a double-pass 127° monochromator of exceptional current and very low spectral background, in combination with a single-pass analyzer. The guaranteed instrumental resolution of 3 meV is combined with very high signal levels. Further, the instrument is offered in three standard mounting configurations for ease in system integration.

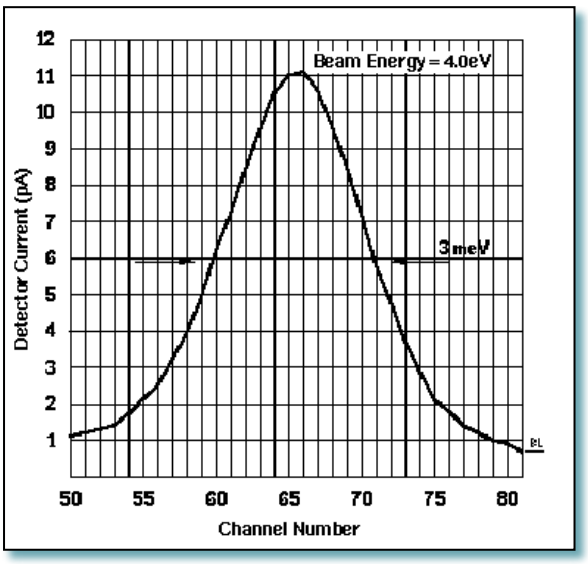
LK Technologies was first to offer fully computer-based control electronics (Model LK2000-DAC). This innovative PC-based system features menu-driven software that permits setup and optimization of all spectrometer voltages and monitoring of critical current levels. The ability to read and store complete tables of spectrometer settings on disk allows a speed and flexibility not possible with conventional EELS power supplies. This is the only commercial system to provide advanced software for auto-optimization of signal level and peak shape. This integrated system includes signal recovery electronics and menu-driven software for acquisition, display and analysis of the EELS vibrational spectra.

PERFORMANCE SPECIFICATIONS

1. Energy Resolution and Currents

FWHM	Sample Current	Detector Current*
3meV	> 100 pA	> 10 pA
4meV	> 180 pA	> 20 pA
6meV	> 350 pA	> 60 pA

*As measured in direct beam geometry



(Above) Direct beam measurement of channeltron detector current showing an instrumental resolution of 3meV (FWHM) at primary energy of 4eV. The analyzer transmission is greater than 10%.

2. Signal Levels

Typical count rates in elastic channel are 10 KHz to 3 MHz for 3-6 meV system resolution. Count rate is a strong function of sample condition and primary beam energy

3. Background

Ratio of elastic channel intensity to background intensity greater than 10^5 at 25 meV energy loss and above (instrumental)

