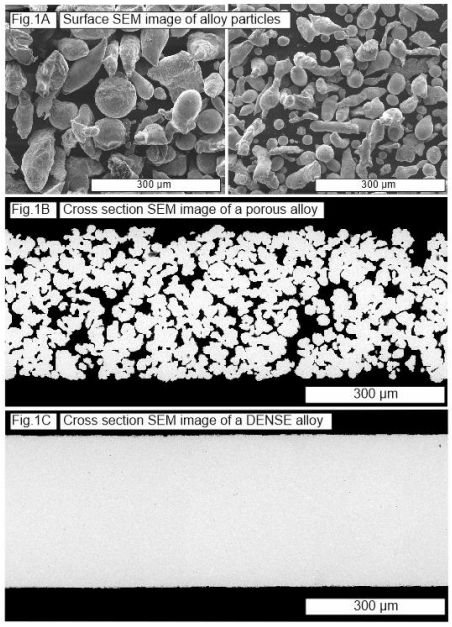
High-temperature corrosion studies and development of oxidation lifetime model of alloy powders and sintered porous alloys: effects of composition and microstructure.

Sebastian Molin
Laboratory of Functional Materials, Faculty of Electronics, Telecommunications and Informatics
Gdańsk University of Technology, Gdańsk, Poland

General project summary

Advanced metallic alloys find many applications in everyday life. It would be impossible to have modern cars, planes or high rise buildings without them. Alloys can be also used at high-temperatures, e.g. gas turbines, exhaust systems of vehicles etc. Due to their unique properties: low price, easy forming, high thermal and electronic conductivity, they can become an alternative material to more expensive ceramics. For example, they can replace ceramics in high-temperature fuel cells, diesel particulate filters or gas separation membranes. In all these applications they can be used in order to lower the price, which often is prohibitive for new advanced technologies.



The project will study alloys in special form: with high surface-to volume ratio, like particles/powders and porous alloys, as presented in Figure 1. High surface area leads to differences in oxidation of alloys due to mechanical stresses caused by curvature and limited reservoir of protective elements.

In this project, different alloy powders and sintered porous components will be evaluated for their high-temperature properties. Samples will be prepared from commercially available alloy powders and from specially fabricated alloys with controlled chemical composition. Sintered components will be prepared by die pressing and tape-casting, as well as by 3D printing of special filaments.

Powders and sintered components will be subjected to short (~100h) and long term oxidation experiments (up to 10000h for selected samples). In addition, porous components will be tested for their mechanical properties at high-temperature in a specially designed measurement rig.

High-temperature oxidation of alloys causes formation of an oxide scale on the metal surface and thus leads to a decrease of porosity, an increase of the electrical resistance and to dimensional changes. For successful application of porous alloys at high-temperatures, it is thus required to obtain detailed knowledge about their basic high-temperature corrosion properties, which is the aim of this project. Improved understanding of the high-temperature properties of particles and porous alloys will allow to find their possible safe operation window: working temperature range and time to expected breakaway.

In addition to performing the experiments, an important part of the project is development of a model for oxidation of particles and porous alloys, based on 3D geometry and input from experiments will be created. It will take into account mechanical and oxidation properties. Model will allow for prediction of the lifetime of particles and porous alloys, depending on the temperature, atmosphere etc. Prepared model will be published in the form of an open source code, available to all interested researchers.

This project will create new knowledge and contribute to improved understanding of high-temperature corrosion of alloy particles and porous alloys. In the long term, project realization will allow for construction of more cost efficient high-temperature devices.