Chapter 3
Characterization of Nanomaterials

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ABSTRACT

This chapter provides a general introduction to the new learners in the field of the synthesis and characterization of nanoparticles. The people who are familiar with this field but are unable to interpret the data will learn how to interpret from various data available. Keeping in the mind the usefulness of numerical data, this chapter includes a number of tables and graphs for the help and easy understanding of the students.

CHARACTERIZATION OF NANOMATERIALS

Nanotechnology is an emerging interdisciplinary area with wide application in all fields of science and technology. The basic of nanotechnology lies with the fact that with decrease in the particle size to nanometer range the properties of the materials changes noticeably (Joshi et al., 2008). But measuring the particle size is not a very easy task and they are posing challenges to the scientists working in this field. Thus, the discovery of various sophisticated nano characterization techniques has helped in better control of the size, morphology of the materials in nano range.

There are various characterization techniques; some of them are surface area analyzer, characterization by spectroscopy, characterization by X-Ray, characterization by microscopy, thermal analyzer and magnetic property analyzer.

Nanomaterial Characterization by Spectroscopy

Use of spectroscopic methods for the characterization began in late 1950s. These methods can provide information about the chemical nature of the surfaces as well as help in determining their concentration. Sometimes it is seen that the chemical nature of the surface of a solid is different from the interior of the solid. So, one shouldn't focus completely on the interior bulk composition, because the composition of the surface layer may be more important.

DOI: 10.4018/978-1-5225-5745-6.ch003

Ultraviolet and Visible Radiation (UV-Vis)

Principle

Ultraviolet-Visible spectroscopy works with the principle of Beer Lambert's law.

"When a beam of monochromatic light is passed through a solution of an absorbing substance, the rate of decrease of intensity of radiation with thickness of the absorbing solution is proportional to the incident radiation as well as the concentration of the solution."

The expression of Beer-Lambert law is- $A = \log (I_0/I) = \mathcal{E}cl$

Where, A = absorbance, I_0 = intensity of light incident upon sample cell, I = intensity of light leaving sample cell, C = molar concentration of solute, L = length of sample cell (cm.), $\mathcal{E}$= molar absorptivity

Ultraviolet light: wavelengths in the range of 190 and 400 nm, Visible light: wavelengths in the range of 400 and 800 nm

- **Light Source**

Tungsten filament lamps: Rich in red radiations, emit the radiations of 375 nm.

Hydrogen-Deuterium: Emits the radiations below 375 nm

Ultraviolet-Visible (UV-Vis) spectroscopy is a characterization technique that is used to quantify the amount of light that is absorbed and scattered by a sample. Absorption is associated with the **excitation of electrons** from lower to higher energy levels. The Double beam UV-Vis spectrophotometer is shown in figure 1.

Working

The cell holding the sample is transparent, and is usually made up of quartz or fused silica. The thickness of cell is usually 1 cm. Cell containing the sample is placed between a light source and a photo detector (figure 1), and the intensity of a beam of light is measured before and after passing through the sample based on Beer- Lamberts law.

Figure 1.