

Design, synthesis and catalytic activity studies of heterometallic rare-earth complexes in the synthesis of polymer anticorrosion coatings.

The energy crisis facing the world poses significant challenges for the chemical industry. One of such challenges is to make the chemical industry independent of significant energy inputs, which are primarily used for synthesis, separation and purification processes. The chemical industry plays a critical role in providing essential materials and chemicals for various sectors, including agriculture, pharmaceuticals, construction, and transportation. Therefore, when designing new chemical processes, we must prioritize energy efficiency in order to mitigate the effects of an energy crisis. One of the most important preventive factors may be the development of new or optimization of existing catalytic systems, which play an important role in improving industrial processes, allowing for more efficient and sustainable production of chemicals. Through appropriate optimization, significant improvements can be achieved in terms of:

- efficiency (causing reactions to occur under milder conditions can result in reduced energy consumption);
- selectivity (higher purity of desired products minimizes additional purification steps and decreases waste generation);
- yield (reduction of waste results in a more sustainable and cost-effective process);
- overall productivity (the chemical industry can move towards a more sustainable and circular economy and minimize its environmental footprint).

Over the past thirty years, special attention has been brought to heterometallic rare-earth complexes, which have found use as catalysts in enantioselective catalysis or polymerization of heterocyclic monomers, but also as molecular optical or magnetic materials. Synergistic effects between the metal ions in the structure of heterometallic compounds enhance their catalytic activity and lead to obtaining molecular materials of strictly defined physicochemical properties, shaped experimentally, by the appropriately designed synthesis.

Currently, there is a lack of foundational works in the existing literature concerning the controlled synthesis of isostructural heterometallic complexes of rare earth metals, preventing a distinctive analysis of experimental results. RE compounds are usually obtained in the reactions of inorganic or organic acids salts with phenolic ligands in the presence of amines as ligand deprotonation agents. The large structural diversification of the resulting products makes it difficult to carry out further application research, and prevents direct interpretation of the results obtained.

In contrast to previous research, the core concept of this project revolves around developing universal methods to obtain heterometallic clusters of rare-earth ions with well-defined physicochemical properties and reactivity. These properties will be precisely tailored during the synthesis process using structurally defined target complexes: s and d block homometallic precursors, which will dictate the formation of heterometallic bonds and the distribution of individual metal ions within the central core's structure. This approach will allow for a better understanding of the relationships between the structure of heterometallic complexes and their catalytic activity, or chosen physicochemical properties.



Figure 1. Simplified course of project implementation.

This project aims to answer questions regarding how the structure of target compounds influences the architecture, reactivity, and physicochemical properties of the newly synthesized heterometallic clusters. The applicational studies will explore the influence of the central core structure on the catalytic activity of the synthesized complexes. The results of this project are expected to provide valuable information on the synthesis of resins used in the production of anti-corrosion coatings to protect metal surfaces.