At the beginning of the 20th century, humanity faced many new challenges, including climate change and limited availability of resources. An important issue connecting these two issues is the constantly growing demand for electricity. Therefore, aspects such as unconventional energy sources and their distributed generation are being increasingly researched. One of the very promising development paths is hydrogen management. Fuel cells are devices used to produce electricity from hydrogen. There are many types of them, which are usually divided according to the operating temperature. Low-temperature ones are used in mobile applications, e.g., in cars, and high-temperature ones are used as stationary energy generators. This project focuses on the second of these types of cells. Each of them consists of three elements: cathode, electrolyte, and anode. At the cathode, oxygen is reduced, an electric charge is created, transported by an external electric circuit, and ions are created, moving through the electrolyte towards the anode. Hydrogen is oxidized and combined with the supplied ions and electrons at the negative electrode, leading to water formation. These devices are characterized by many advantages that distinguish them from conventional solutions. First of all, they do not emit greenhouse gases, which helps fight climate change. They do not contain moving parts, which allows for tranquil operation, and most importantly, they are characterized by very high efficiency and the possibility of working in a cogeneration system.

In a high-temperature carbonate fuel cell (MCFC), the slowest reactions determining the system's efficiency occur on the cathode surface. Therefore, optimizing this electrode is crucial in increasing the efficiency of the fuel cell. Optimization of the positive electrode can be carried out in two directions - chemical composition and microstructure. Many studies describe the first issue, but in the case of the second one, the research is insufficient, considering the potential of increasing cell efficiency. The standard cathode has a porous structure resulting from the sintering of a base powder, most often nickel. According to the conducted research, the addition of spherical porogens, i.e., substances burned during the thermal process and leaving empty spaces in the cathode structure, increases the specific surface area, pore tortuosity, and other parameters and, as a result, allows for an increase in the power density in the cell. Since the share and size distribution of spherical porogens particles in the cathode is crucial in moving the bar in terms of the achieved efficiency of the entire cell, optimizing other pore parameters will also allow for the improvement of this device.

This project aims to investigate the influence of the shape and share of the porogens particles used to form the cathode microstructure on the material properties and, as a result, on the performance of the molten carbonate fuel cell. During the planned research, tests will be carried out using both spheres and other shapes, such as flakes or fibers in various variations of share and size. Such an innovative and comprehensive approach to the issue of shaping the pore microstructure will allow to compare the results for all combinations and determine the impact of individual parameters on the achieved results. The analysis of the relationship between porous microstructure and application properties will be carried out based on a series of tests characterizing the microstructure (e.g. scanning electron microscopy, gas and mercury porosimetry, computer microtomography) and properties (e.g. strength tests, impedance spectroscopy, and performance tests). Based on 3D microstructure models prepared from computer microtomography, computer simulations of the properties will be carried out to understand the analyzed aspects better.