4. Primary Energy

Variable from 0-240 eV
Sample bias ± 15 V

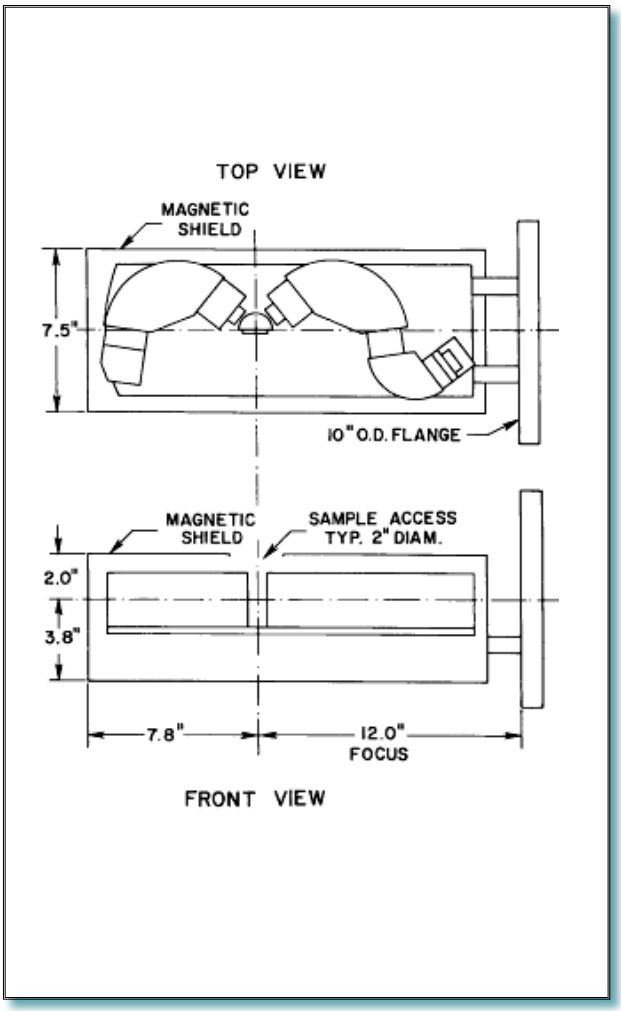
5. Energy Scan

-5 eV (gain) to +15 eV loss energy (optional +50 eV)

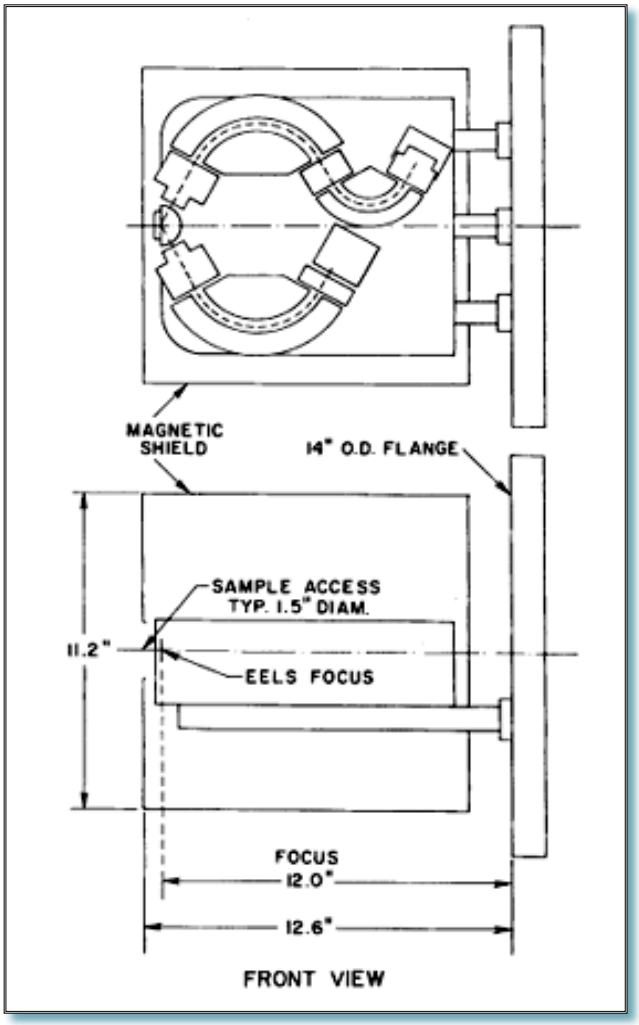
6. Computer Controlled Electronics

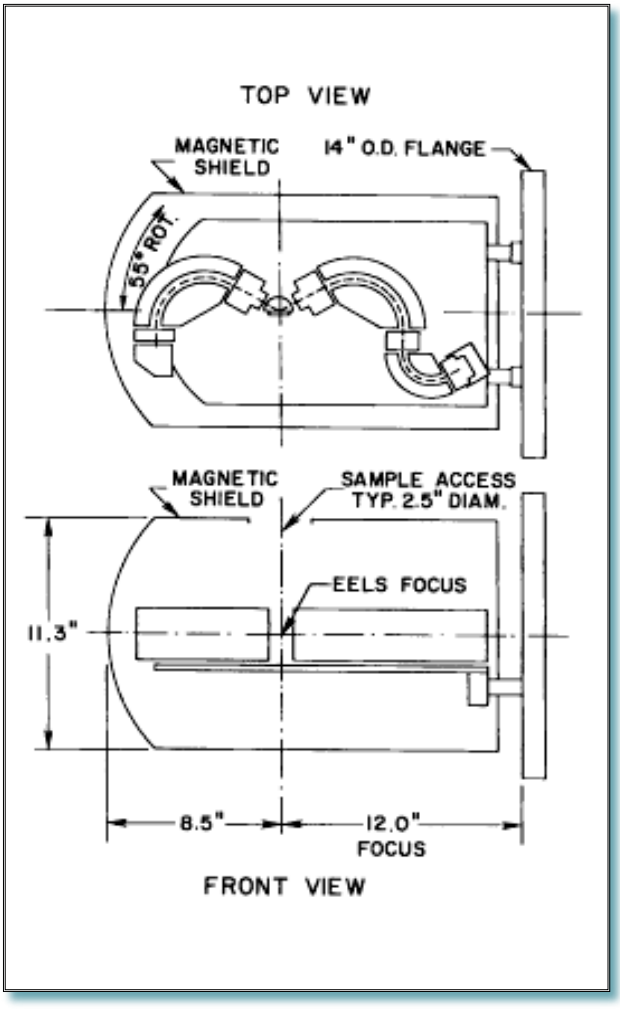
Operation to 240 eV beam energy
Low noise-ripple less than 250µV P-P
Drift less than 1 mV/week
Easy readout of all spectrometer voltages and critical currents
Total optical isolation
Software allows manual or auto-optimization of spectrometer voltages

