



**ANALYTICAL  
CHEMISTRY  
LABORATORY**  
CAPABILITIES BROCHURE

Tektronix, Inc.  
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Beaverton, Oregon 97077

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## ANALYTICAL CHEMISTRY LABORATORY

The Analytical Chemistry Laboratory, a laboratory unit within the Technical Laboratory Group of Tektronix, Inc., provides support to research, development, and manufacturing operations.

The nature of the support is best described as a material characterization function. Chemical and physical analytical techniques are utilized to analyze, identify, and characterize the various materials used in the operations of Tektronix.

The laboratory is equipped with considerable equipment for both chemical and physical analysis. The major equipment in the laboratory is as follows:

1. Cary 17 Spectrophotometer for IR, Vis and UV.
2. Atomic Absorption
3. Gas Chromatograph
4. Carbon-Sulfur Analyzer
5. X-Ray equipment
  - a. Topographic cameras
  - b. Laue cameras
  - c. 3 powder film cameras
  - d. Diffractometer
  - e. Rigaku Fine Focus Generator
6. 3.4 meter emission spectrograph
7. I-R Spectrophotometer
8. P.E. Thermal Analysis unit
9. Auger Electron Spectroscopic unit

Numerous smaller items for analysis and complete chemical equipment for chemical analysis.

Also available to the laboratory is considerable additional equipment available through cooperative agreements with the Oregon Graduate Center, Portland State University and other educational institutions.

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# WET CHEMICAL METHODS

## Electrometric Titrations

1. Potentiometric Titrations  
Bromide and Chloride content of compounds can be determined to three significant figures depending upon the amount of sample available. Minimum amount of sample required: 100 mg per analysis.
2. pH Titrations  
Example: Base content of 4:1 HRP Developer, Acid—Base Titrations.

## Optical Methods

1. Absorption Spectrophotometry  
Example: Phosphorous and Silicon can be detected to 0.002%.
2. Flame Photometry, Emission  
Discussed under Atomic Absorption.

## Separation Methods—Ion Exchange

1. Alloys can be separated into their components by Ion Exchange, allowing Quantitative determination of each component.

## Chelometric Titrations using EDTA

1. The metallic content of compounds can be determined to three significant figures depending upon availability of the sample. Minimum sample required is 100 mg per analysis.  
Elements: Al, Ba, Bi, Ca, Co, Cu, Fe, Gd, La, Mg, Mn, Ni, Tb, Y, Yb, Zn.  
Example: Co assay in reclaimed cobalt.

## Gravimetric Methods

1. Silica, Gold, if present in substantial amounts in a sample may be determined to 3 significant figures. Minimum sample required is 500 mg per analysis.

## Titration Methods

1. These methods are applicable to plating solutions and their constituents. Minimum sample required is 100 mg per analysis. This will give accuracy to 3 significant figures.  
Examples: Content of Ag, KCN and  $K_2CO_3$  in silver plating solution.  
Content of Ni,  $NiCl_2$ , brighteners and  $H_3BO_3$  in nickel plating solutions.  
Content of S in  $La_2O_2S$ .

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# GAS CHROMATOGRAPHY

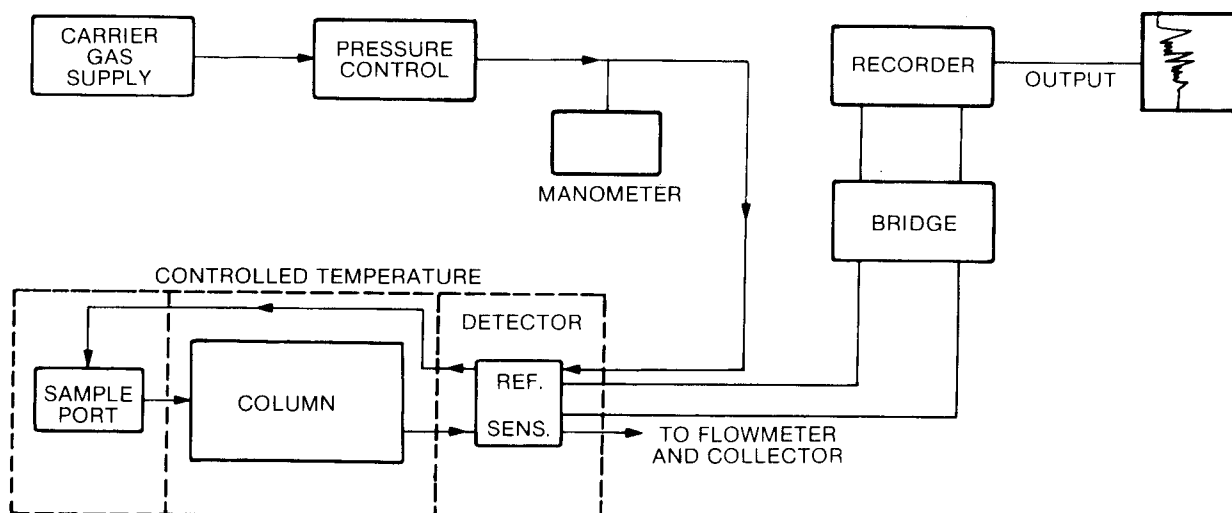
## Principle

Volatile organics are vaporized in a hot injection port, then pushed through an analytical column by an inert gas. Separation of the volatiles occurs within the column due to different partition coefficients between the stationary column packing and the mobile phase. The separated organics are then detected as they emerge from the end of the analytic column by a variety of techniques and are displayed as peaks on a strip chart recorder or a microprocessor printout.

## Sensitivity

Depending upon the compound detected, the matrix and the resolution, sensitivity varies from 0.01% using a thermal conductivity detector to 1 ppm using a flame ionization detector and, if an electron capture detector is used, to a few ppb.

## Schematic



## Data Presentation

The output signal from the detector forms peaks on a strip chart recorder. The relative magnitude of the individual peaks are proportional to the relative concentration of that compound in the mixture.

The time from injection to detection is constant for a given compound under fixed chromatographic conditions. Thus, this time can be used for tentative identification if a known is available for comparison.

## Applications

The technique is ideally suited to the analysis of volatile, thermally stable, organic compounds; generally, those with boiling points below 250°C.

GC is also well suited to the analysis of gasses such as oxygen, nitrogen, carbon monoxide, carbon dioxide, hydrogen, inert gasses, and the low molecular weight hydrocarbons.



# GAS CHROMATOGRAPHY-MASS SPECTROSCOPY (GC-MS)

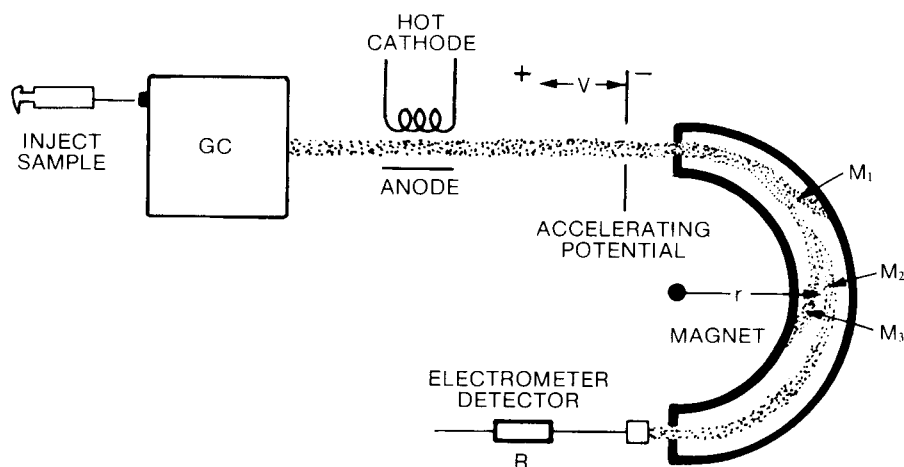
## Principle

GC-MS combine two independent techniques into one powerful analytical tool. Gas Chromatography (GC) separates (as described elsewhere) a complex mixture into pure compounds for identification by Mass Spectroscopy. The pure gaseous compounds leaving the GC detector are introduced directly into the Mass Spectrometer. The organic molecules are then bombarded with high energy electrons and undergo ionization, cleavage, and some rearrangement. These ions are accelerated by a potential field, focused by a slit and then subjected to a magnetic field which alters their path into a circular path the radius of which is dependent upon the mass of the particle. By varying the magnetic field, the particles of different mass strike a detector and their mass is determined.

## Sensitivity

A mass spectra may be obtained from as little as  $0.1 \mu\text{g}$  of sample. However, the lower limit of sample size is not usually instrument sensitivity but the ability to manipulate minute amounts of sample and is thus somewhat matrix and situation dependent.

