The influence of the alkyl substituent in ligands and temperature on the luminescence of terbium complexes

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INTRODUCTION

The study of new luminescent compounds is an important task of modern optics and spectroscopy. Rare earth elements coordination compounds are important objects of research due to their narrow bands, long lifetime and high luminescence intensity. Terbium complexes emit light in the visible wavelength range with the most intense peak in the green region.

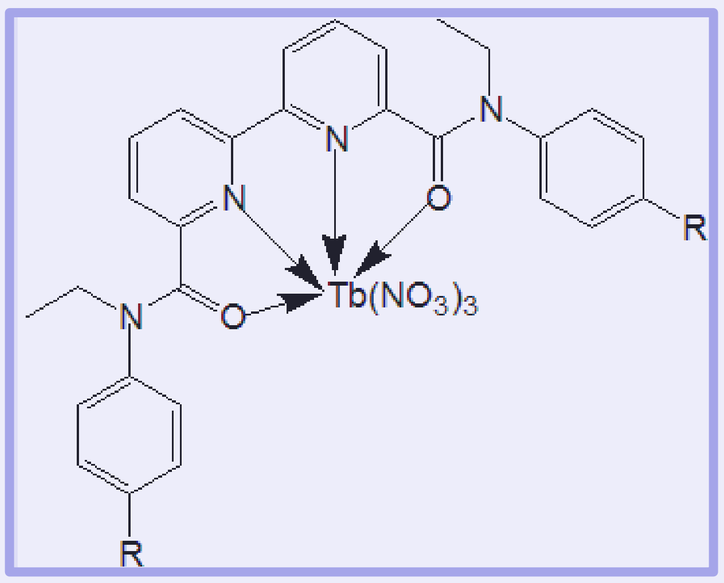
The aim of this work was to study the effect of the alkyl substituent in ligands based on 2,2´-bipyridyl-6,6´-dicarboxamides and temperature on the luminescent properties of terbium complexes.

METHODS OF RESEARCH

The luminescence spectra of the terbium complexes were recorded in solid state on a Hitachi F-7000 luminescence spectrometer at room temperature and in liquid nitrogen.

OBJECTS OF RESEARCH

Terbium complexes with ligands based on 2,2´-bipyridyl-6,6´-dicarboxamides were studied in this work.



Sample 1	R = H
Sample 2	R = Me
Sample 3	R = Et
Sample 4	R = Pr
Sample 5	R = Bu
Sample 6	R = Am
Sample 7	R = Hex
Sample 8	R = *i*Pr
Sample 9	R = *t*Bu
Sample 10	R = *c*Hex

Figure 1. Structures of terbium complexes.

RESULTS

The luminescence emission spectra of terbium complexes contain trivalent terbium ion characteristic peaks corresponding to the $^5D_4 \rightarrow {}^7F_6$, $^5D_4 \rightarrow {}^7F_5$, $^5D_4 \rightarrow {}^7F_4$, and $^5D_4 \rightarrow {}^7F_3$ transitions (Fig. 2).

The luminescence excitation spectra contain bands corresponding to the absorption of light by the ligand, as well as direct absorption of light by terbium ions (Fig.3).

Luminescence lifetimes of terbium complexes are determined at room temperature and in liquid nitrogen using luminescence kinetics (Fig. 4).

Table 1. Luminescent characteristics of terbium(III) complexes at room temperature and liquid nitrogen temperature: asymmetry ratio (R), luminescence lifetime (τ).

