## Abstract

Developing new methods for water purification and combating the growing resistance of microorganisms to antibiotics are crucial challenges in modern science. The main sources of water pollution include industrial and agricultural activities, which contribute to the presence of substances such as pharmaceuticals, pesticides, dyes, and heavy metals. These pollutants pose a significant threat to both human health and the fauna living in contaminated environments. At the same time, according to WHO reports, the problem of antibiotic resistance in microorganisms is increasing, primarily due to the excessive use of antibiotics in medicine and agriculture.

In response to these challenges, my research focused on the synthesis and characterization of oxo-titanium(IV) complexes (TOCs), as well as an analysis of their photocatalytic and biological properties induced by ultraviolet and visible radiation. The research also included an evaluation of the application potential of TOCs as active components in composite coatings, in which these complexes were dispersed within a polymer matrix. During the synthesis, I isolated complexes with varied core structures $\{Ti_aO_b\}$, stabilized by carboxylate ligands such as 4-hydroxybenzoate, 4-aminobenzoate, and 9-fluorene-carboxylate, as well as α-hydroxy-carboxylate ligands, including almond and 9-hydroxy-9-fluorenecarboxylate. Additionally, I conducted studies on the photocatalytic activity of ruthenium(III) complexes, a relatively underexplored scientific area. The results were compared with data on TOCs, which allowed for a better understanding of their mechanisms of action.

I studied the photocatalytic and biological activity of TOCs in terms of the effect of the stabilizing ligand type and the titanium-oxygen core structure in composite systems (PMMA + TOCs) [**P1**, **P2**]. I also assessed the impact of the ligand in complexes with the $\{Ti_4O_2\}$ core, stabilized by 4-aminobenzoate or 9-fluorene-carboxylate ligands, after incorporation into a poly(caprolactone) (PCL) matrix [**P3**]. The next step involved synthesizing and structurally characterizing TOCs with $\{Ti_4O\}$, $\{Ti_6O_4\}$, and $\{Ti_8O_2\}$ cores, stabilized by α-hydroxycarboxylate ligands such as 9-hydroxy-9-fluorenecarboxylate and almond [**P4**, **P5**]. I also compared the photocatalytic activity and adsorption capacity of PMMA + TOCs composites

stabilized by α-hydroxycarboxylate ligands and compared them with PMMA + Ru(III) composites [**P6**].

In summary, my research resulted in the synthesis of eight new oxo-titanium(IV) complexes, which were subjected to structural and spectroscopic characterization. Photocatalytic activity was tested for seven new and three previously synthesized Ti(IV) oxo-complexes, as well as two known Ru(III) complexes. Antimicrobial activity was analysed for five new and three previously known Ti(IV) oxo-complexes.