## Schematic



## Data Presentation

Data presentation is in the form of a graph of mass to charge ratio vs. relative intensity. Often the unknown spectra is computer searched for comparison to files of known mass spectra for identification.

## Applications

Limitations to the type of sample that may be analyzed are similar to those for gas chromatography; i.e., volatile organics. However, the sample needs to be relatively clean in order to avoid contaminating the ion source.

This service is available through cooperative agreement with OGC.



# CARBON ANALYZER

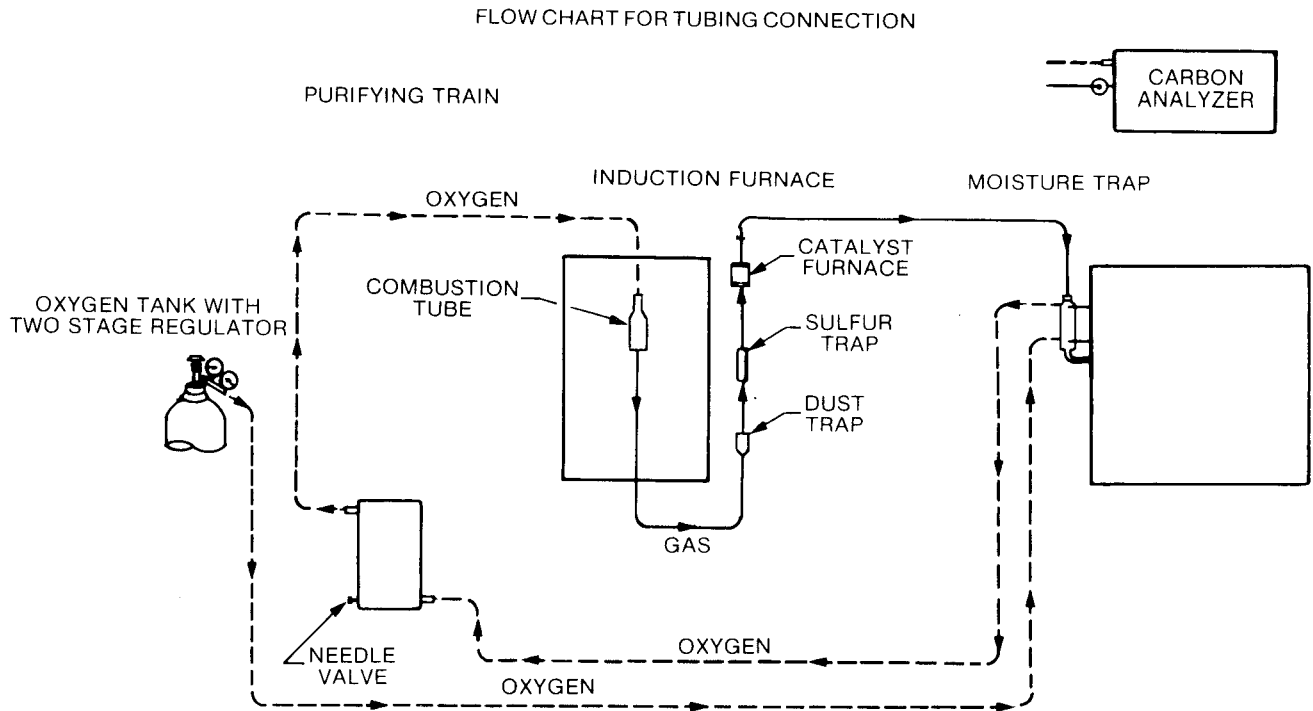
## Principle

The sample is heated in an induction furnace in the presence of oxygen. The effluent gases are filtered, purified, and trapped, and the amount of CO<sub>2</sub> is determined by a thermistor type conductivity cell.

## Sensitivity

Sample dependent. Generally  $\pm 5\%$  of total carbon present. Lower limit of detection 0.005.

## Schematic



**Data Presentation** Digital readout.

**Application** Determination of carbon in metals or inorganic compounds.

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## SULFUR ANALYZER

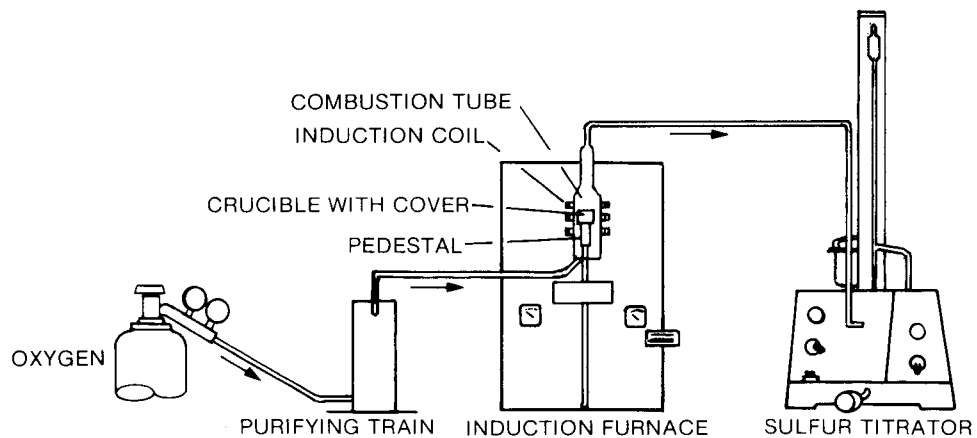
### Principle

The sample is heated in an induction furnace and the gasses are collected and titrated using a standardized  $\text{KIO}_3$  solution with a starch indicator.

### Sensitivity

Sample dependent. Generally  $\pm 5\%$  of total sulfur. Lower limit of detection 0.05%.

### Schematic



### Applications

Sulfur content of iron, steel, non-ferrous metals, and inorganic compounds.



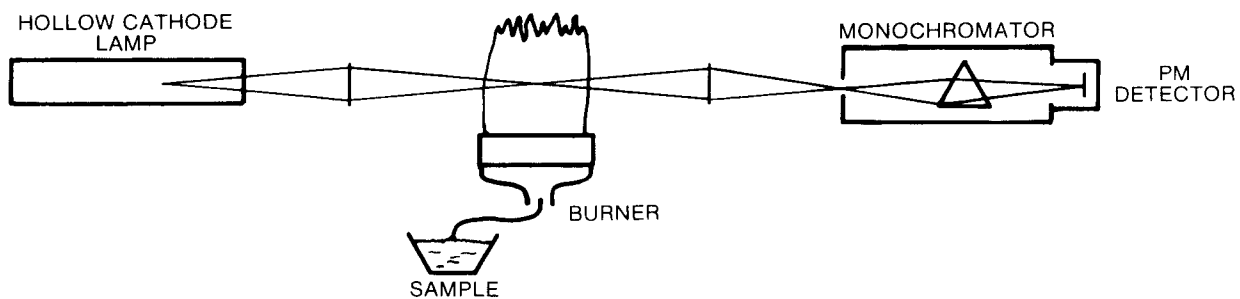


# ATOMIC ABSORPTION

**Principle** The sample is vaporized and those atoms present in the ground state absorb monochromatic light of their characteristic emitting frequency proportional to their number.

**Sensitivity** Element and matrix dependent. Generally in the sub ppm to picogram level.

**Schematic**



**Data Presentation** The amount of light absorbed by the atoms is detected by a photomultiplier and displayed digitally. The wavelength of the measured light is determined by the element of interest.

**Applications** Mainly aqueous solutions or solids which can be dissolved.

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**CONVENTIONAL ATOMIC ABSORPTION SENSITIVITIES IN PPM FOR AQUEOUS SOLUTIONS**

H											He						
Li	Be											Ne					
0.0004 <sup>a</sup>	.014																
Na	Mg											A					
0.001 <sup>a</sup>	0.004																
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga*	Ge*	As	Se	Br	Kr
0.01 <sup>a</sup>	0.004 <sup>a</sup>	0.25	1.5	0.96	0.04	0.03	0.05	0.05	0.05	0.04	0.01			0.63	0.27		
Rb	Sr	Y	Zr	Nb*	Mo	Tc	Ru*	Rh	Pd	Ag	Cd	In*	Sn	Sb	Te	I	Xe
0.02 <sup>a</sup>	0.041	0.6 <sup>a</sup>	9.2		0.28			0.22	0.14	.04	0.01			0.88	0.28	0.21	
Cs	Ba	La	Hf*	Ta	W	Re	Os*	Ir*	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
0.33	0.02 <sup>a</sup>	0.2 <sup>a</sup>		12	16.9	8.5			1.0	0.1	2.5	0.23	0.08	0.22			
Fr	Ra	Ac															
Ce*	Pr	Nd*	Pm	Sm*	Eu*	Gd	Tb*	Dy*	Ho*	Er	Tm*	Yb	Lu*				
	44				20					0.67		0.10					
Th*	Pa	U*															

\*Possible to analyze but sensitivities unpublished for ACL instrument.

