Improving the physicochemical properties of materials, while simultaneously maintaining the cost intensity and time consumption of their production, constitutes is one of the main criteria for sustainable civilisation development. An equally important aspect that accompanies this is environmental protection, which has been taken into account only since a few decades ago. In order to meet these challenges, the Directive of European Parliament 2017/2102 from November 15 was passed, which completes the previous document 2011/65/UE from June 8 2011 concerning limitations in using certain harmful substances (among others: Pb, Cd, Hg, Cr) in electric and electronic equipment. The scope of this directive also includes ferroelectric materials used up to now.

Ferroelectric materials are one of the more important groups of materials used in modern technology. A fundamental property of ferroelectrics, which also defines this group of materials, is the existence of spontaneous polarization, the direction of which can be changed by an external electric field. Furthermore, these materials exhibit a high dielectric constant and also demonstrate piezoelectric and pyroelectric properties. Thanks to such a wide spectrum of possibilities, these materials are used to manufacture several types of elements and components in electric and electronic equipment, including production of capacitors, electromechanical converters, sensors, electronic memories, thermal imaging devices, etc. Among ferroelectric materials currently available on the market, those based on toxic lead are predominant, the main one of which is a $PbZrO_3$-$PbTiO_3$ (PZT) solid solution. Thus, it has become necessary to develop new kinds of ferroelectric materials with properties comparable to those of PZT, which would not contain lead in their compositions.

In light of the above, the proposed research project will focus on developing **a new class of lead-free ceramic ferroelectric materials doped with selected rare-earth elements**. The project will also take into account basic requirements imposed by sustainable development strategy, among which the main goal will be to eliminate heavy metals. The most important task in the project will be to develop a way to fabricate innovative ceramic materials with high ferroelectric properties on a potassium-sodium niobate $(K_xNa_{1-x})NbO_3$ (KNN) matrix doped with selected rare-earth metal ion pairs (e.g.Yb+Tb, Tm+Ho, Nd+Er, Yb+Sm). In order to synthesize nano-powders, necessary for dense and uniform ceramic sinter fabrication, the use of wet chemical methods is planned. In the subsequent stage of studies, the influence of the chosen rare-earth elements on the physical and chemical properties of the obtained dielectric ceramic will be determined. It is worth adding that dopants of these elements cause a number of interesting optical phenomena, including luminescence. On the basis of the performed studies, it will be possible to identify the influence of the dopants on the parameters and properties of the finished sinters, including density, dielectric constant value, electrical conductivity and luminescence intensity depending on the excitation wavelength. Realising this project will lead to an expansion of knowledge on the topic of electrical, spectroscopic, chemical and optical properties of a new type of ferroelectric materials free from toxic components, which have a chance to contribute to the development of electronics and optoelectronics.