Abstract

Rare-earth tantalates(V) have been extensively studied in scientific literature due to their high potential for applications, particularly in the field of optoelectronics and photocatalysis. However, compared to other oxide systems, the number of literature reports on rare-earth tantalates is still relatively low. This can be attributed to the high chemical passivity of tantalum itself and its compounds, which presents challenges in their synthesis and subsequent characterization for potential applications. To address these limitations, alternative synthesis methods for rare-earth tantalates(V) need to be explored.

In this doctoral dissertation, developed of new and optimized of literature methods for synthesizing undoped and Sm^{3+}-doped rare-earth tantalates(V) were presented. The specific systems investigated included M'- $YTaO_4$ (both micro- and nanocrystalline), $LaKNaTaO_5$, $LaRbNaTaO_5$, $RbLaTa_2O_7$ and $CsLaTa_2O_7$. The structural and morphological characterisation of these systems was carried out using the X-ray analysis (XRD), scanning and transmission microscopy (SEM, TEM), as well as ICP-AES and SEM/EDS analysis.

Another significant aspect of the doctoral dissertation involved a comparative analysis of the optical properties of the above-mentioned tantalates(V), specifically employing the Sm^{3+} ion as a luminescent probe. This analysis included measurements of electronic absorption and emission spectra at different temperatures and activator concentrations, as well as measurements of the luminescence decay time measurements. Moreover, semi-empirical models such as the Judd-Ofelt theory and the Inokuti-Hirayama model, along with group theory-based correlation analysis, were utilized for quantitative analysis.

The spectroscopic studies conducted in this research also aimed to determine the strength of the electron-phonon coupling in selected systems. This parameter is crucial in understanding the interaction between electron and lattice, which is fundamental to the design of new luminescent materials.