Synthesis and Luminescence Spectra of Eu\(^{3+}\)-Tris(thenoylacetylacetone) Complexes Co-coordinated by N- and O-Donor Ligands

H. Bettentrup\(^a\), D. Uhlich\(^b\), T. Weyhemüller\(^b\), H. Büttner\(^b\), and T. Jüstel\(^a\)

\(^a\)FH Münster, FB Chemieingenieurwesen, Stegerwaldstraße 39, D-48565 Steinfurt, Germany
\(^b\)MPI für Bioanorganische Chemie, Stiftstraße 34 – 36, D-45470 Mülheim an der Ruhr, Germany

Introduction

In the last few years the interest in lanthanoid chelates as light emitting materials for photonic applications\(^{1,2}\), such as light emitting diodes (LED) and optical fibres, has increased remarkably. Rare earth complexes consist of the central lanthanoid ion surrounded by organic ligands which act as chromophores. By the introduction of organic chelat ligands high quantum efficiencies can be achieved. Moreover, broad excitation bands caused by the conjugated aromatic systems occur and narrow defined emission lines from the rare earth ions can be observed. The effect of the organic ligand is known as “antenna effect”.\(^3\) (Fig. 1)

To obtain complexes with high quantum efficiencies it is necessary to choose organic molecules with pronounced internal conversion (IC), efficient energy transfer from the ligand to the metal ion, and an efficient luminescent ion. For these reasons, we chose trivalent Europium as a red line emitter and as chromophores \(\beta\)-diketonates in combination with 2,2’-Bipyridyl, 1,10-Phenanthroline, and Pyridyl derivates. (Fig. 2)

Synthesis

The reactions were carried out in ethanol or a mixture of ethanol and acetonitrile in two steps. First the \(\beta\)-diketonate complexes were synthesised, which are still coordinated by two solvent ligands. The second step is a ligand exchange, wherein the solvent ligands were replaced by the neutral organic ligand. (Fig. 3)

Results and Conclusions

Two reaction products (1 and 2) yielded suitable crystals for X-ray single crystal analysis which gave the supposed crystal structures. (Fig. 4 and 5)

<table>
<thead>
<tr>
<th>Co-ligand</th>
<th>QE 350 [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Chlorpyridine</td>
<td>10.9</td>
</tr>
<tr>
<td>H(_2)O</td>
<td>20.8</td>
</tr>
<tr>
<td>Picolinic acid-N-oxide</td>
<td>44.7</td>
</tr>
<tr>
<td>2,2’-Dipyridyl-N,N’-dioxide</td>
<td>61.4</td>
</tr>
<tr>
<td>4,7-Diphenyl-1,10-phenanthroline</td>
<td>46.7</td>
</tr>
<tr>
<td>Picolinic acid-N-oxide</td>
<td>44.7</td>
</tr>
</tbody>
</table>

Tab. 2: Quantum efficiencies of [Eu\(^{3+}\)(TFPA)\(_3\)X] complexes with different neutral ligands X

References