LK2000-10



LK2000-14





LK2000-14-R

SPECIFICATIONS

Model LK2000-14 or Model LK2000-10 High Resolution EELS Spectrometer

Flange mounted spectrometer with rigid optics, including all electrical feedthroughs, electron multiplier arid magnetic shielding. See brochure for dimensional details.

Model LK2000-14-R High Resolution EELS Spectrometer

Flange mounted spectrometer with 55 degree precision rotating analyzer, including all electrical feedthroughs, electron multiplier and magnetic shielding. See brochure for dimensional details.

Model LK2000-DAC

Digital control electronics package. Includes digital control of spectrometer voltages and readout of critical currents. Package includes picoammeter, noise reduction filter, power supply, 386 PC/AT with color monitor, hard disc, dual floppies, graphics card and interface equipment. Includes menu-driven software for data acquisition, auto-optimization and control of spectrometer voltages. Includes Model LK2000-CE counting electronics package with necessary interface.

Model LK2000-CE

Counting electronics package with preamplifier, amp/discriminator, ratemeter (1 MHz), 11V power for electron multiplier and NIM-bin power supply.

UHV Systems

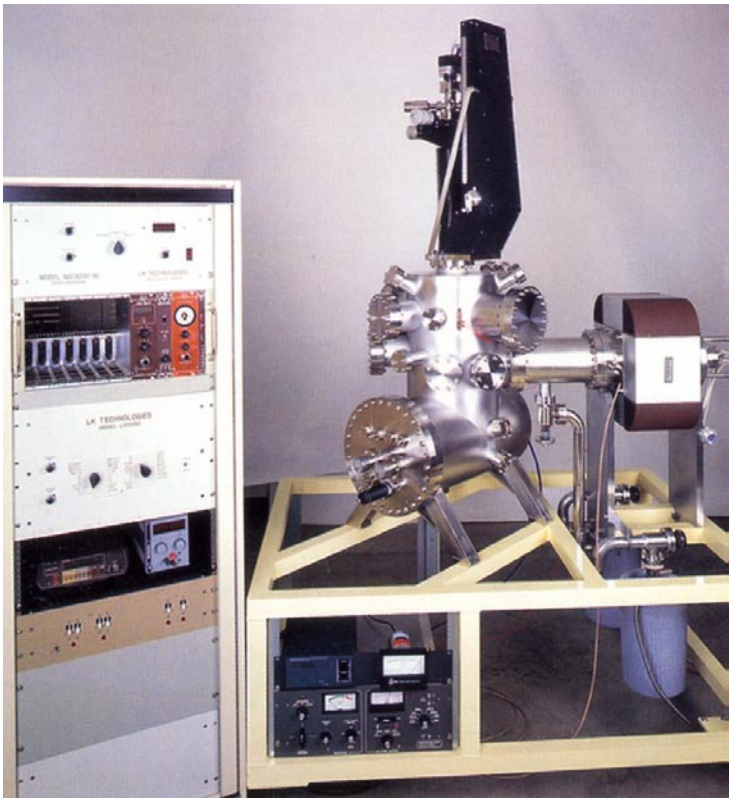
Complete ultrahigh vacuum systems are available for use with the Model LK2000 series EELS spectrometers. These systems would normally include a custom stainless steel vacuum chamber, ion and/or turbo pumping, and precision sample manipulation with heating/cooling options.

