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SPECTROSCOPIC TECHNIQUES FOR STUDYING OPTICAL PROPERTIES OF NANOMATERIALS AND ITS APPLICATIONS FOR POWER ELECTRONICS DEVICES

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ABSTRACT

Optical spectroscopic techniques are widely used in the study of optical properties of different materials including nanomaterials. The different techniques are usually based on measuring absorption, scattering or emission of light that contains information about properties of the materials. Commonly used techniques include electronic absorption (UV-vis), photoluminescence (PL), infrared red (IR) absorption, Raman scattering, dynamic light scattering, as well as time-resolved techniques, such as transient absorption and time-resolved luminescence. Other more specialized techniques include single molecular spectroscopy and nonlinear optical techniques such as second harmonic or sum frequency generation and luminescence up-conversion. These different techniques can provide different information about the molecular properties of interest. Impedance spectroscopy technique at a constant frequency is used to determine the dielectric properties of the composites at low temperatures. The materials of polymer were analyzed by X-ray diffraction (XRD).

In this paper several common spectroscopic techniques are reviewed with emphasis on their principle of operation as well as spectral interpretation. The main objective is to explain how one can get useful physical information about the nanomaterials under study from the optical spectrum measured experimentally. After observing the successful material it is used to make some power electronic devices.

Many times in composite materials, a polymer material is used because polymers are flexible, easy to fabricate and superior in dielectric break down strength. This type of composites has high capability of energy storage and can be used in capacitors and energy storage device. Dielectric materials have very low electrical conductivity but can support large electrostatic fields. Dielectric ceramics are used to make capacitors, resistors, and insulators.

For this reason in this study we have characterize a polymeric system composed of a thermoplast polymer filled with nanometer size ceramic particles. Composites with different filler weight concentrations are prepared and their dielectric performance is characterized. Impedance spectroscopy technique at a constant frequency is used to determine the dielectric properties of the composites at low temperatures. The materials of polymer were analyzed by X-ray diffraction (XRD). The polymer ceramic composites were prepared using polyvinyl alcohol (PVA) as polymer matrix and ceramics powder by hot pressing technique. The microstructure/surface morphology of the composite was analyzed by scanning electron microscope (SEM). It is possible to decouple the transport and other physical properties to enable new ways to tailor dielectric materials properties and performance for power sector applications like Power Electronics.

KEYWORDS: optical spectroscopic; nanomaterial; impedance spectroscopy.

INTRODUCTION :

Electronic absorption or UV-visible spectroscopy is one of the simplest and yet most useful optical techniques for studying optical and electronic properties of nanomaterials. This technique is based on the measurement of light absorption by a sample, typically using commercially available spectrometers at reasonable cost. As illustrated in Fig. 2.1, the intensity of light from a light source, e.g. a lamp, is measured by a light detector, e.g. photodiode, photomultiplier tube (PMT) PMT or charge coupled device (CCD) detector, without (blank) and with a sample between the light source and detector. If the sample absorbs light at some wavelength, the transmitted light will be reduced. The intensity of the transmitted light plotted as a function of light wavelength will give a spectrum of the sample absorption. Most spectrometers cover the wavelength range from about 200 nm to 800 nm. Extending the measurement beyond 800 nm is possible but usually requires different light source, optics, and detector.

BLOCK DIAGRAM :

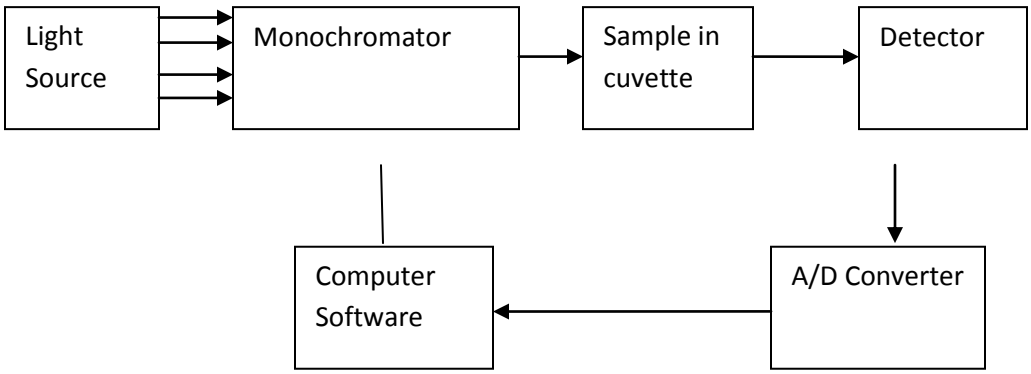

Fig (a) Schematic diagram of key components of a typical UV-vis spectrometer that

