

ON THE QUENCHING OF TRIVALENT TERBIUM LUMINESCENCE LIGANTE LOW LYING TRIPLET STATE ENERGY. THE [Tb(tta)₃ 2H₂O] CASE

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Highlight

- The luminescence quenching in Tb complexes with low lying triplet state energies is rationalized in terms of intramolecular energy transfer involving mainly the ⁷F₅ state, instead of the ⁷F₆ ground state of the Tb³⁺ ion.

Abstract

The description of the processes which follow the absorption of light by organic ligand and energy transfer (ET) to the lanthanide ion that emits in the visible is one of the most important problems in the design of luminescent lanthanide complexes. In Tb³⁺ complexes with the energy of the ⁵D₄ state very close to the ligands triplet energy levels (T₁), luminescence quenching is observed due to efficient back transfer (BT). A typical case is the [Tb(tta)₃ 2(H₂O)] complex. It is known that in this complex at room temperature both Tb luminescence and ligand phosphorescence are practically absent, and only at low temperature they are weakly observed [1]. The ET from T₁ to the ⁵D₄ level, in principle, requires the Tb³⁺ ion to be initially in the ⁷F₆ ground state, once the ⁷F₁ excited levels are not thermally populated. However, curiously enough, the ⁷F₅ level has an unusual long lifetime [2] and, in the present case, the ⁵D₄ → ⁷F₅ transition is in excellent resonance conditions with the ligand phosphorescence peak. Taking into account the selection rules on the total angular momentum quantum number (J) [3], these facts strongly suggest that ET and BT occur efficiently through the exchange mechanism involving the ⁷F₅ level. Fig. 1 shows the energy level scheme used in setting up an appropriate system of rate equations to describe the level populations.

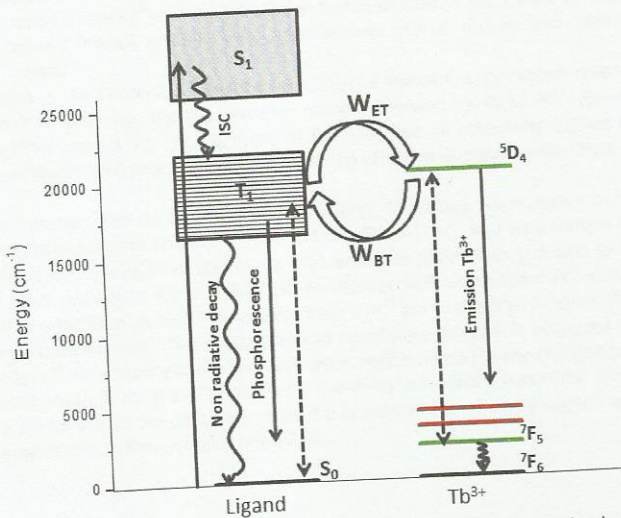


Figure 1. Energy level diagram for the [Tb(tta)₃ 2(H₂O)] complex showing the channel for the energy transfer (W_{ET}) and back transfer (W_{BT}) process

The calculated transfer rate for the exchange mechanisms is $2.7 \times 10^7 \text{ s}^{-1}$. Numerical estimates of the ⁵D₄ decay-curve are in good agreement as compared to the experimental results.

Acknowledgement:

Inct-INAMI and CAPES for financial support.

References:

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