		Number of sample									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
77 K	R	2.8	3.9	3.7	3.6	3.6	3.6	4.2	2.9	3.1	6.4
	τ, ms	0.65	1.51	1.53	1.41	1.47	1.51	1.61	1.46	1.52	1.32
293 K	R	3.0	2.7	2.4	2.7	2.0	-	2.8	3.0	2.5	3.5
	τ, ms	0.27	1.03	1.00	0.92	0.88	-	0.93	0.83	0.87	0.66

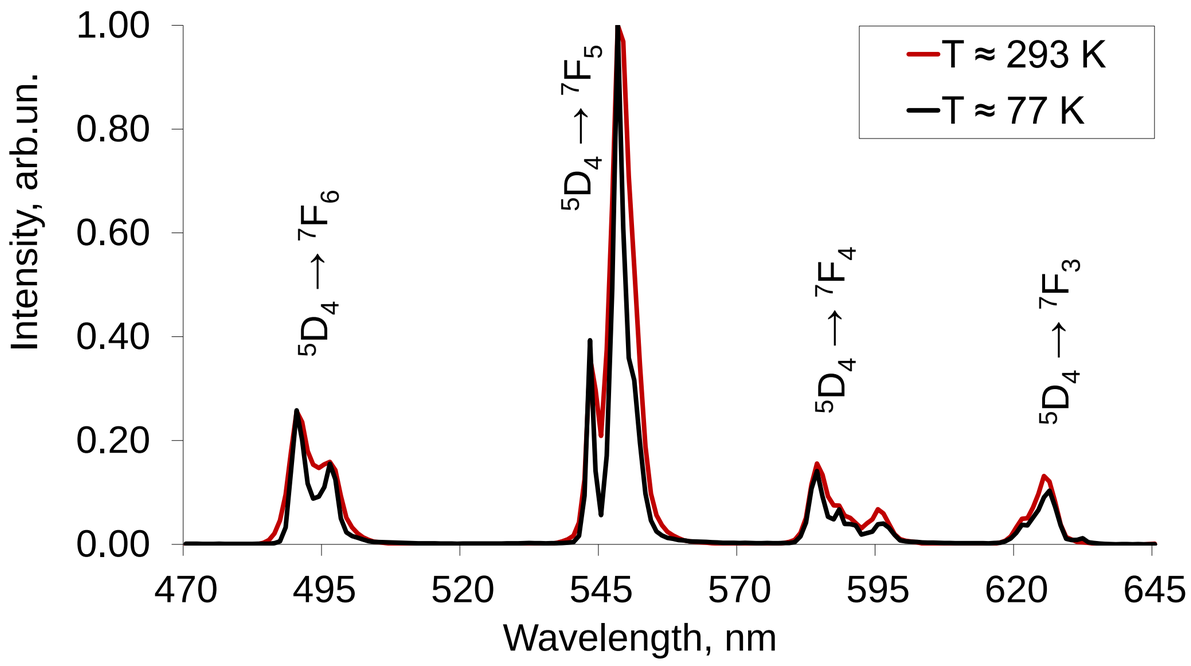


Figure 2. Luminescence emission spectra (λ_{ex}=320 nm) of Sample 1 at room temperature and in liquid nitrogen.