includes a light source, e.g. a lamp, monochromator to disperse the incident light, sample

cuvette and holder, detector, e.g. PMT, photodiodes or CCD, analog-to-digital (A/D)

convertors, and computer with software to control the scan of the monochromator and data acquision

TECHNIQUES AND METHODS:

Photoluminescence and electroluminescence spectroscopy:

At the fundamental level, the principle underlying photoluminescence (PL) spectroscopy is very similar to that of electronic absorption spectroscopy. They both involve electronic transition of initial and final states coupled by the electrical dipole operator. The main difference is that the transition involved in PL is from a higher energy level or state to a lower energy level. There is also an important practical difference between the two techniques in that PL is a zero background experiment, i.e. no signal detected when there is no PL, which is in contrast to absorption spectroscopy that is a nonzero background experiment. Zero-background experiments are intrinsically more sensitive than nonzero

background experiments. Therefore, PL is typically more sensitive than electronic

absorption measurement. A typical PL spectrum is just a plot of the PL intensity as a function of wavelength for a fixed excitation wavelength. A photoluminescence excitation (PLE) spectrum, however, is a measure of PL at a fixed emission wavelength as a function of excitation wavelength. To a good approximation, PLE is similar to the electronic absorption spectrum as long as no complications are involved, e.g. involvement of multiple overlapping excited states or formation of excimers (excited dimers). PLE is

useful for studying samples for which electronic absorption spectrum is challenging to obtain, e.g. due to low transmission as a result of thickness or high concentration of the sample.

Infrared (IR) and Raman vibrational spectroscopy:

Infrared and Raman are two common vibration spectroscopy techniques useful for characterizing structural properties such as vibration frequencies of molecules and phonons as well as crystal structures of solids. Since they often have different selection rules for transitions, they are complementary. IR spectroscopy is based on the measurement of transmitted IR light through a sample. The absorbance measured as a function of frequency contains information about the vibration or phonon modes or frequencies of the sample. The key components for an IR spectrometer are similar to

that of UV-visible spectrometer except that the light is in the IR and the detector and optical components such as gratings and mirrors all need to be appropriate for IR light. Various commercial spectrometers, including FTIR (Fourier transform IR), are usually available in most institutions. The sample for IR spectroscopy measurement needs to be thin or dilute enough so Beer's law is valid or saturation can be avoided, similar

to UV-visible spectroscopy. For molecules, the IR spectrum reflects their

RESULT:

This Paper covers some of the most commonly used optical spectroscopy techniques including electronic absorption, luminescence, IR, Raman, as well as time-resolved techniques, such as transient absorption and time-resolved luminescence. More specialized techniques such as single molecular spectroscopy and nonlinear optical techniques have also been briefly discussed.