<sup>a</sup>These elements are most suitably run by flame emission and sensitivities are for that mode.



**CARBON ROD FURNACE ATOMIZER ACCESSORY WITH ATOMIC  
ABSORPTION SENSITIVITIES IN PICOGRAMS ( $10^{-12}$  g) FOR AQUEOUS  
SOLUTIONS**

H																					He					
Li	Be																					Ne				
3	0.1																					F				
Na	Mg																					Cl				
0.4	0.7																					S				
		0.4		30																						A
K	Ca	Sc*	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br						Kr				
10	40		30	15	0.5	1.0	0.3	3	2.5	0.8	0.2	5.2	40	6	10											
Rb*	Sr	Y	Zr*	Nb*	Mo	Tc	Ru*	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I						Xe				
		1.0		1300				10		0.3		11		6		8		7								
Cs*	Ba	La	Hf*	Ta*	W*	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At						Rn				
		4		58		1000		270		1.0		4.8		5												
Fr	Ra	Ac																								

Ce*	Pr*	Nd*	Pm	Sm*	Eu*	Gd	Tb*	Dy	Ho	Er	Tm*	Yb	Lu*
						1600		53	90	50		1.3	
Th*	Pa	U											
		3100											

\*Possible to analyze but sensitivities unpublished for ACL instrument.

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# EMISSION SPECTROSCOPY

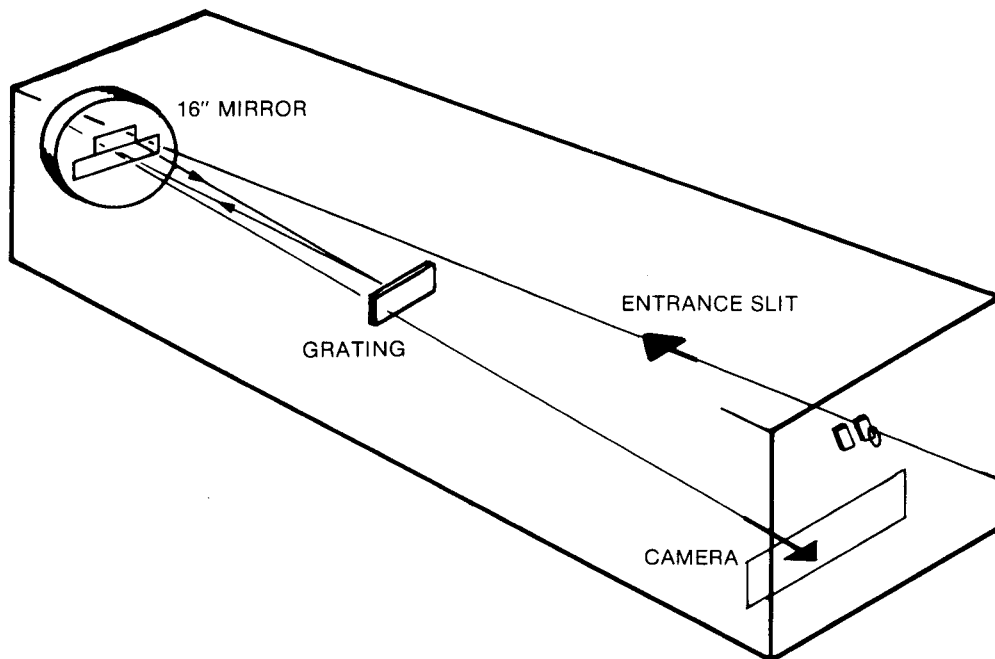
## Principle

The sample is burned in a DC arc or spark. Elements in the sample are excited into a higher energy state when vaporized. Returning to the ground state, the excess energy is emitted as visible or ultra-violet radiation. The wavelength of this radiation is characteristic for each element. Analysis of this radiation provides semi-quantitative or quantitative data of the sample depending on the method used.

## Sensitivity

Generally in the low ppm range depending on the element, matrix, excitation conditions and type of analysis procedure.

## Schematic



## Instrumentation

3.4 meter Ebert configuration Jarrell-Ash Mark IV Emission Spectrograph with DC arc, Spark, Uni-arc and Ignited AC arc power sources.

Grating ruling—15,000 lines per inch; peak blaze 4000 Å. Reciprocal linear dispersion.

1st order	5.1 Å per mm.
2nd order	2.6 Å per mm.
3rd order	1.6 Å per mm.

## Data Presentation

The radiation emitted by the vaporized sample is dispersed by the grating into its various characteristic components and are recorded on a photographic plate. Comparison of these lines with a "Standard Plate" provides identification of the elements and the density of the lines provides a visual estimate of the concentration (semi-quantitative). Densitometer measurement of the line vs. an internal standard line and plotted on analytic curves provide accurate quantitative values.

## Applications

Rapid impurity analysis of bulk samples, solutions, oils, and miscellaneous materials; quantitative analysis of metals and alloys; identification of unknown materials.

Special methods can be devised for quantity estimates of exceptional materials.











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# EMISSION SPECTROSCOPY DETECTION LIMITS

ZnO MATRIX, PPM  
SEMI-QUANTITATIVE

H																	He					
Li	Be															B	C	N	O	F	Ne	
	1															1						
Na	Mg															Al	Si	P	S	Cl	A	
75	.1															1	1					
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr					
1000	10		1	1	1	1	1	1	1	1												
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe					
	100		1		1					1	10		1									
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn					
	10													1	10							
Fr	Ra	Ac																				

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U											

1) 2) 3) 4) 5) 6) 7) 8) 9) 10)

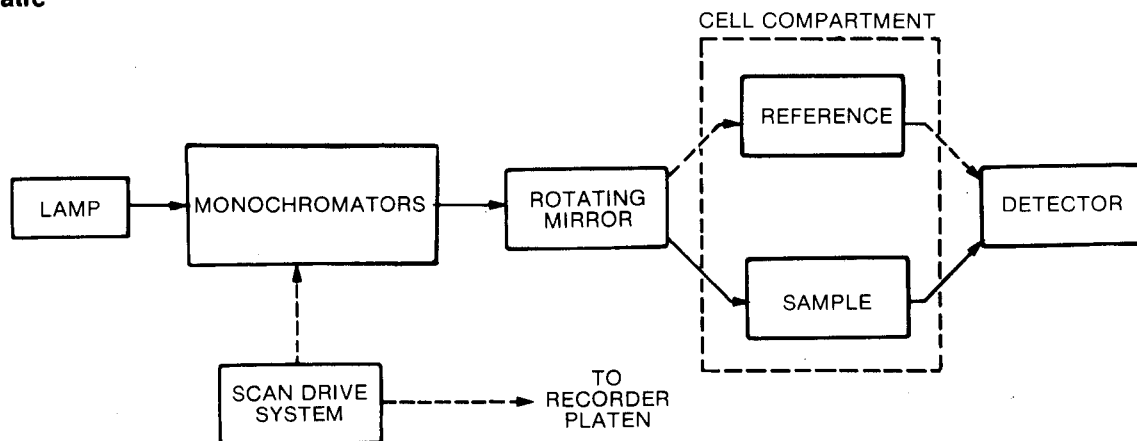


## UV—VISIBLE—NEAR IR

**Principle** Electromagnetic radiation in the range from 190 nm to 1800 nm is scanned and absorption of this energy by the sample is detected and plotted as a function of wavelength.

**Sensitivity** Sample dependent.

**Schematic**



**Data Presentation** Digital readout, strip chart recorder of wavelengths vs. absorbance or transmittance.

**Applications** Identification of organic compounds. Transmittance characteristic of films, glasses, and filters, etc. Thickness determinations of films, etc. Transition energies for lone-pair and  $\pi$  electrons.

