# Photouminescence and Optical Properties of $PVP/Tb(TTA)_2(Ph_3PO)_2NO_3$ Nanocomposites

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## ABSTRACT

Thin films (1-10 μm thickness) of nanocomposites (NCs) based on coordinated compounds (CC) $Tb(TTA)_2(Ph_3PO)_2NO_3$ (where TTA is thenoyltrifluoroacetonate ($C_8H_5F_3O_2S$), $Ph_3PO$ - triphenylphosphine oxide) and polymer – polyvinylpyrrolidone (PVP) (($C_6H_9NO)n$)) were obtained by chemical methods. NCs were characterized by measurements of optical transmission ($T(\lambda)$), and photoluminescence (PL) at different concentrations of CC in NCs. Using the optical transmission spectra, the characteristic parameters of NCs such as threshold of absorbance and the position of the absorption edge versus the concentration of the CC in NCs, etc., were determined. A slight displacement of absorption threshold to infrared region was observed with increasing of concentration of coordinated material in NCs. It was established that the excitation spectrum at which the photoluminescence (PL) in NCs take place covers the range of wavelengths from 200 to 410 nm. The PL of nanocomposites was detected as specific for internal transitions $4f \rightarrow 4f$ of the $Tb^{3+}$ ion $^5D_4 \rightarrow {}^7F_i$ ($i$ = 6, 5, 4 and 3) centered at 488, 543, 589 and 614 nm, respectively at T=300 K. The dominant PL was observed at 543 nm and its halfwidth is less than 10 nm. The intensity of photoluminescence signal at 543 nm in the case of NCs films is 2 times higher than the intensity of PL of $Tb(TTA)_2(Ph_3PO)_2NO_3$powders at equal conditions of excitation. PL intensity of the NCs to 77 K is growing more than 20 times compared with that at 300 K.

**Keywords:** nanocomposites, rare earth, photoluminescence, polymer, energy transfer, laser emission

## 1. INTRODUCTION

Nanocomposites based on polymers and coordinate complex of organic compounds of rare earth elements (Re) are excellent materials for a new generation of light emitting devices with high efficiency due to strong luminescence, easy colour tuneability, temperature insensitivity, and high stability. For the visible spectrum, more frequently are used the compounds with Europium ($Eu^{3+}$) and Terbium ($Tb^{3+}$) ions. Improving of their luminescence properties depends on the type of ligands using for surrounding of the rare earth ions. Photoactive complexes of organic compounds of lanthanides may be used, for example, $Eu^{3+}$ chelated with β-diketonates, or cyclic ligands for obtaining different coordination number of $Eu^{3+}$ (varies from 6 to 9) [1-2]. The fundamental studies of the spectroscopy photophysic of compounds with rare earth ions with effective luminescence with the halfwidth of the luminescence bands less than 10 nm in the visible and near-infrared regions of spectrum at different excitations are of special interest.

Advantages offered by coordinated compounds of rare earth ions with β-diketonates and nanocomposites are determined by the so-called "antenna" effect, or the transfer of excitation energy from outside of the system of singlet (S) and triplet (T) levels to internal levels of rare earth ion. The population of upper energy levels of Re ion is increased in this case. The transitions *4f-4f* of Re ion are shielded outdoor and in this way it minimizes irradiative transitions. From our preliminary study of NCs with *Eu(III)* coordination compounds it was found the amplification of the photoluminescence of NCs in comparasion with of PL of $Eu(TTA)_2(Ph_3PO)_2NO_3$ powders at equal conditions of excitation [3-4].

In the present work we present new nanocomposites on the base of polyvinylpyrrolidone and coordinated compound $Tb(TTA)_2(Ph_3PO)_2NO_3$ with coordination number of *Tb(III)* ion 8 and three ligands which present a special scientifically interest.

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