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Synthesis and Photoluminescence study of Strontium salts with 2-Methyl-8-Hydroxyquinoline and 8-Hydroxyquinoline

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Abstract. The pure green and turquoise green-emitting organometallic complex of strontium(II) with 8-Hydroxyquinoline and 2-methyl-8-hydroxyquinoline were synthesized by using Co-precipitation method. The structure of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8Hq)_2$ was studied with Fourier transform infrared spectroscopy, and the vibrational peak of the Sr-O bond was found at 503 cm^{-1} and 499 cm^{-1} respectively. The X-Ray diffraction spectra are taken and compared with XRD data of raw materials to confirm the formation of the complex. Further UV-Absorption was studied, and the optical band gap is 2.813eV and 2.852eV, respectively, by using Taucs plot method. The photoluminescent study carried out in solution medium, and the emission wavelength found at 526nm and 509nm, and the color is confirmed using the CIE plot method, and the emission color is pure green and turquoise green. The complex may have significant applications as emitters in organic optoelectronic devices.

1. Introduction

Currently, Organic light emitting diode (OLED) is becoming a significant component of display technology. OLED offers high contrast ratio, thinner, brighter and flexible display; wide viewing angles; and simple fabrication method[1-3]. The drawback of OLED devices is low stability and small life span. High demand for new organic materials for OLEDs with good thermal and electrical stability, excellent compatibility with host materials, highly soluble in organic solvent (for solution-processable device fabrication), and low cost[4].

In this research, the luminescent properties of strontium complexes of 8-Hydroxyquinoline and 2-methyl8-hydroxyquinoline were studied. The 8-hydroxyquinoline as a ligand possesses few properties like excellent electrical and thermal stability; Good electron transport properties, great compatibility with host materials; it forms nanorods metal chelates possessing high lengths to diameter ratio which is suitable for OLED hence chosen for the study[1-5].

The luminescent properties of Alq_3; Znq_2; Liq; Cdq_2; Mgq_2; Baq_2; Pbq_2; Cuq_2; Beq_2; Inq_3; Geq_3 and $Zn(Mq)_2$; $Pb(Mq)_2$; $Cd(Mq)_2$; $Al(Mq)_3$ are already studied (Where q is 8-hydroxyquinoline and Mq is 2-methyl-8-hydroxyquinoline)[1-19]. As strontium is abundant in nature and not studied much hence the present attempt was made.

2. Experimental

All the chemical reagents were of analytical grade and used without purification.

2.1. Synthesis of bis(8-Hydroxyquinoline)Strontium(II)

`1.05gm strontium nitrate` was dissolved in `20ml` of double distilled water, this solution was added drop by drop to a solution prepared by dissolving `1.45gm` of `8-Hydroxyquinoline` in `80ml` of `methanol` under continuous stirring of 2500rpm at room temperature. This reaction was carried out for 4 hours and precipitate was collected by filtering the solution and washed several times with methanol. Further precipitate was dried for 2 hours in a hot air oven at 100^0 C and resultant powder sample was collected.

2.2. Synthesis of bis(2-methyl-8-Hydroxyquinoline)Strontium(II)

`1.05gm strontium nitrate` was dissolved in `20ml` of double distilled water, this solution was added drop by drop to a solution prepared by dissolving `1.59gm` of `2-methyl-8-Hydroxyquinoline` in `80ml` of `methanol` under continuous stirring of 2500rpm at room temperature. This reaction was carried out for 4 hours and precipitate of greenish white color was collected by filtering the solution and washed several time with methanol. Further precipitate was dried for 2 hours in a hot air oven at 100^0 C and resultant powder sample was collected.

2.3. Characterization Techniques

The powered sample characterized by X-Ray Diffraction using *Rigaku mini flex benchtop X-ray diffractometer* with CuK_α radiation scanned with a step size of 0.5^0. The Fourier transform infrared spectrum of the sample recorded on ZnSe pellets using *Bruker Alpha. Shimadzu UV1800* was used to study the absorption spectra, and the optical bandgap of the sample was studied using the *Taucs plot method*. The photoluminescence property of the sample was studied using *Shimadzu RF5301PC Spectrometer* with slit width 3nm. Both studies were done in a liquid medium by taking *0.0002moles of Sr(8-Hq)$_2$, and Sr(2-M-8-Hq)$_2$ in DMSO (Dimethyl Sulfoxide)*.