APPLICATION TO UPS

The high-resolution analyzer of the LK2000 may also serve as an angle-resolving instrument for photoelectron spectroscopy (UPS) studies with laboratory or synchrotron light sources. Please contact LK Technologies for the latest information on this application.

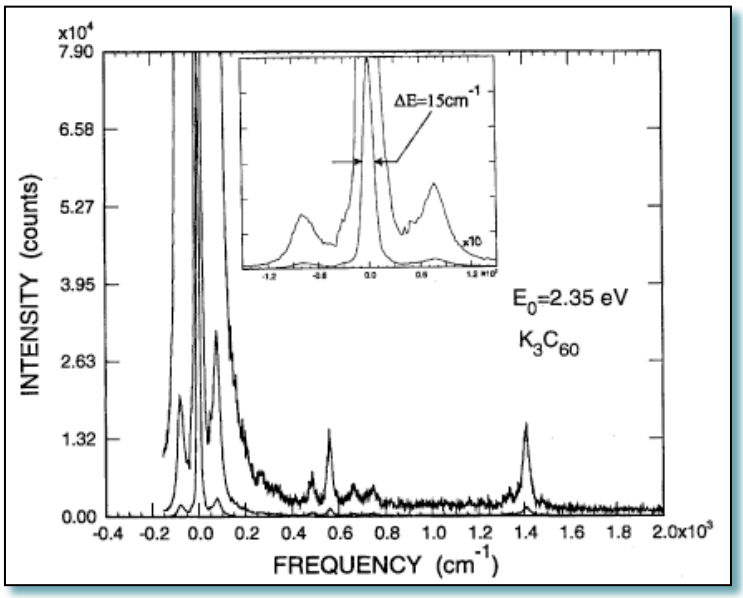
Mechanical Specifications:

- Mounting on 10 in. or 14 in. O.D. CFF standard (custom designs on request)
- Compatible with 8 in. or 12 in. O.D. tabulations
- Flange to focus distance 12 in.
- UHV chamber sizes 12 in. and 18 in. O.D.
- Several sample access modes available
- Unit bakeable at 200° C



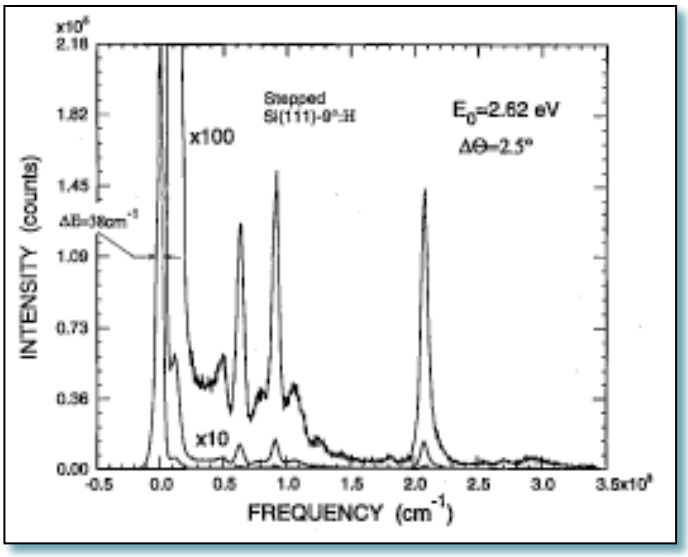
LK Technologies provides complete EELS systems as well as components. Shown here is the model LK 2000-14-R with two-level UHV chamber, sample manipulator, and pumping system.

The EELS data (graphs below and back page) attest to the excellent scientific results achieved by our customers.

