Optical study of environmental and light induced effects on 8-hydroxyquinoline derivative metal complex small molecules thin films

Vivek Kumar Shukla , Debjit Datta, and Satyendra Kumar
Department of Physics, and Samtel Centre for Display Technologies
Indian Institute of Technology Kanpur, Kanpur – 208016, India
E-mail : satyen@iitk.ac.in

Abstract:

We report on the synthesis and film formation on a variety of small molecules such as Alq_3, Znq_2 and Inq_3, used as light emitting material in organic light emitting diodes (OLEDs) .

The organic materials are usually susceptible to environmental aging and photo-oxidation, which influences their viability for commercial utility. Here, we examine the effects of oxygen and light on these organic materials to enhance the efficiency and lifetime of OLEDs. Optical techniques – ellipsometry, photoluminescence and infrared spectroscopies- have been used to study of environmental and light induced effects on 8-hydroxyquinoline derivative metal complex small molecules thin films

1.Objectives:

Since the first report on EL device using organic thin film, organic materials such as small molecules have attracted much attention as a candidate for organic light emitting devices [1]. Tris (8-hydroxyquinoline) metal complexes are used for the fabrication of organic light emitting displays (OLEDs) [2]. Tris (8-hydroxyquinoline) aluminium (Alq_3) is one of the widely used green light-emitting layer in organic light emitting devices. The organic materials like Alq_3 are usually susceptible to environmental aging [3,4], and photo-oxidation [5], which influences their viability for commercial utility. Therefore, it is necessary to understand the effects of oxygen and light on these organic materials to enhance the efficiency and lifetime of OLEDs.

2.Results:

In the process of synthesis of 8-hydroxyquinoline metal complexes (eg: Alq_3), warm solution of 8-hydroxyquinoline (HQ) is added slowly to a metal salt solution (eg: $AlCl_3$). The pH value of mixed solution was adjusted. The obtained colored precipitate is filtered and washed with warm water for several times, dried and purified.

The films of Alq_3, Znq_2 and Inq_3 were prepared by standard thermal evaporation in vacuum on Si and quartz substrates in vacuum. Prior to deposition, the substrates were cleaned in an ultrasonic bath followed by different steps with acetone, trichloroethylene,

distilled water and ethanol. A molybdenum boat was used for evaporation and substrates were kept at room temperature.

Thickness of the film during the growth was monitored using digital thickness monitor. The thicknesses of the films were also directly measured outside the chamber using Alphastep profiler and also by fitting the data by Spectroscopy Ellipsometry measurements. The thicknesses in all cases are in good agreement with each other.

Photoluminescence data at room temperature was recorded using a spectrofluorometer (Fluorolog 3, Jobin Yvon) with front face detecting geometry, in which the emitted signal is collected at ~22° with respect to the normal at the surface of the sample, coincident with the excitation light direction. Transmission spectra at room temperature have been measured using Perkin Elmer UV/VIS Lambda 40 Spectrometer on these thin films deposited on quartz substrate. Spectroscopic ellipsometry (SE) data was recorded on the samples using a phase modulated spectroscopic ellipsometer (UVSEL, Jobin Yvon Horiba) with a wavelength scanning range from 260 to 1700 nm.

The films are exposed with UV and visible light in different experimental conditions of air, vacuum and temperature.

The effect of light and air on these luminescent thin films have been examined and it has been observed that the photoluminescence intensity of the samples kept in light goes down very fast than the samples kept in dark which shows that these films are very much sensitive to light.

The effect of annealing on these films have also been observed. The annealed films show a loss in their photoluminescence intensity.

In order to probe the structural transformations of these films, we performed the infrared (IR) measurements on the films deposited on both side polished *c*-Si substrates. The IR spectrum provides information about the photo-degradation processes.

3. Impact:

The study of light induced and environmental effects on these organic luminescent small molecule thin film is very important for the application in organic LEDs. It has been observed that these films are very sensitive to light and loss their intensity on exposure. A comparative study of three materials will be shown.

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5. References:

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