Components made of **aluminum and its alloys** are an integral part of our lives. We encounter them every day and everywhere - from ordinary grocery foil, through bicycle or lamppost frames, to car or aircraft parts. The widespread use of aluminum-based materials is due to its chemical properties. It is a **lightweight**, **strong**, and **relatively inexpensive** metal most often alloyed with other elements to further improve its properties. Despite so many advantages, these products are not perfect. The main problem with these materials is their susceptibility to deterioration through **corrosion** (especially, pitting corrosion). Manufacturing sectors such as the automotive, marine, and aerospace industries are constantly striving to improve the service life of their products which brings a constant pursuit for a material that is resistant to harmful environmental factors combined with the best possible mechanical strength. The ever-increasing demand for resilient, long-lasting, and environmentally friendly construction materials is quite a challenge.

In order to minimize the deterioration of materials, industry has long sought a way to protect its structures. In the case of aluminum, oxide protective coatings are used, produced e.g. by the **anodizing** process. It is a method that involves immersing a component in an aqueous solution of salts, acids or alkalis and then applying a positive DC terminal to the material to be protected, making it an **anode**. When the counter-electrode (cathode) is plugged into the circuit, current flows through it. The result of such action is the formation of a thin oxide, non-conductive film on the surface of aluminum components because of a series of electrochemical reactions. The resulting coating effectively protects aluminum from aggressive agents but has one disadvantage - the baths usually used in the process are harmful to the environment and humans. For years, the European Union and the Western world have been recommending environmentally friendly solutions for many technical issues. Therefore, considering contemporary problems, one question arises - how to protect construction materials for many years, while minimizing the environmental impact?

The answer to this question is the **Plasma Electrolytic Oxidation** (**PEO**) process. This is a special case of anodic treatment of transition metals such as aluminum, titanium, or magnesium. This process differs from classical anodizing in the value of the used voltage - in the PEO process this value can exceed even 600 V. The application of such a **high voltage** result in the formation of plasma on the surface of the workpiece which manifests itself in the form of short-lived, high-temperature micro discharges. These discharges that are mainly responsible for the growth of the oxide layer. Electrolytic baths used in this process are much less harmful to the environment and humans. Classical anodizing utilizes dangerous acid solutions or carcinogenic chromate-based compounds. Meanwhile, the PEO process is based on dilute silicate or phosphate solutions which are harmless. In addition, the substances in the solutions **can incorporate into the resulting film**, giving researchers many opportunities to modify such coatings to improve their properties.

The goal of the scientific team carrying out this project is to obtain complex ceramic oxide layers containing substances that enhance **mechanical strength**, **corrosion resistance** and **antibacterial properties**. The proposed treatment described in the following project should provide a significant improvement in the service life of aluminum components, both in everyday use and in aggressive environmental conditions.

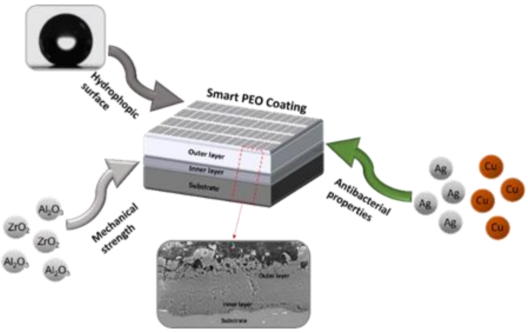

Fig. 1. Schematic structure of the protective oxide film to be obtained in the project

The first stage of the research will be the selection of appropriate PEO process conditions to allow the incorporation of the desired substances into the layer composition, while maximizing the corrosion resistance of the material. The resulting ceramic layers will be subjected to a series of mechanical, electrochemical and microbiological tests using various bacterial cultures. A key stage of the project will be to obtain a layer containing both particles that improve mechanical properties and **antibacterial compounds**. In the final step, the produced coatings will be additionally **hydrophobized**. It means that the resulting films will be able to repel water which is a crucial aspect when considering the corrosion resistance of the coated aluminum elements.

The knowledge obtained in the project will allow a better understanding of the process of Plasma Electrolytic Oxidation in suspensions and open the door towards further modifications of ceramic layers on the surface of not only aluminum but other metals. Recent years have shown mankind how important the functionality of the design is, especially in terms of antibacterial properties.