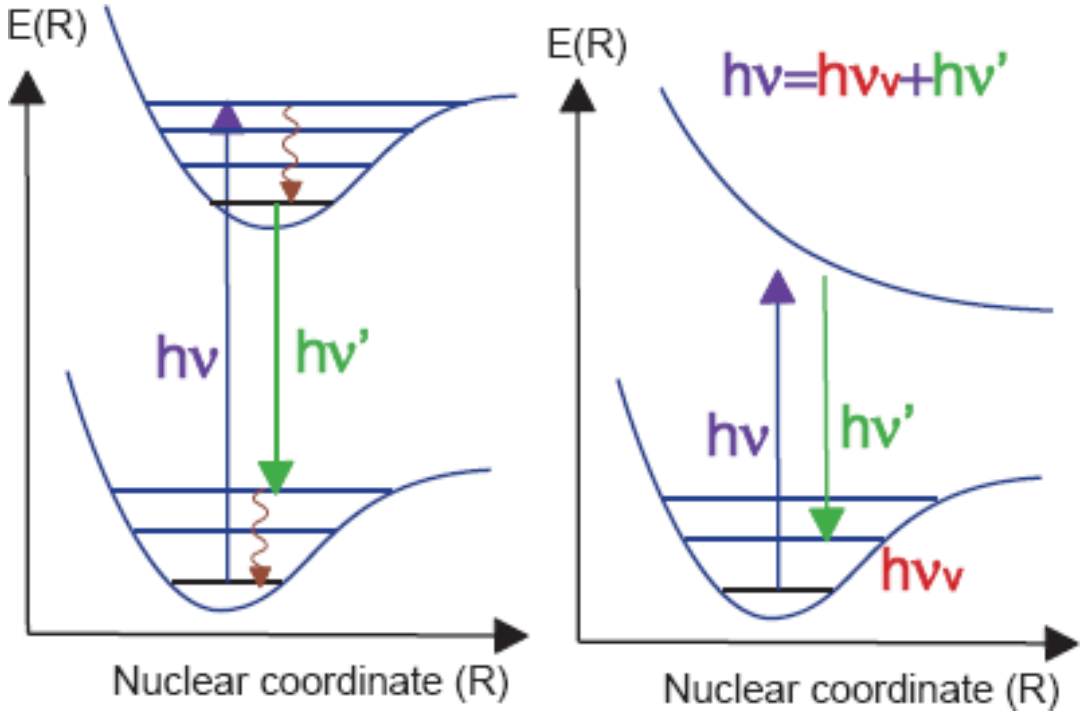

Fig. 2. Schematic illustration of electronic transitions in a diatomic molecule with two

different excited state potential energy curves: bound (left) and repulsive (right). The long

vertical arrows indicate electronic transition while the shorter red arrows indicate vibrational transition or IR absorption in the ground electronic state.

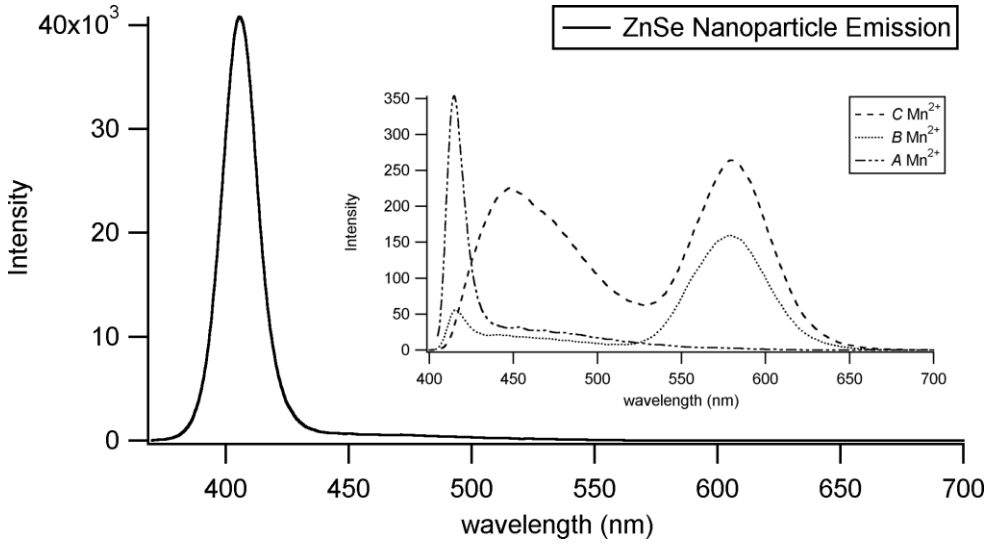

Fig. Comparison of the luminescence spectra of undoped and Mn2+-doped ZnSe nanoparticles samples A, B and C with increasing level of Mn2+ doping when going from
A to B to C.

CONCLUSION :

This More specialized techniques such as single molecular spectroscopy and nonlinear optical techniques have also been briefly discussed. Selection of these different techniques for applications depends on the information of interest. In further applications, many specific examples of applications based on these various techniques will be used to demonstrate how to extract physical information from the measured spectrum.

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