I. MOLECULAR BEAMS

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A. COMPARISON OF TECHNIQUES FOR SURFACE MEASUREMENTS

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During this early stage in the development of the molecule microscope, we have found it useful to survey and compare various techniques and the microscopy that can be applied to surface measurements. To simplify categorizing the various techniques, surface measurements have been expressed schematically as shown in Fig. I-1. The classification has been made along the following lines: Some form of energy (or particle) (1) is incident on the surface, and one or more forms of energy (or particles) are detected either (2) from scattering by the surface or (3) by scattering through the surface.

In Table I-1 various surface measurement techniques are compared on the basis of incident energy versus detected energy. Each technique is listed in abbreviated form (standard abbreviations are used for the more developed techniques) and pertinent references are given. Standard reference works are listed for the better established techniques such as electron microscopy. Whenever it is possible we refer to a recent,
Table I-1. Techniques for surface measurements.

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KEY

CTEM Conventional transmission electron microscopy

SEM Scanning electron microscopy

STEM Scanning transmission electron microscopy

LEED Low-energy electron diffraction

HEED High-energy electron diffraction

AES Auger electron spectroscopy

AEM Auger electron microscopy

IS Ionization spectroscopy

PES Photoelectron spectroscopy

PEM Photoelectron microscopy

XES Exo-electron spectroscopy

XEM Exo-electron microscopy

SE Secondary emission

INS Ion neutralization spectroscopy

TE Thermionic emission

FES Field-emission spectroscopy

FEM Field-emission microscopy

EM (MA) Electron microprobe (mass analysis)

CIS (X-ray) Characteristic isochromat spectroscopy

APS (X-ray) Appearance potential spectroscopy

CL Cathodoluminescence

LM Light microscopy

COL Colorimetry: IR, VIS, UV, x-ray, y-ray absorption spectroscopy

ELL Ellipsometry

HOL Holography

IRS Internal reflectance spectroscopy

NMR Nuclear magnetic resonance

ESR Electron spin resonance

MÖSS Mössbauer spectroscopy

XRD (Glancing incidence) X-ray diffraction

NIR Neutral impact radiation

IIR Ionic impact radiation

IMXA Ion microprobe x-ray analysis

ES Emission spectroscopy

TL Thermoluminescence

EL Electroluminescence

ESD (Low energy) Electron-stimulated desorption

SDMM Scanning desorption molecule microscopy

PD Photodesorption

LMP Laser microprobe

MBSS Molecular-beam surface scattering

α Accommodation coefficient measurements

σ(p) Adsorption isotherm measurements

MM Molecule microscopy

ISD Ion-stimulated desorption

FD (Thermal or) Flash desorption

IM (MA) Ion microprobe (mass analysis)

ISS Ion surface scattering

SI Surface ionization

FIS Field ion spectroscopy

FIM Field ion microscopy

ΔH_ads Heat of adsorption measurements

ASW Acoustic surface-wave measurements

CPD Work-function measurements by contact potential difference

SC Surface capacitance

MS Magnetic saturation
relatively accessible review article concerned with the usefulness of a particular technique for surface measurements (for example, LEED, AES, ellipsometry). As for the more recent techniques, we refer either to articles reporting initial results in the construction of prototype instruments (as in photoelectron microscopy or molecule microscopy) or to design studies or project proposals for instruments or techniques that are under investigation (as in scanning desorption molecule microscopy). Unreferenced entries in Table I-1 are those for which we were unable to find a general reference to an application of a technique to surface measurements, although the potential for such an application of the technique exists.

References


(I. MOLECULAR BEAMS)


