Reg. No: 2015/19/P/ST8/03995; Principal Investigator: dr Wojciech Jerzy Nowak

Metallic materials are one of the most popular material types used in almost all aspects of our life. In this group, various materials can be classified into: pure metals (e.g. Ni, Ti, Cr etc.), steels (e.g. plain carbon steels or stainless steels) as well as non-ferrous alloys such as Ni-based, Co-based or Ti-based. Compared to ceramic and polymer materials the above mentioned metallic materials are characterized by very good electrical and heat conductivity and excellent mechanical properties such as high strength and toughness. However, a large problem during the service of these materials is their degradation due to different reactions between the material and the environment, like low temperature corrosion (e.g. rusting of low-alloyed steels) or (when exposed at elevated temperature) high temperature corrosion. All of these reactions result in formation of oxide films or "scales" in the surface of metallic components. We all know this problem from the everyday life, as rust can form at the metallic parts of our bikes, cars or fences when exposed to the humid environment. Usually the oxide scales possess different physical and mechanical properties than the metals. Therefore the overall properties of the oxidized metallic components changes. Moreover, in real applications the oxide scales tends to flake off from the surface (The process known as spallation). Repeated scale formation and spallation can lead to substantial loss of the components wall thickness, decreased strength of materials and therefore, reduced functionality. Consequently the above mentioned environmental degradation processes are undesirable.

There are several methods to protect the metals against the destructive influence of the environment, such as painting with organic layers (for low temperature components), application of different kinds of coatings characterized by better resistance against the reaction than the base metal etc. However, the paints and coatings are additional manufacturing steps that require time and produce additional costs. When metallic materials are exposed in air at high temperatures, they form oxide scales on their surfaces. Contrary to low temperatures the scales constantly grow at high temperatures. Some oxide scales e.g. Cr-oxide or Al-oxide are protective, i.e. the slow growing, leading to slower material wastage. The reaction rate depends on many factors. One of these factors is the metal surface condition i.e. degree of plastic deformation introduced by different surface treatment, e.g. grinding, polishing, sand-blasting etc.

In the frame of the present project the influence of surface preparation of the different kind of model alloys with very well controlled chemistry, on their corrosion resistance will be investigated. The surfaces of the above mentioned materials will be modified using different methods and exposed at different temperatures in various aggressive gases. The obtained results will help to understand and describe the basic mechanisms responsible for corrosion resistance of the materials as a function of surface condition as well as to find the best way of surface preparation to increase the corrosion resistance for a given material. Based on the obtained results a numerical model will be developed allowing for the designing of novel materials and/or surface treatments.