Analytical Answers, Inc.

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SCANNING ELECTRON MICROSCOPY (SEM)

Scanning Electron Microscopy (SEM) is a high resolution, great depth of field imaging technique. It shows topographical, structural and some elemental information at magnifications of 10X to 300,000X.

SEM Applications include:

1. Materials Evaluation:

Grain size distribution
Surface roughness and porosity
Particle sizing
Materials homogeneity
Intermetallic distribution
Characterization of elemental diffusion

2. Failure Analysis:

Contamination location
Examination for mechanical damage
Electrostatic discharge determination
Microcrack detection

3. Quality Control Screening:

Comparison of good to bad samples
Material thickness determination
Dimension verification
MIL-standard screening

Principle of Operation:

A finely focused electron beam is scanned across the surface of the sample generating secondary electrons, backscattered electrons and x-ray signals. These signals are collected by specific detectors and displayed on a viewing cathode ray tube. The raster on the cathode ray tube corresponds to the raster on the sample, while the brightness on the cathode ray tube corresponds to the amount of signal generated at each point on the sample.
Secondary Electron Imaging (SEI) shows the topography of surface features as small as 6 nm.

The production of the SEI signal is primarily dependent on surface roughness.

High Resolution Secondary Electron Imaging (HRSEI) shows the topography of features as small as 3 nm. HRSEI can also image films and stains as thin as a few atomic monolayers. An HRSEI equipped SEM can evaluate electron beam sensitive and charging sensitive materials at magnifications up to 300,000X, often without the need for sample coating and without sample damage.

Cryogenic Secondary Electron Imaging (CSEI) shows the size, structure, and shape of wet materials such as hydrated polymers, slurries, oils, biological materials and food products. An SEM equipped with a cryo-preparation system will allow all SEM imaging and analysis capabilities without the need for drying the sample or extensive extraction procedures.

Backscattered Electron Imaging (BEI) shows the lateral distribution of elements or compounds within the top micron of the sample. An SEM equipped with a high resolution Robinson type detector (RBEI) can analyze features as small as 10 nm and composition variations of as little as 0.2 percent. The production of the RBEI signal is primarily dependent on surface composition. The Robinson Backscattered Electron Signal is sorted by intensity to produce images which show the distribution of elements and compounds within the top 0.5 microns of the sample's surface.

Electron Beam Induced Current (EBIC) Imaging shows the location of sub-surface opens or shorts in microelectronic devices. It is a useful failure analysis diagnostic tool.

Voltage Contrast (VC) Imaging shows presence of applied bias on the surface of a circuit or device. It identifies opens or shorts as well as voltage drops across a circuit.

Electron Channeling Patterns (ECP) show localized crystallinity in a 3 micron area. It can analyze the crystalline structure of a material on a microscale and locate defects within structures.

Data Output:

The SEM images are viewed on a TV screen and photographed from a high resolution (2000 lines per inch) cathode ray tube with positive or positive/negative Polaroid film.

Sample Constraints:

The sample can be up to 15 cm x 10 cm x 7.5 cm in size. The sample must be compatible with a 10^{-6} torr vacuum; i.e., non-volatile and not susceptible to electron beam induced damage.