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# IR

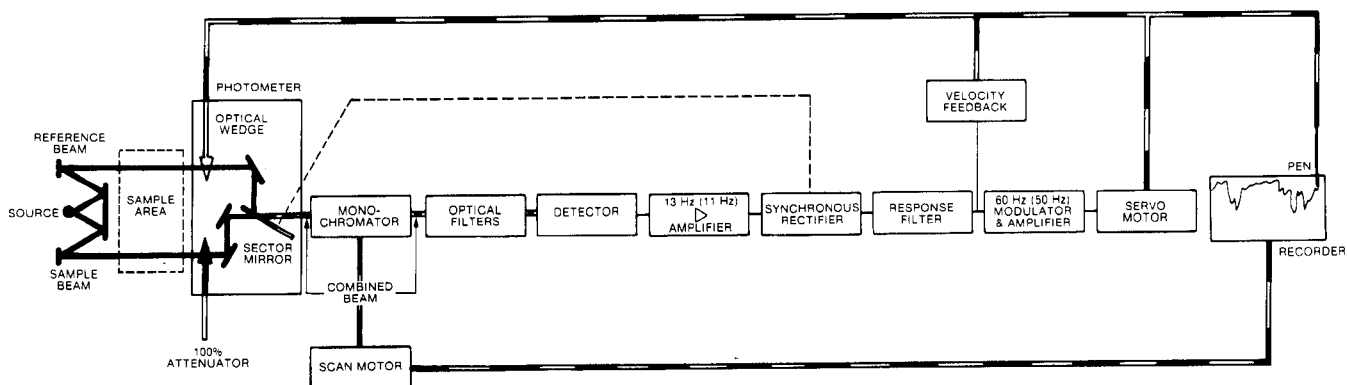
## Principle

Electromagnetic radiation in the range of  $4000 - 650 \text{ cm}^{-1}$  ( $2.5 \mu - 15.4 \mu$ ), is absorbed by the sample and converted into molecular vibrations. These absorptions are detected and plotted as a function of wavelength (frequency).

## Sensitivity

Highly dependent upon sample.

## Schematic



**Data Presentation** An X-Y plot of transmittance vs. wavelength.

## Applications

Identification of organic solids, liquids, and gasses; identification of some inorganics; determination of thin film thickness (IR transparent).



# DIFFERENTIAL SCANNING CALORIMETER

## Principle

A sample and reference cell are heated at a selected programmed rate and the difference in the electrical energy necessary to maintain them at the same temperature is measured. The power necessary to keep them isothermal is directly proportional to the heat of reaction ( $\Delta H$ ) of the observed transition.

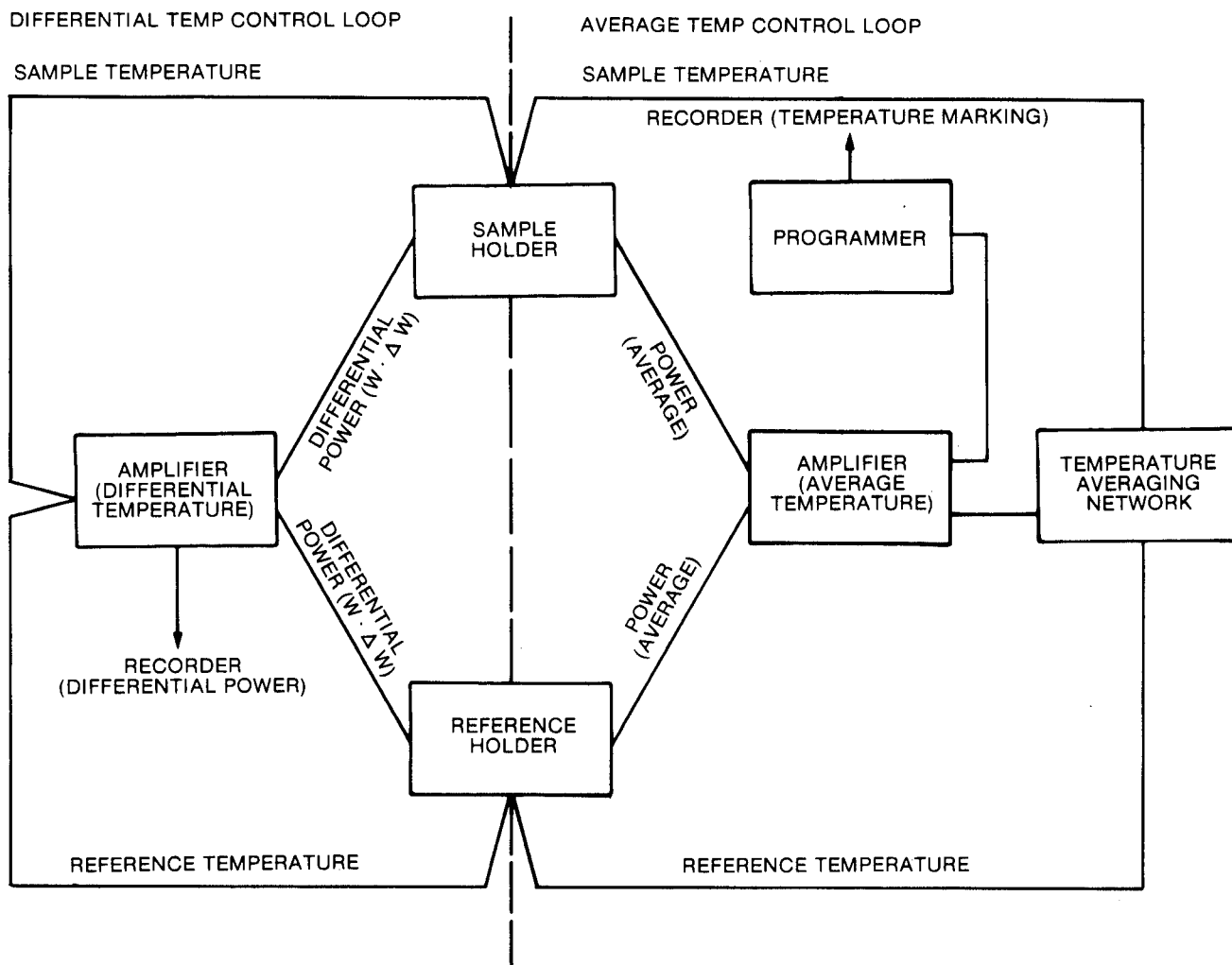
## Sensitivity

Transition temperatures  $\pm 0.2^\circ\text{C}$ . Heats of Fusion ( $\Delta H_f$ ) and Heats of Reaction ( $\Delta H$ ) are determined to  $\pm 0.5\%$  depending on sample.

## Data Presentation

Data is presented as X-Y plots and calculator printouts.

## Schematic



## Applications

Methods are available for determining Heats of Fusion, Heats of Reaction, Glass Transitions, Purity, Phase Transitions.



# THERMOMECHANICAL ANALYSIS

## Principle

The sample is placed in one of several selectable probes, then is heated at a programmed linear rate. As the sample expands, contracts, or softens, the position of the probe will detect the change. This change of position is monitored with a linearly variable differential transformer (LVDT). The LVDT provides a signal which is proportional to the displacement.

## Sensitivity

$0.5 \times 10^{-4}$  inches/inch on a 10 mV recorder.

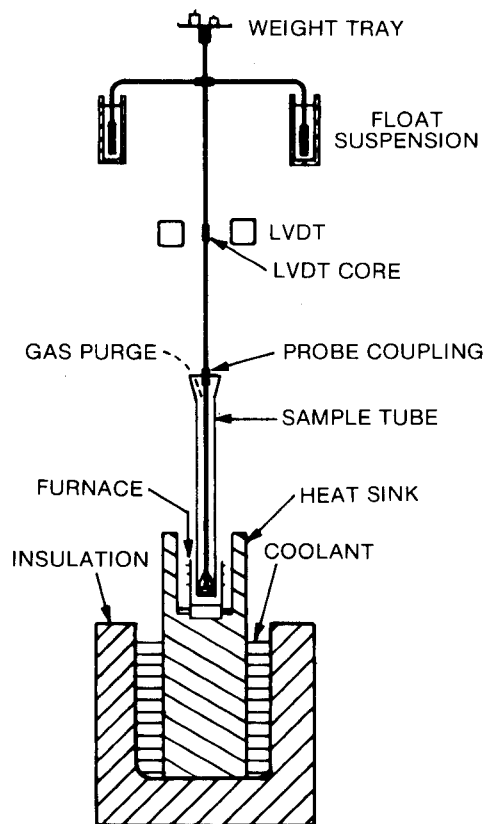
## Data Presentation

A direct or derivative two pen recording of temperature vs. displacement.

## Applications

Expansion coefficients, softening points, Flexure, and Modulus.

## Schematic







# NMR

## Principle

The nuclei of atoms spin. The spinning of these charged nuclei generates a magnetic moment along the axis spin so that these atoms behave as small bar magnets.

When placed in an external magnetic field, these atoms align with or against this applied field. By varying the magnetic field over a small range while applying a constant radio frequency, the resonance frequency of the various nuclei may be found.

## Sensitivity

Sample dependent. Generally at least several milligrams of pure sample required.