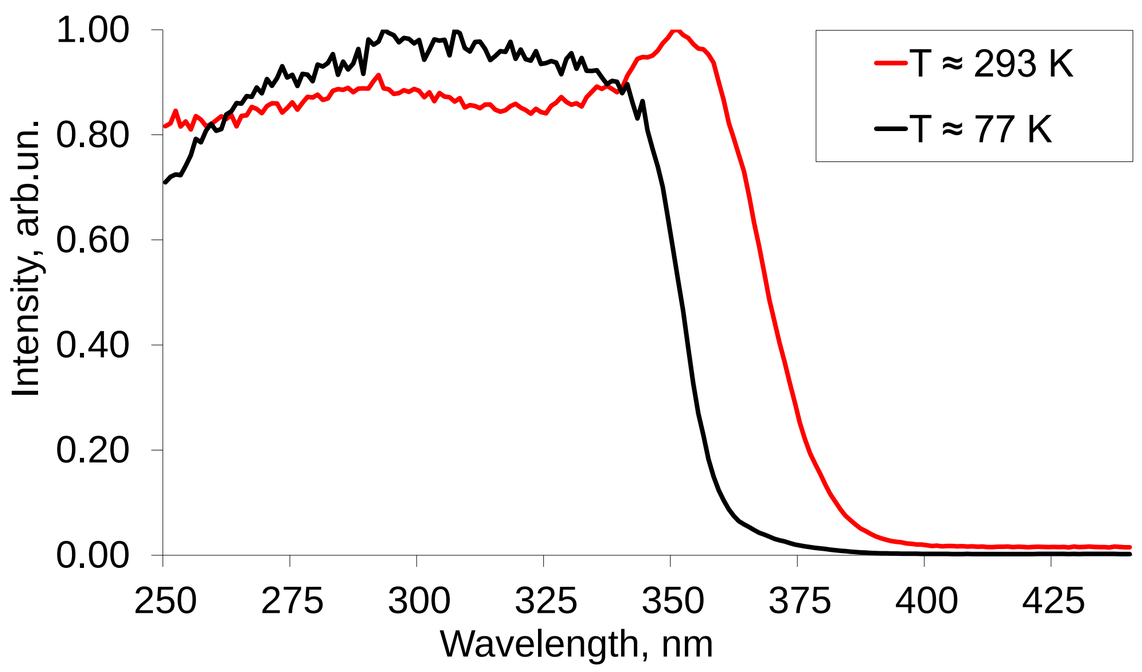


Figure 3. Luminescence excitation spectra (λ_{em}=645 nm) of Sample 1 at room temperature and in liquid nitrogen.

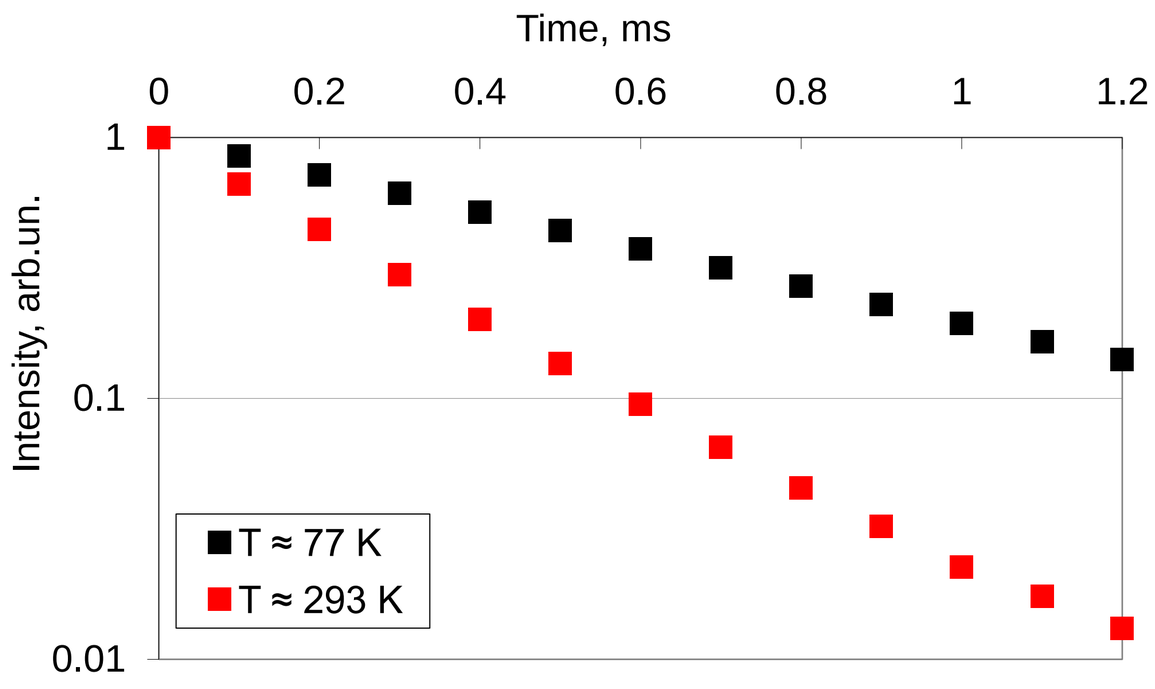


Figure 4. Luminescence kinetics of Sample 1 at room temperature and in liquid nitrogen.

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