3. Results and Discussion

3.1. X-Ray Diffraction

The XRD spectrum is shown in Figure 1 The X-Ray diffraction spectra of Sr(8-Hq)$_2$ and Sr(2-Me-8-Hq)$_2$ is recorded. These X-ray diffraction spectra are compared with X-ray diffraction data of its raw materials $Sr(NO_3)_2$ [JCPDS No.76-1375]; 8-Hydroxyquinoline [JCPDS No.24-1897]; all the peaks were unique and did not match with the data of its raw materials which confirms the formation of the complexes. Also, the sharp peaks indicate the purity of the complex. The significant peaks in Sr(8-Hq)$_2$ are at 2θ values 20.06^0, 21.41^0, 21.55^0, 21.76^0, 21.90^0, 22.60^0, 24.07^0, 24.23^0, 31.29^0, 33.59^0. And for Sr(2-Me-8Hq)$_2$ are at 10.70^0, 11.85^0, 13.77^0, 14.97^0, 15.62^0, 16.85^0, 18.92^0, 17.52^0, 18.90^0, 18.98^0, 19.35^0, 19.56^0, 19.77^0, 19.88^0, 20.72^0, 21.58^0, 24.15^0, 33.93^0.

3.2. Fourier Transform Infrared Spectroscopy

The FTIR spectrum is shown in Figure 2 The FTIR spectrum of Sr(8-Hq)$_2$; Sr(2-Me-8-Hq)$_2$ is being recorded and summarized in the table. The Sr-O bond peak in Sr(8-Hq)$_2$ is observed at 503 cm^{-1} and in Sr(2-Me-8-Hq)$_2$ at 499 cm^{-1}, which confirms the formation of the complex. Remaining peaks and their interpretation is given in Table 1.

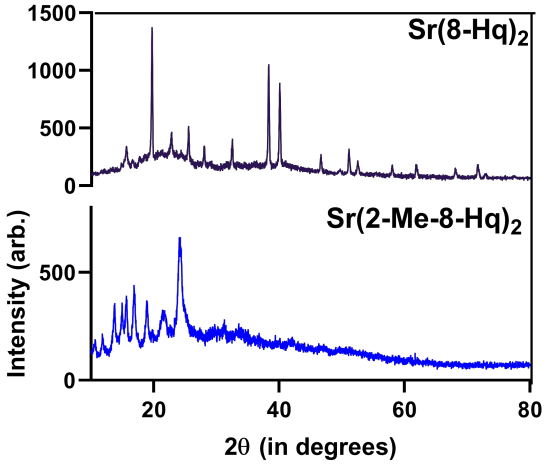

Figure 1. XRD Patterns of of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$

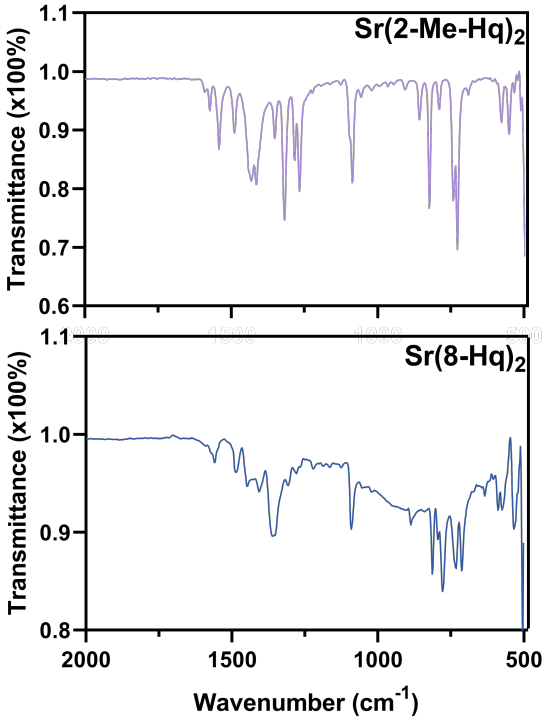

Figure 2. FTIR Transmission Peaks interpretation of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$

Table 1. Fourier Transform infrared spectroscopy peak interpretation for $Sr(8\text{-}Hq)_2$ & $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$

Molecular Bond	$Sr(8\text{-}Hq)_2$ Wavenumber (cm^{-1})	$Sr(2\text{-}Me8\text{-}Hq)_2$ Wavenumber (cm^{-1})
Sr-O	502	498
Ring Deformation	532, 573, 586	532, 551, 576
Quinoline Stretching	812, 1089	822, 857, 1019
C-H wagging	633, 712, 730, 778, 793	605, 667, 689, 727, 740, 788
C-O Stretching	1125, 1163, 1187	1125, 1161, 1191
C-H Stretching	1219, 1278	1222, 1265, 1282
Quinoline molecule	1352, 1359, 1406, 1446, 1558	1316, 1350, 1430, 1541, 1572
Phenyl Group	1486	1488

3.3. Absorption Spectra

The UV absorption spectra studied for liquid medium, the 0.0002M solution of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$ is prepared in DMSO. The absorption peak for $Sr(8\text{-}Hq)_2$ is observed at 401nm and 333nm, and for $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$, it is observed at 391nm and 329nm wavelength. As shown in the figure and which extensively used to study photoluminescent study. To determine the optical bandgap, Tauc's plot method was used, and the optical bandgap found to be 2.813eV and 2.852eV for $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$ respectively as shown in the Figure 3 & 4.