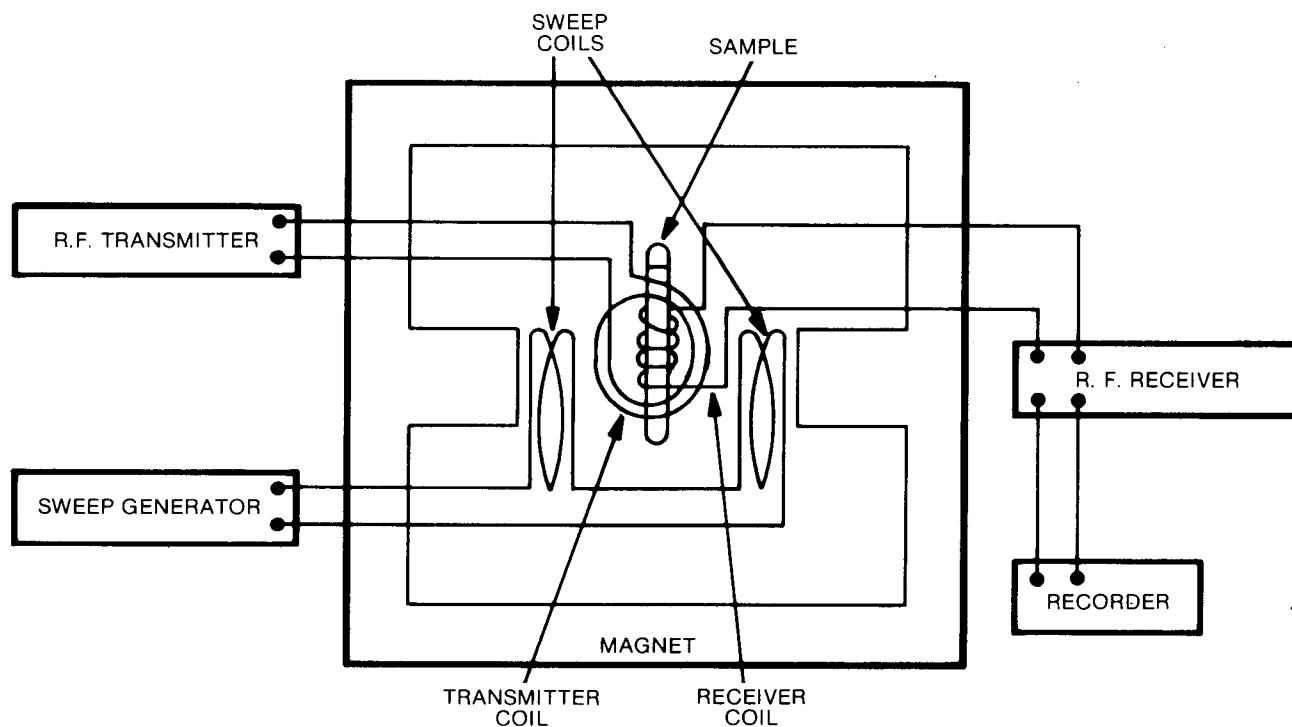
## Data Presentation

An X-Y plot of radiation absorption vs. ppm or Hertz.

## Application

Organic materials identification using  $H^1$  and  $C^{13}$  nuclei; quantitative analysis of many organics; identification and quantification of inorganic complexes.

## Schematic



This service is available through cooperative agreement.



## WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE

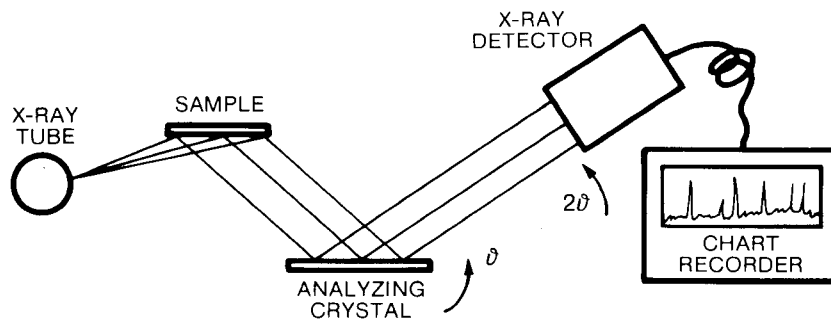
### Principle

X-rays are used to excite the atoms of the sample. Returning to the normal state, the sample atoms emit fluorescent X-rays. This radiation is directed onto a crystal rotating at a selected angular rate. A detector, rotating at twice this rate, detects the characteristic radiations from the atoms when the Bragg conditions are met during rotation. The peak intensities are proportional to the number of atoms present.

### Sensitivity

Element and matrix dependent sensitivities are in the ppm range. Some lighter elements cannot be detected; these limits vary with the crystal used, detector type and matrix interference. Sodium is generally the lowest atomic numbered element that can be detected.

### Schematic



### Data Presentation

Normal presentation is by Strip Chart Recording of the detector output during scan. Quantitative measurements are made by count ratioing of standards and the sample.



## X-RAY DIFFRACTION—FILM TECHNIQUE

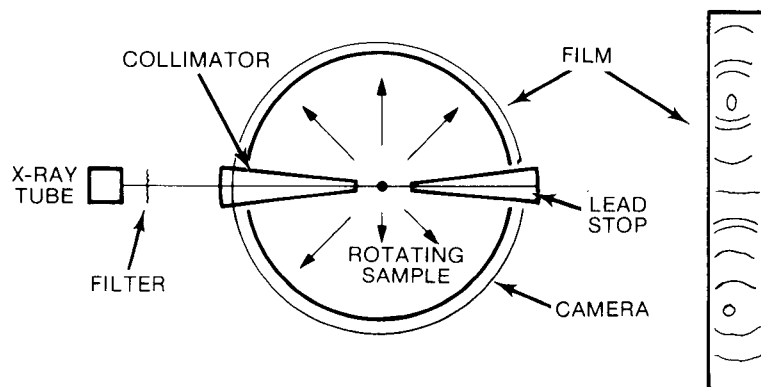
### Principle

A collimated beam of monochromatic X-Rays is directed upon a finely divided (500 mesh or finer) crystalline sample. The sample is in a thin capillary or in the form of a thin rod. This rod is rotated in the X-Ray beam and, as the various planes of the crystal are brought into the correct Bragg condition, the X-Rays are reflected radially outward. A film placed radially around the sample is exposed to these X-Rays and the random arrangement of the crystallites produces curved lines on the film. Proper measurement of the line spacings and knowledge of the wavelength permits highly accurate determination of the planar spacings and consequent molecular identifications.

### Sensitivity

Lattice parameter determinations can be made to an accuracy of  $\pm 0.001$  Angstroms.

### Schematic



### Data Presentation

Data is presented as a film strip from which the necessary measurements are made.

### Remarks

X-Ray Diffraction is probably the only technique which provides molecular and structural identification of solid materials or liquids or gasses which can be crystallized. As an example, ZnS can be determined by several chemical techniques but the fact that there are both a cubic and hexagonal form with different physical and electronic properties can only be determined positively by X-Ray Diffraction.



## X-RAY DIFFRACTION—DIFFRACTOMETER

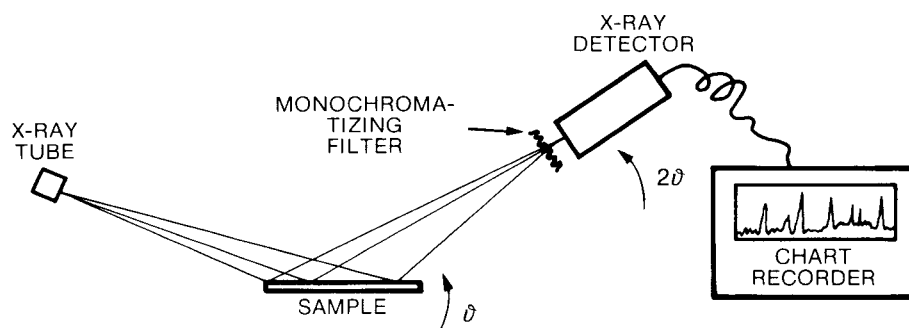
### Principle

A collimated beam of X-Rays is directed upon a flat sample of a finely divided material to be studied. The sample rotates at a fixed angular rate. A detector rotated at twice this angular rate. The detector, sample and X-Ray beam are precisely positioned so that when the Bragg condition is met, the X-Rays from the plane are reflected to the detector. The radiation is filtered at the detector so that only the characteristic  $K\alpha$  radiation reaches the detector. Lattice parameters can be accurately measured and identifications of compounds can be made.