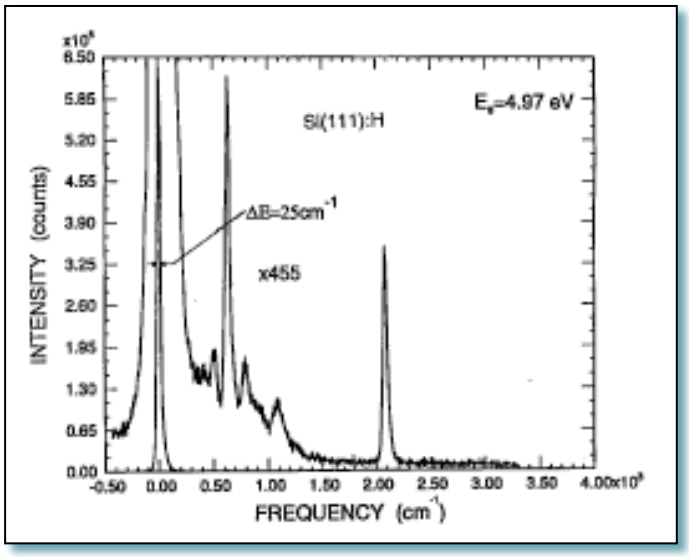


EELS data in specular scattering ($\Theta_i = 60°$) for an epitaxial $K_3 C_{60}$ film deposited on Cu (111). The intense gain and loss peaks at 78 cm^{-1} energy correspond to the Fuchs-Kliewer modes of the ionic material and are shown more clearly in the expanded scale inset figure. Other modes at 480, 560 and 1410 cm^{-1} are mainly C-C bend and stretch modes of the C_{60} molecule which are shifted by ~ 30 cm^{-1} due to the indirect coupling of the K^+ ions. Note the very high resolution of 1.85 meV.*

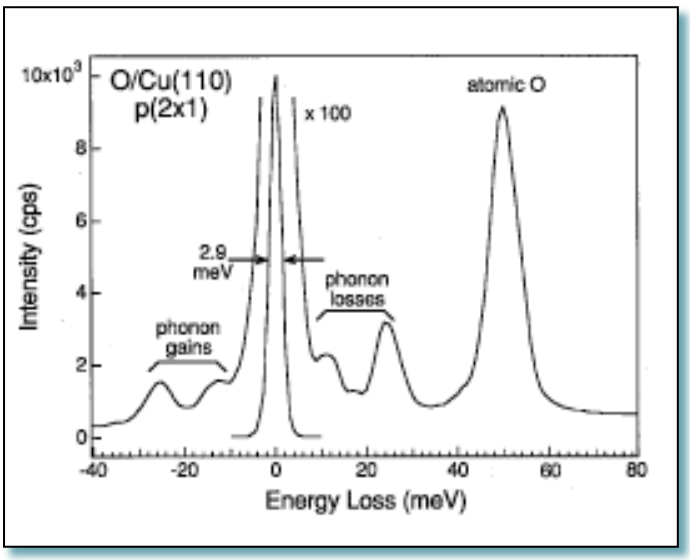
* Used with permission of Or. J. E. Rowe, AT&T Bell Laboratories.



Energy loss spectra for a 9° miscut Si(111) surface covered with atomic hydrogen by wet chemical etching. In addition to the Si-H stretch and bend modes at 2084 and 636 cm^{-1} there is an intense peak at 910 cm^{-1} due to the Si-H_2 scissor mode of the dihydride step atoms. The weak peaks at 1255, 1815, 2560 and 2705 cm^{-1} are assigned to overtones and combination bands of Si-H and Si-Si modes. System resolution is 4.7 meV.*



Electron energy loss spectrum of a wet chemically prepared Si (111) surface covered with atomic hydrogen in the atop site in specular scattering at incidence angle, 60°. The peaks at 2084 cm^{-1} and 636 cm^{-1} correspond to the Si-H stretch and bending modes respectively. Weaker peaks at 520, 790 and 1105 cm^{-1} are substrate modes or due to residual contamination from the etching preparation. System resolution is 3.1 meV.*



Electron energy loss spectrum for ordered oxygen adsorption on a copper (110) surface showing the O-Cu stretching mode and energy losses and gains associated with surface phonons. The system resolution is 2.9 meV.**

* Used with permission of Dr. J. E. Rowe, AT&T Bell Laboratories.

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LK TECHNOLOGIES

LK Technologies, Inc
1590 S. Liberty Dr., Suite A
Bloomington, IN 47403
Tel: (812) 332-4449
Fax: (812) 332-4493
http://www.lktech.com
email:lktech@lktech.com