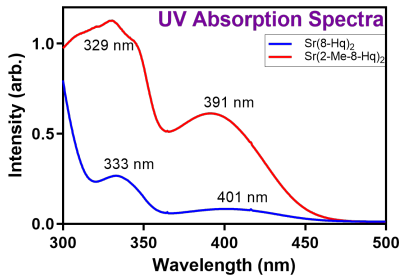

Figure 3. UV absorption Spectra of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$

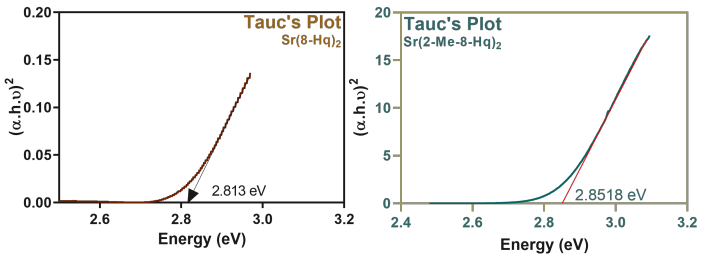

Figure 4. Tauc's Plot for $Sr(8\text{-}Hq)_2$ (left)and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$ (right)

3.4. Photoluminescence Spectra

The photoluminescence spectra of (8-hydroxyquinoline)strontium (II) showed in Figure 5 The (8-hydroxyquinoline)strontium(II) shows the emission wavelength at 526nm and the excitation wavelength at 416nm. The CIE plot shown in Figure 6, which describes the pure green emission. The photoluminescence spectra of (2-Me-8-hydroxyquinoline)strontium(II) showed in Figure 5. The (2-Me-8-hydroxyquinoline)strontium(II) complex shows the emission wavelength at 509nm and the excitation wavelength at 415nm. The CIE plot shown in Figure 6, which describes the emission, is turquoise green.

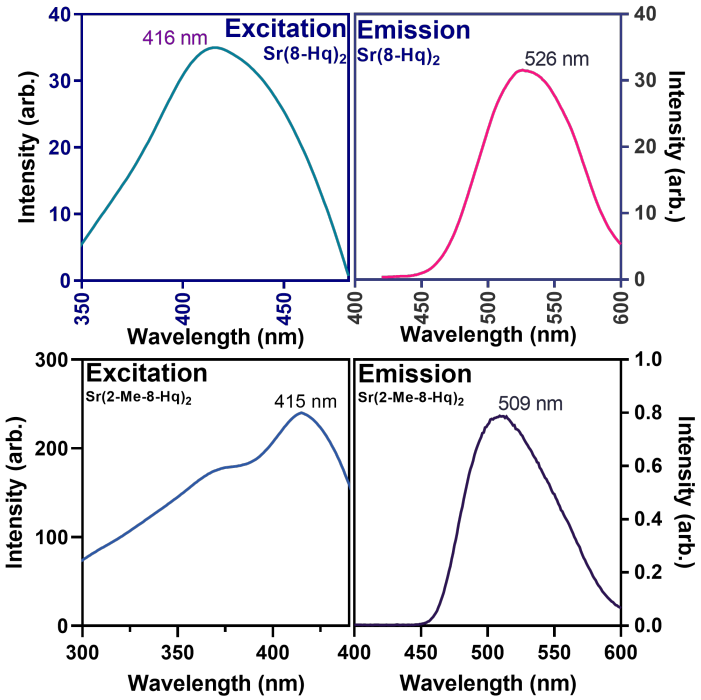

Figure 5. Photoluminescence spectra of $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$

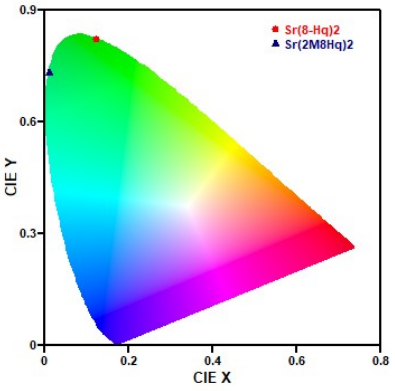

Figure 6. Colour Coordination Index for $Sr(8\text{-}Hq)_2$ and $Sr(2\text{-}Me\text{-}8\text{-}Hq)_2$ to understand colour of emission wavelength

4. Conclusion

The organometallic complex of strontium with 8-Hydroxyquinoline and 2-methyl-8-Hydroxyquinoline as ligands were studied. These complexes emit pure green and turquoise green color and have low molecular weight compared to Alq_3. They may have potential application in organic optoelectronic devices and for this further research is invited.

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