### Sensitivity

Lattice parameter determinations can be made to an accuracy of  $\pm 0.001$  Angstroms or better.

### Schematic



### Data Presentation

Data is presented as a strip chart recording of the detector output during the scan. Quantitative measurements can be made by introducing a standard and ratioing peak heights of the standard and sample.

### Remarks

Broadening of the lines can determine crystallite sizes and strains within the crystallites. This technique also gives molecular and structure identification of crystalline materials.





## SINGLE CRYSTAL LAUE TECHNIQUE

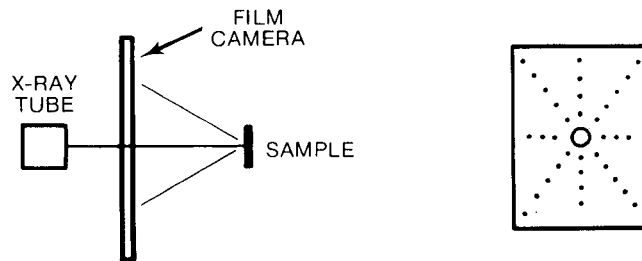
### Principle

A thin collimated pencil of "white" X-Rays is directed on a single crystal. The various planes within the crystal select an appropriate X-Ray wavelength and at an angle determined by Bragg's Law reflects the X-Ray onto a film. Depending on the orientation of the crystal planes, a pattern is produced (spot pattern). The technique is only useful for orientation determination of crystals and for orientation errors.

### Sensitivity

Variations of orientation can be determined to a high degree of accuracy, generally 0.02 degrees. This depends upon calculation methods, measurement accuracy, and equipment alignment.

### Schematic



### Data Presentation

Data is presented as a polaroid photograph of the resultant spot pattern. Calculations are made from this photograph based on film, crystal, and X-Ray beam positions and distances.



# X-RAY TOPOGRAPHY

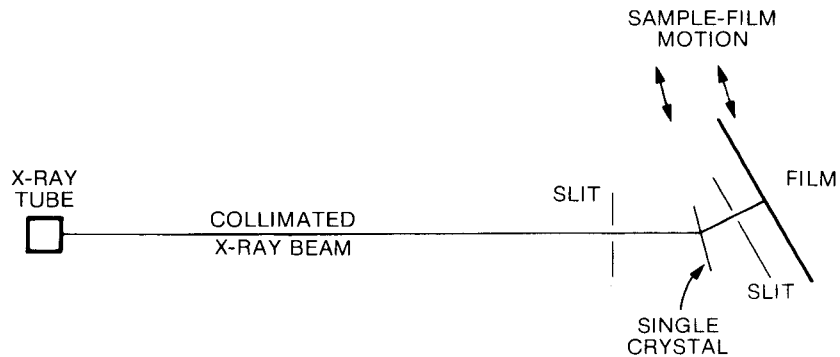
## Principle

X-Rays are used to display and record defects in thin single crystals. A thin collimated beam of characteristic X-Rays is directed on to a thin single crystal which has been prepositioned to the proper Bragg angle for a selected crystal plane. This plane reflects the beam onto a film. The crystal and film are scanned back and forth in parallel across the X-Ray beam. Defects such as etch pits, slip planes, etc., cause deviations from the Bragg angle causing an interruption of the reflection. These deviations create a photographic image on the film of the defect.

## Sensitivity

Sensitivity is really photographic quality and is determined by film grain, processing technique, X-Ray beam collimation, and slit widths.

## Schematic



## Data Presentation

Results are presented as an enlarged photograph of the crystal showing the defects.

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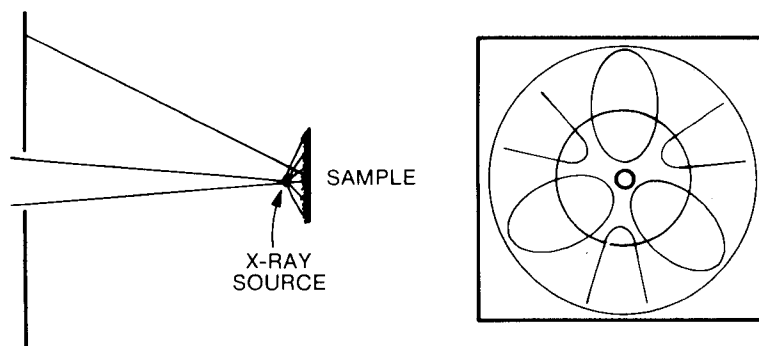
)

## PSUEDO-KOSSEL AND KOSSEL TECHNIQUES

**Principle** A point source of white radiation radiates hemispherically striking a single crystal placed in close proximity to the source. A film placed behind the source picks up the X-Ray reflections similar to a Laue photograph but in elliptical patterns, not spots as in Laue.

**Sensitivity** If the material is known and the ellipses are indexed, accurate measurements of the film, source, and crystal distances can provide lattice parameter accuracies of better than 0.001 Angstroms. Twinning and gross defects can also be detected readily by the breaks and other characteristics of the ellipses.

**Schematic**



**Data Presentation** Data is a photographic film displaying the ellipses. Measurements are made from this film.



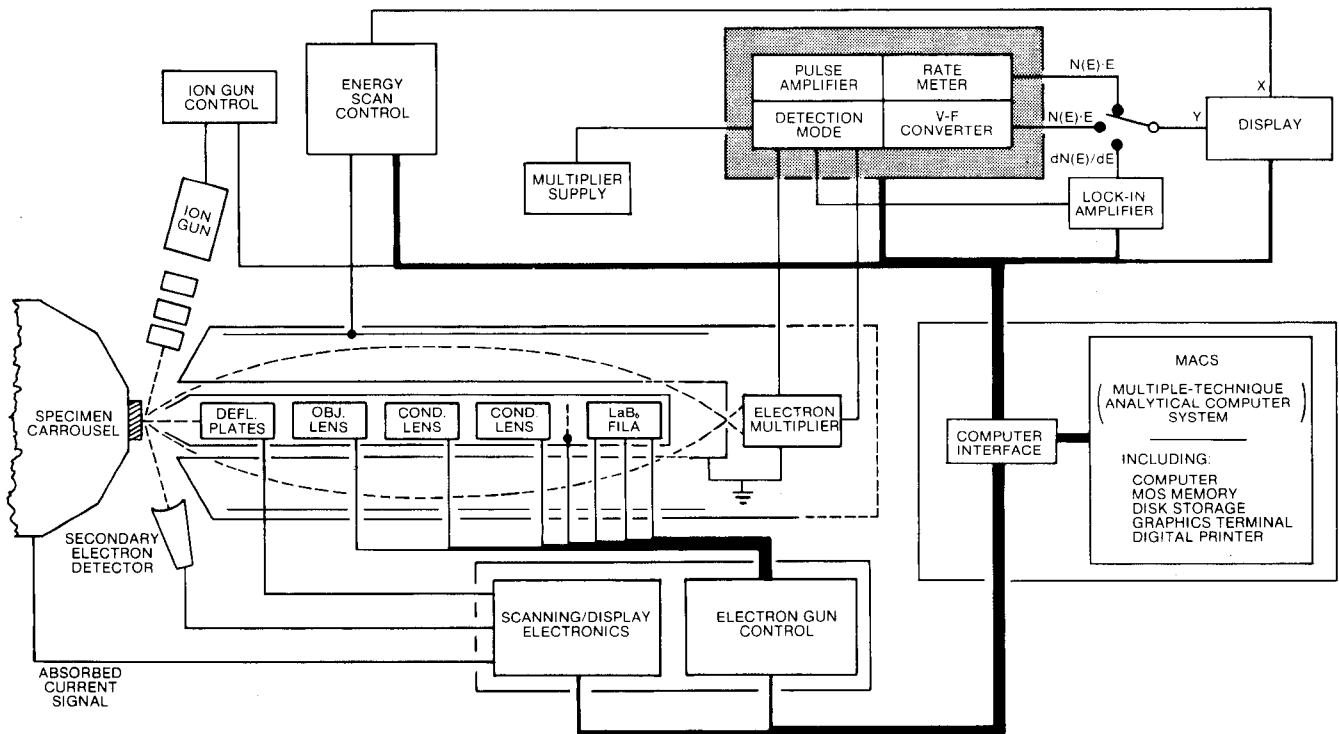
# SCANNING AUGER MICROSCOPY

## Principle

A 0.2 micron (2000 Å) to 5 micron beam of 1 to 10 kV electrons is rastered over a specimen exciting the surface atoms. Relaxation occurs through emission of Auger electrons whose characteristic energies identify the element from which they come. Spatial distribution of an element on the surface is obtained with the rastered electron beam.

