The ever-increasing amount of electronics surrounding us, the growing energy demand, combined with the environmental crisis, force the intense development of specific materials, characterized by versatile but tailorable properties. One of the most prominent examples are spinel-structured oxides, which find their use in a vast spectrum of applications, from everyday electronic devices, through catalysis, to zero-emission transport and renewable energy conversion technologies. The reason behind their popularity stems directly from their atomic structure, which allows for a complex interplay between different elements, leading to a huge variety of synergistic effects. Still, the constant demand for new, better materials, imposes a search for novel ways of expanding, controlling, and tailoring their functional properties. One of the most recent concepts, which may provide the necessary means of achieving these objectives, is the high-entropy approach to materials design, a strategy, which emphasizes the synergistic effects between the elements. The main idea behind this concept is to utilize several elements in equimolar or near-equimolar ratios, which drastically increases the number of possible interactions between them, while also enhancing the stability of such systems, through enhancing the value of the so-called configurational entropy, a parameter describing the structure's level of disorder. Despite the fact that the first oxide materials utilizing these principles were developed just 6 years ago, back in 2015, they have already proved their potential in a number of applications, including magnetic materials, catalysis, and energy-conversion technologies such as solid-oxide fuel cells (SOFCs) or Li-ion batteries. Unfortunately, despite often spectacular results, our understanding of the origins of their unusual properties remains extremely limited, which to a large degree stems from the almost complete lack of data regarding the atomic-level structure of these materials. The project's main objective is to address this issue, through the application of a comprehensive, multidisciplinary approach, combing cutting-edge experimental characterization of carefully selected high-entropy spinels, with the theoretical description of the systems, carried out within the framework of the quantum-mechanics, density functional theory (DFT).

To achieve these objectives, the project will concentrate on the preselected spinel-structured oxide systems, designed to emphasize a variety of possible different behaviors in terms of atomic-level occupancy of the cationic lattice sites. After careful assessment of the materials' microstructure and homogeneity, the atomic-level structure of the materials will be investigated, with the use of several magnetic, and element-sensitive probes, including such methods as vibrating-sample magnetometer, VSM, alternating-current (AC) susceptibility, Mössbauer and Raman spectroscopies, X-ray photoelectron spectroscopy (XPS), as well as X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD) synchrotron techniques. Their application will allow for elucidating the valence and magnetic state of the cations, also providing information about the nearest-neighbor coordination sphere of each ion. Data interpretation will be further supported by *ab-initio* DFT calculations, which will be the key for the results' generalization, providing a tool with predicting power enabling conscious design of materials, characterized by desired sets of properties. Considering the wide variety of possible applications, as well as the ever-growing popularity of the high-entropy materials, it can be expected that the collected data will have an immediate impact on a number of different scientific fields, ranging from electronics to the energy-conversion technologies, allowing for further development of the next-generation functional materials.