Abstract for the general public

In everyday life, one can encounter aluminium components at every turn. Items as trivial as food & drinks containers or street lights poles and even more sophisticated, like musical instruments, cars and aircrafts are all made of aluminium. Naturally, aluminium is seldom used in its pure form. Its rather found as a base material for many alloys doped with elements such as copper and magnesium, which vastly improve its properties and widen its areas of application. Although, it is a relatively light, durable and cheap material, it is fairly susceptible to corrosion, unless it is properly protected against it. It is very common to coat aluminium with large array of protective layers. These are usually paint coatings and so-called anodic oxide films. The latter allow to improve the surface hardness and corrosion resistance of the base material coupled with an aesthetic surface finish. The source of these remarkable features is corundum, *i.e.* aluminium oxide, which is produced during electrochemical oxidation process.

Anodic electrochemical treatment of metals is realized by immersing the metallic workpiece in an aqueous solution with addition of appropriate salts, acids, alkalis, etc. which is followed by connecting the metal with positive terminal of direct current. At this point metal piece can be dubbed anode. When there is another electrode present in the solution (cathode), which is then connected with the negative terminal, the circuit is closed and the current is allowed to flow through the system. As a result of movement of charge across the system electrode reactions can occur, which lead to formation of oxide coating on top of the treated metal. By choosing the right solution and metal we can grow an oxide layer with good semiconducting properties. However, the presence of the oxide hamper the flow of current. In order to force the charge to keep on moving through the system it is necessary to increase the voltage, *i.e.* transfer of energy to the charge carriers is mandatory to breach the obstacle. This, in hand, leads to further growth of the oxide. Therefore, along with the oxide growth the process voltage increase must follow, up to a certain limiting value. Above so-called dielectric breakdown voltage, if the conditions are right, plasma, *i.e.* ionized gas, can be formed on the treated surface. The plasma manifest itself in the form of numerous sparks waltzing across the treated surface. From this point on, the rules change. Now the growth of the oxide layer is not only sustained by the electrochemical oxidation but also thanks to the presence of the surface discharges, which additionally help incorporating molecules that surround the treated metal. These sparks are incredibly hot, however, they last only fractions of seconds and the solution that surrounds the metal effectively absorb the produced heat. Such a treatment is known as plasma electrolytic oxidation (PEO). It is worth noting that unlike many of electrochemical processes used in industry the solutions used in PEO treatments are inherently environmentally friendly.

Investigators who embark on realizing this research project aim to produce PEO coatings on aluminium in such a way, that they will incorporate organic additives inside of their structure, which will help to improve the corrosion resistance of the base metal. Such coatings should remain undamaged even in the event of scratching of the surface, since the organic additives will be so-called corrosion inhibitors, *i.e.* substances, which decrease the rate of corrosion or stop it from happening altogether.

At the beginning the investigators will choose the PEO process conditions in such a way that the surface sparks will have the most effective ability to incorporate substances form the solution into the oxide layer and at the same time the plasma will remain 'delicate' enough to prevent destruction of the organic components. In the next step it will be verified if the additives are indeed introduced into the oxide coatings in course of the designed treatment and it will be checked which of the substances (fatty acids, amines, polymer monomers) will be incorporated to the greatest extent. For the sake of reference point these substances will also be introduced into 'blank' PEO coatings, produced in course of the treatment in organics-free solutions, with the use of a multistep treatment. In the last stage of the research project anticorrosion properties of the obtained coatings will be tested with the use of electrochemical measurements. The final evaluation of the coatings, however, will be carried out at out-door atmospheric corrosion site. The oxide films will have a harder time resisting the corrosion, since some of them will be scratched prior to the exposure to verify if they possess the ability to 'self-heal'.

If the research project will finish as a success, many doors of the electrochemical treatment of aluminium and other metals will stand open. For instance, colorizing of metallic pieces during the PEO treatment in a single step will become possible. It will also help to appreciate the nature of PEO process in a fuller extent, enhance control over its course and to enhance the understanding of the mechanism of protection of aluminium surface in aggressive environments. At present, a vast majority of literature reports regarding PEO treatment comes from China, which further motivates that the European investigators to caught up in this area of scientific endeavor.