The ever-growing global development of many industries using technical gases entails constant challenges. Among these gases, oxygen plays an important role, the use of which is necessary in the production of steel and non-ferrous metals, petrochemicals, glass, ceramics, as well as in medicine or power generation technologies. At present, most of the oxygen produced for large-scale industry needs is created by cryogenic distillation, which, however, due to the high energy consumption of the liquefaction of gases from the air is an expensive method. Other production methods include pressure swing adsorption, as well as the use of membranes for gas separation. Nevertheless, the ever-increasing restrictions of environmental and energy efficiency regulations create the need of developing new, low-cost and efficient technologies of oxygen generation. A promising alternative method of oxygen production is the air separation by temperature swing absorption (TSA), in which materials with the ability to selectively adsorb air components play an important role. This process seems to be particularly interesting if the temperature range of the TSA system would correspond to the values for waste heat, which is often not used effectively.

From the application point of view, the requirements for oxygen storage materials (OSM) in the aforementioned technology are primarily the largest possible, selective and reversible oxygen storage capacity (OSC), a narrow range of oxidation and reduction temperatures and their moderate values, as well as operation in conditions close to atmospheric pressure. Interestingly, OSMs can also be used in a different air separation technology. If the OSM is prepared in a proper way, it can act as a so-called oxygen permeable membrane (OPM) – under the influence of pressure difference, only oxygen passes through such a membrane, while the other gases are blocked. Polymer membranes, typically used in air enrichment/depletion technology are well developed, but their operating temperature is limited by the thermal stability of the polymer and the purity of obtained oxygen reaches only about 40%. A promising alternative are ceramics with mixed ionic-electronic conductivity (MIEC), i.e. in which electric charge carriers are not only electrons but also ions. Although this technology is still at a relatively early stage of development, it has one major advantage that makes research worth conducting, namely, the maximum possible oxygen purity practically reaches 100%.

This project concerns investigations of properties of currently very poorly described materials with a general formula $Y_{1-x}R_xMnO_{3+\delta}$ (R: Pr, Nd, Sm and Gd), belonging to a group of hexagonally-structured rare-earth manganites (REM). The scientific aim of the project focuses on elucidation of nature of the interstitial oxygen transport mechanism, realized by interstitial oxygen anions present in those oxides at ambient pressure and moderate temperatures. It is worth to mention that such interstitial mechanism of charge transport in oxide materials is not a common phenomenon. Understanding of that transport mechanism will also let to design effectively-working oxygen storage material, capable of enriching air with oxygen *via* temperature swing absorption at a very low temperature range of 200-350 °C. At the same time, likely unique and breakthrough-type studies are planned to utilize the best developed compound as the oxygen permeable membrane, which possibly may operate at exceptionally low temperatures of 200-300 °C.

The realization of the assumed objectives will be made basing on the analysis of systematically planned measurements of physicochemical properties of the compounds discussed. This will allow to determine the relationships between the chemical composition of the parent ($YMnO_{3+\delta}$) and modified ($Y_{1-x}R_xMnO_{3+\delta}$) compounds, their crystal structure in reduced ($\delta \approx 0$) and oxidized ($\delta >> 0$) forms, maximum oxygen nonstoichiometry δ (this is the quantity on the basis of which the OSC can be directly determined), the temperature range of the oxidized forms stability, the electrical conductivity both ionic and electronic, as well as the reversibility of the oxygen storage process. In order to investigate all these properties, variety of advanced solid-state analysis methods will be applied: ambient and high temperature X-ray diffractometry, thermogravimetric analysis, impedance spectroscopy, scanning electron microscopy, density functional theory calculations and more.