Master Thesis Project

A study on the failure mechanism of high-temperature austenitic stainless steels

Scientific background

Austenitic stainless steels, with their excellent combination of strength, corrosion resistance and thermal stability, have wide applications in harsh service environments. The high-temperature austenitic stainless steels targeted in this project are typically used in fluidized bed reactors and furnace parts, critical for component production in electronics and automotive sectors. Their properties are tailored to have excellent microstructural stability for a long duration and at the same time good creep resistance up to 1100 °C. Secondary precipitation phases, like sigma phase, gamma-prime and $M_{23}C_6$, are commonly observed when the materials are subjected to prolonged high-temperature exposures. These precipitate phases are usually formed around austenite grain boundaries and they are detrimental for the high-temperature performance of these steels, since fracture initiates and propagates around the interface of the precipitate phases and austenite.

Project aim

This master project aims at investigating the failure mechanisms of these high-temperature austenitic stainless-steels at prolonged high-temperature exposure service. Different alloy chemistries and high-temperature exposure treatments will be investigated to develop a comprehensive understanding of the controlling failure mechanisms. The understanding achieved in this project can assist design of new austenitic stainless steels that have longer lifetime under high-temperature service.

Project plan

The specific plans of this project are:

- Literature survey
- Understanding the formation and evolution of precipitation phases after different high-temperature exposure treatments for different alloys by using SEM-based techniques, including SE/BSE imaging, EDS and EBSD, together with computational thermodynamics and kinetics using the Thermo-Calc software.
- Quantifying the phases in the samples after different high-temperature exposure treatments using synchrotron X-ray diffraction in a large-scale infrastructure.
- Report writing

Starting date: As agreed in autumn 2024 or beginning of 2025.

Duration: 5 months
Location: KTH, with a couple of weeks' visit to Outokumpu Stainless AB (Avesta)
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