MSE 310 Lecture 9

Surface Morphology

Surface analysis is the use of microscopic chemical and physical probes that give information about the surface region of a sample. (The term **sample** refers to any piece of material, structure, device, or substance that is under study). The probed region may be the extreme top layer of atoms (the only true surface, for purists), or it may extend up to several microns (millionths of a meter) beneath the sample surface, depending on the technique used. The analysis is done to provide information about such characteristics as the chemical composition, the level of trace impurities, or the physical structure or appearance of the sampled region. Such information is of importance to researchers or manufacturers who must understand the materials in order to verify a theory or make a better product.

Many of the techniques used to probe surfaces use a beam of ions (SIMS) to strike the surface and knock off atoms of the sample material. These atoms are ionized and are identified and measured using a technique known as mass spectrometry. Other probes strike the surface with electrons (Auger spectrometry) or X-rays and measure the resulting electron or photon emissions to probe the sample. Measurements of the way high-energy helium nuclei bounce off a sample can be used as a sensitive measure of surface layer composition and thickness (RBS). Surface structure on a microscopic scale is observed by using electron microscopes (SEM), optical microscopes, and atomic force or scanning probe microscopes (AFM/SPM).

Even when one is not solely interested in the surface, sometimes a technique that happens to probe only the surface can provide better information than other

techniques that probe the entire the sample. A surface analysis technique is then often used when it is reasonable to assume that a surface measurement is representative of the rest of the sample. In the case of tiny particles, such as the fly ash from a waste incinerator or a piece of cosmic dust, the surface region makes up theentiresample.

Surface Morphology is a subset of Analytical Imaging, which is an advanced form of high spatial resolution imaging that uses sophisticated microscopes to produce images of products, samples and objects that cannot be seen with the naked eye. Such images originates from the exposed **surface** of the sample or product. Morphology is a qualitative evaluation of the three dimensional shape of a surface, whereas topography provides quantitative feature dimensions.
Morphology studies the shape, texture and distribution of materials at a surface, whereas topography focuses on the quantitative dimensional measurement of features on a surface. The choice of analytical technique therefore depends on whether qualitative or quantitative information is required, and when required, both can be obtained on the sample surface simultaneously.

Surface morphology can be examined with the help of optical and electron microscope. A light **microscope** uses light to illuminate specimens and glass lenses to magnify images, an **electron microscope** uses a beam of **electrons** to illuminate specimens and magnetic lenses to magnify images. The resolution (the level of image detailing) is the main **difference between** these two **microscopes**.
Optical microscopes use a simple lens, whereas **electron microscopes** use an electrostatic or electromagnetic lens.**Optical microscopes** use photons or **light** energy, while **electron microscopes** use **electrons**, which have shorter wavelengths that allows greater magnification.

Differences between Light Microscope and Electron Microscope	
Light Microscope	**Electron Microscope**
Illuminating source is the Light.	Illuminating source is the beam of electrons.
Specimen preparation takes usually few minutes to hours.	Specimen preparation takes usually takes few days.
Live or Dead specimen may be seen.	Only Dead or Dried specimens are seen.
Condenser, Objective and eye piece lenses are made up of glasses.	All lenses are electromagnetic.
It has low resolving power (0.25µm to 0.3µm).	It has high resolving power (0.001µm), about 250 times higher than light microscope.
It has a magnification of of 500X to 1500X.	It has a magnification of 100,000X to 300,000X.
The object is 5µm or thicker.	The object is 0.1µm or thinner.
Image is Colored.	Image is Black and White.
Vacuum is not required.	Vacuum is essential for its operation.
There is no need of high voltage electricity.	High voltage electric current is required (50,000 Volts and above).
There is no cooling system.	It has a cooling system to take out heat generated by high electric current.
Filament is not used.	Tungsten filament is used to produce electrons.
Radiation risk is absent.	There is risk of radiation leakage.
Image is seen by eyes through ocular lens.	Image is received in Zinc Sulphate Fluorescent Screen or Photographic Plate.
It is used for the study of detailed gross internal structure.	It is used in the study of external surface, ultra structure of cell and very small organisms.

The characteristics and features of solid **surfaces** depend on the chemical structure of the **surface**. A **surface analysis** method is a technique for discovering the chemical structure of an extremely shallow and thin area called the **surface** number atomic layer of the solid matter.

In this course following surface techniques will be introduced:

X-ray fluorescence
Auger electron spectroscopy,
Secondary ion mass spectroscopy
Scanning tunneling microscopy
Photoelectron spectroscopy
Atomic force microscopy