## Sensitivity

Element and matrix dependent. About 500 ppm to absolute  $10^{-18}$  g in  $10 \text{ Å}$  depth using 2000 Å beam. All elements except H and He.



## Data Presentation

A plot of the number of Auger electrons or its derivative vs. energy provides elemental identification and semi-quantitative determinations.

A crt display synchronized with the rastering electron beam and brightness modulated proportional to Auger Electron quantity yields a spatial distribution map for any chosen element; SEM images are also possible.

When an ion sputter gun is used, concentration of elements as a function of depth into a sample is determined with resolution as good as  $10 \text{ Å}$ .

A PDP11/34 computer controls data acquisition and reduction. A microprocessor controls analyzer and scanning system.

## Applications

(Surfaces and films)

- Surface elemental analysis with high spacial resolution.
- Analysis depth  $\approx 10 \text{ Å}$  (a few atom layers).
- Correlation of surface topography to element location at up to 10000X.
- Surface vs. bulk differences using sputter profiling.
- Some chemical bonding identification, e.g., Si vs.  $\text{SiO}_2$ , Ti vs.  $\text{TiO}_2$ .





# AUGER ELECTRON SPECTROSCOPY

Typical Detection Limits  
 (All values atomic percentage)  
 Best Detection Limits  $\approx 0.1$  X Typical  
 (No standards available for elements marked "—")

H																	He
Li	Be															Ne	
0.5	0.8															—	
Na	Mg															A	
0.3	0.6															—	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
0.09	0.2	0.3	0.2	0.2	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.1	—
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
1.6	2	0.8	0.5	0.4	0.3	—	0.2	0.1	0.09	0.09	0.08	0.09	0.09	0.1	0.2	0.2	0.3
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
0.5	0.7	0.2	0.3	0.6	0.7	0.9	—	0.3	0.2	0.2	2.8	0.2	0.2	0.2	—	—	—
Fr	Ra	Ac															
—	—	—															

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
0.5	0.3	0.3	—	0.4	0.4	0.4	0.8	0.8	0.9	0.3	1.1	0.9	1.1
Th	Pa	U											
0.3	—	0.2											



## SECONDARY ION MASS SPECTROSCOPY

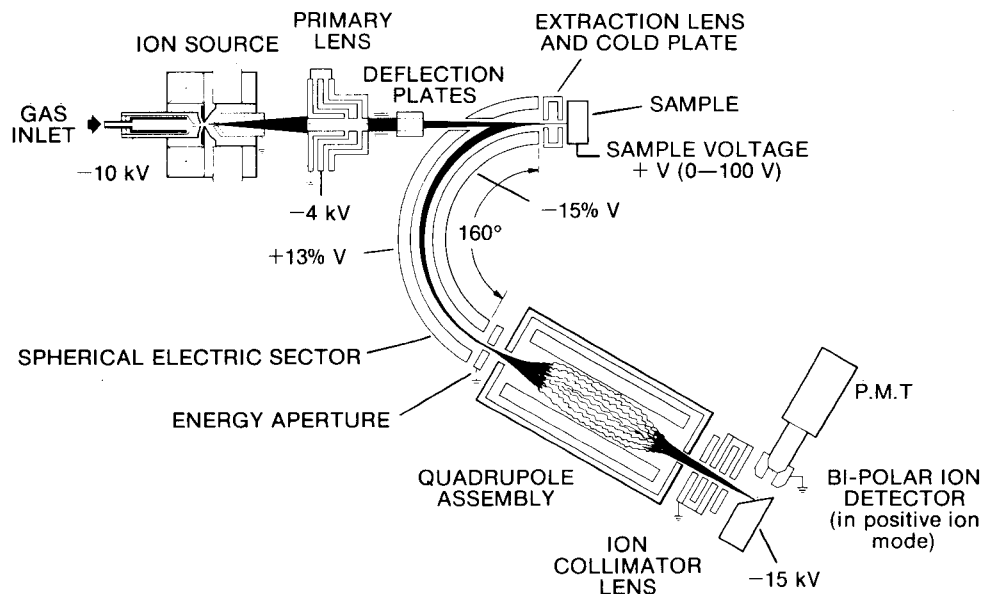
### Principle

An energetic beam of specific ions impinges on a sample and dissipates its energy to lattice atoms causing surface and near surface species to be ejected from the sample. The ionic portion of these atoms and molecules are energy and mass analyzed providing elemental information. An inherently destructive surface analytical technique.

### Sensitivity

Element and matrix dependent. Very wide range: 0.1 ppm (Li) to 500 ppm (Ne). All elements and isotopes.

### Schematic



### Data Presentation

A plot of secondary ion intensity vs. mass/charge is the data used for elemental and molecular fragment identification. Isotopes of the same element can be distinguished. Either positive or negative ions may be analyzed.

By rastering the primary ion beam and synchronizing the secondary ion signal to it on a CRT display, an elemental map of the surface is obtained.

Computer control of data acquisition and reduction is available to a limited degree.

### Applications

(Surfaces and films)

- Surface elemental and isotopic analysis.
- Very high detection sensitivity for some elements (alkali metals—ppb's).
- Spatial resolution elemental mapping.
- Hydrogen detection capability.
- Chemical structure sometimes possible by identification of secondary ion molecular fragments.
- Quadrupole mass analyzer inherent in system allowing residual gas analysis.

This service is available through external organizations.



# SECONDARY ION MASS SPECTROSCOPY

Minimum Detection Limits  
(Semi-quantitative Guide)  
(All values in parts per million (ppm))

H	0.6	He	200
Li	0.1	Be	2
Na	0.2	Mg	3
K	0.3	Ca	3
Rb	0.7	Sr	3
Cs	0.6	Ba	4
Fr	0.9	Ra	5
		Ac	16
		Sc	4
		Ti	15
		V	15
		Cr	10
		Mn	6
		Fe	20
		Co	20
		Ni	25
		Cu	20
		Zn	30
		Ga	15
		Ge	80
		As	95
		Se	100
		Br	115
		Kr	200
		Sr	3
		Y	8
		Zr	30
		Nb	25
		Mo	140
		Tc	15
		Ru	115
		Rh	25
		Pd	115
		Ag	20
		Cd	95
		In	25
		Sn	115
		Sb	80
		Te	130
		I	50
		Xe	300
		Hf	50
		Ta	30
		W	290
		Re	130
		Os	320
		Ir	250
		Pt	200
		Au	45
		Hg	280
		Tl	45
		Pb	200
		Bi	90
		Po	52
		At	45
		Rn	70
		Ne	500
		F	140
		O	60
		S	140
		Cl	55
		A	100
		C	25
		N	70
		P	140
		Si	5
		Al	3

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Dy	Ho	Er	Tm	Yb	Lu
12	8	40	9	35	12	40	50	—	40	10	22	9
Th	Pa	U		Pu								
23	20	33		32								



# X-RAY PHOTOELECTRON SPECTROSCOPY

(Also called ESCA-Electron Spectroscopy for Chemical Analysis)

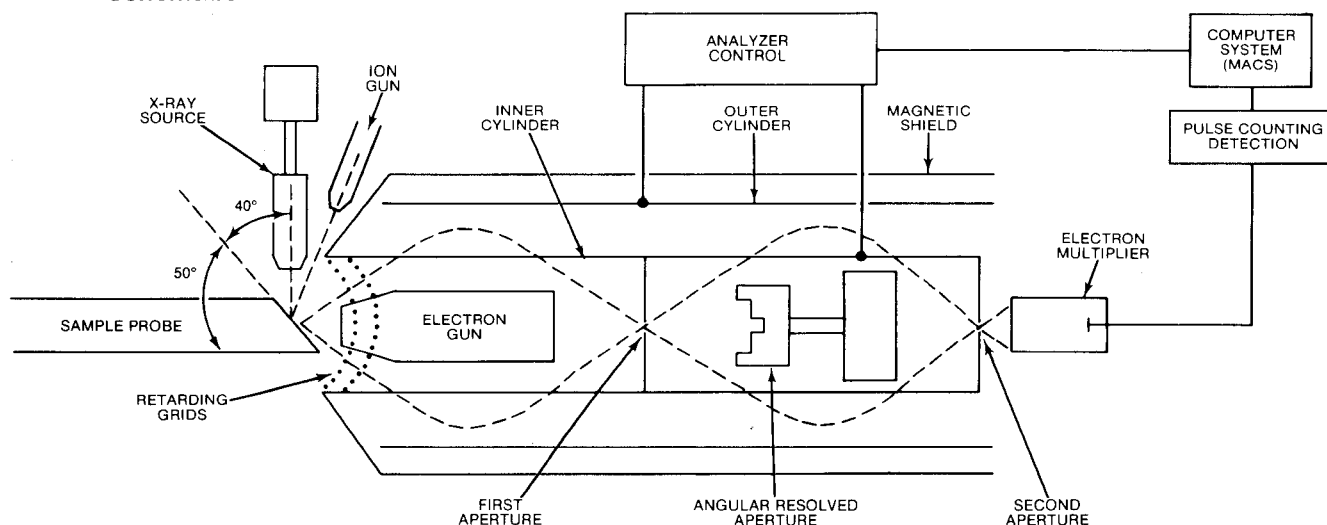
## Principle

A sample is bombarded with a mono-energetic flux of X-Rays exciting the surface atoms. The photoelectrons ejected during the excitation are energy analyzed providing elemental identification from the atomic electron binding energies. Chemical bonding information is deduced from the precise position and shape of the photoelectron vs. energy spectra.

## Sensitivity

Element and matrix dependent. About 10 ppm best. All elements except H.

## Schematic



## Data Presentation

A plot of the number of photoelectrons in a given energy interval vs. energy provides elemental identification. High resolution of the energy allows determination of precise binding energies and peak shapes for chemical bonding information. Quantitative determinations are made from peak height or area measurements.

Depth composition profiles are obtained by sequential ion etching and analyzing. Varying the analyzer acceptance angle relative to the sample gives a nondestructive limited depth analysis; predominately top surface atoms ( $\approx 10 \text{ \AA}$ ) detected with grazing angle acceptance aperture, deeper ( $\approx 50 \text{ \AA}$ ) atoms with high angle acceptance aperture.

Data acquisition and reduction controlled by computer, PDP11 or similar.

## Applications

(Surfaces and films)

- Surface elemental analysis with chemical bonding information.
- Nondestructive probing medium.
- Organic/Polymer surface compatible.
- Glass/Dielectric materials compatible.
- Catalysis studies.
- Surface vs. bulk analysis.
- Variable analysis depth.

This service is available through external organizations.

הנהגות המנהל ( )







## CHEMICAL SUPPLY HUT

The "Chem Hut" is run and operated by the Analytical Chemistry Laboratory. It provides small volume chemicals and chemical laboratory supplies as a service to the company. Special chemical items can be ordered if not in stock. The storage of chemicals for continuing needs can be arranged so that a proper supply will always be readily available.

The "Chem Hut" operates on a "no profit" basis. All supplies are charged at cost with no operating expenses added.

The list of chemicals is too long to include in this brochure but a list of some of the non-chemical items stocked is included.

The "Chem Hut" is located on the loading dock of Building 50. The Mailing Station is 50-199 and the phone extension is 6822.



**NON-CHEMICAL ITEMS STOCKED IN CHEM HUT  
50-199**

Adhesives:

Crystal bond  
Duco cement  
Epoxy patch  
Permabond  
Silicon 3144 RTV sealant

Aerator

Applicators: Cotton tipped

Aprons: Lab, plastic

Asbestos centered gauze, iron wire

Bags: Plastic assorted

Beads:

Glass  
Boiling

Beakers:

Poly:	50 ml.	250 ml.	1000 ml.
	100 ml.	400 ml.	2000 ml.
	150 ml.	600 ml.	4000 ml.
Pyrex:	10 ml.	400 ml.	
	30 ml.	600 ml.	
	50 ml.	800 ml.	
	100 ml.	1000 ml.	
	200 ml.	2000 ml.	
	250 ml.	3000 ml.	
	300 ml.	4000 ml.	
Stainless steel:	600 ml.		
	1200 ml.		
Teflon:	100 ml.		
Tripour	50 ml.	250 ml.	
disposable:	100 ml.	400 ml.	
	150 ml.	1000 ml.	

Blade, surgical: #11, 15, 20, 21, 22, 23

Bottle:

Aspirator, poly  
Boston round: 4 oz., 8 oz., 16 oz., 32 oz.  
Clear squat: 2 oz., 4 oz., 8 oz., 16 oz.  
Dropper  
Amber, narrow mouth  
Oval, poly  
Reagent, pyrex, with glass stoppers  
Wash, poly: 125 ml., 250 ml., 500 ml., 1000 ml.  
Amber, wide mouth

Box, plastic, assorted

Brush:

Acid  
Artist  
Buret  
Flask  
Lab  
Paint  
Test tube

Bulb:

Lamp  
Drying  
Infra red  
250 watt  
Mettler balance  
Microscope, 6V, 15W  
Kjeldahl connecting  
Rubber: single neck  
double neck  
double bulb

Burets: 10 ml., 25 ml., 50 ml., 500 ml.

Burner, Bunsen

Caps, assorted

Carboy, 5 gal.

Carriers, acid

Clamps, assorted

Cleaners:

Alconox  
Basic  
Bon Ami  
Glass  
Micro  
Pipe  
Scotch Brite pads  
Superl  
Ajax

Condensers, assorted

Connectors, T's and Y's

Corks, assorted

Cotton balls

Cover glass, assorted

Handwritten text consisting of a series of vertical lines and symbols, possibly representing a barcode or a specific code system. The symbols are arranged in a regular, repeating pattern.

Crucible cover, assorted				Glasses, safety
Crucibles, assorted				Gloves:
Crucible holder				Cotton
Cylinder, graduated:				Clean room
Glass:	10 ml.	100 ml.	1000 ml.	Latex
	25 ml.	250 ml.	2000 ml.	Nylon
	50 ml.	500 ml.		Poly, disposable
Poly:	10 ml.	250 ml.	2000 ml.	Surgical
	50 ml.	500 ml.	4000 ml.	Goggles, safety
	100 ml.	1000 ml.		Handles:
Cylinder, Hydrometer				Lab scoop
				Scalpel, assorted
Dessicator				Heating mantle
Dish:				Hydrometer, assorted
Aluminum				Kleenex
Crystalization, assorted				Lab coats, size 32, 34, 36, 38, 40, 42, 44, 46
Evaporation				Labels:
Petri, assorted				"Rinsed"
Droppers, medicine, assorted				Safety, assorted
Electrodes, assorted				Lids, assorted
Faucets, teflon				Lotion, hand
Film:				Lubricant:
Polaroid, B&W, 107				Dow Corning high vacuum grease
Polaroid, color, 108				Gas valve
Riston 25 photopolymer resist				Halocarbon 25-5S
Spectrum analysis #1				Stopcock grease
Filtergrip, vacuum				Matting, rubber
Filter holder, plastic and metal				Mylar
Filters, assorted				Needles, Hypo, assorted
Flasks:				Paddle, poly stir
Boiling				Paint, spray
Distilling, 2 neck, 3 neck				Paper:
Erlenmeyer, assorted				Bibulous
Filter, assorted				Filter, assorted
Round bottom, assorted				Powder
Volumetric, assorted				Lens
Flexaframe connectors				pH
Foil, aluminum				Weighing
Funnel:				Pens
Buchner, assorted				Pipets, assorted
Pyrex, long and short stem				Pipet filler
Filtering				Policemen, rubber
Poly, assorted				
Powder, assorted				
Separatory, assorted				
Furnace elements, 120 V				





Pump:

Filter  
Pressure vacuum  
Oscillating

Rack, glassware

Respirator

Ring, for support stand

Rod, metal

Saran wrap

Scissors:

Office  
Surgical

Scoop:

Lab  
Poly

Scriber, diamond tipped

Sieve, assorted

Slides, microscope, assorted

Spatula:

Lab spoon  
Micro spoon  
Porcelain, assorted

Sponges

Stirrer, magnetic

Stir bar, teflon coated, assorted

Stir rod

Stoppers, rubber, assorted

Stopcock, assorted

Support rod, assorted

Syringe:

Disposable, assorted  
Luer-lok tip, assorted

Tape:

4051 blank  
Calculator  
Labeling  
Magnetic, Tek 31  
Scotch, double coated

Texwipes

Thermometer:

Centigrade, assorted  
Fahrenheit, assorted  
Surface

Tissue, Kimwipe

Tong:

Crucible  
Beaker  
Teflon tipped

Towels:

Auto shop  
Kaydry  
Lint free  
Shopmaster

Triangles, assorted

Tube:

Adapter  
Blood sugar  
Centrifuge  
Drying  
Filtering  
Gas dispersion  
Test, assorted

Tubing:

Imperial, assorted  
Pressure vacuum  
Silicon rubber, assorted  
Surgical, assorted  
Tygon, assorted

Tungston boats

Tweezers, assorted

Vials:

Glass, assorted  
Plastic, assorted  
Static free poly, assorted

Watchglass, assorted

Wipes, Webril

