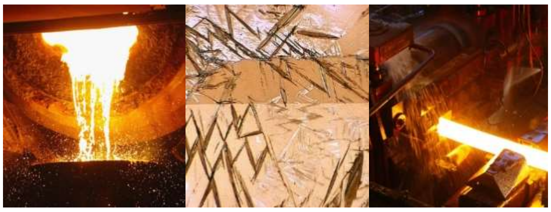
INDUSTRIAL PILOT PROJECTS

# In-situ experiment to follow kinematics of phase transformation and precipitate formation in duplex stainless steels

## THE INDUSTRIAL CHALLENGE

Intermetallic phases and precipitates are commonly identified in duplex stainless steels in heat-affected zones after treatment or welding. Understanding the cause of their formation and following the kinematics of their growth is of great interest for both manufacturers (to optimize the production process) and end-users (to enhance the application and prolong the lifetime).



## WHY USING A LARGE-SCALE FACILITY?

In-house techniques such as electron/light microscopy or x-ray diffraction allow quantification of phases or precipitates to a depth of a few micrometres and for the final product only. Synchrotron radiation, on the other hand, enables following the kinetics of phase transformation during relatively fast heating and cooling processes relevant to e.g. welding, several mm into the bulk.

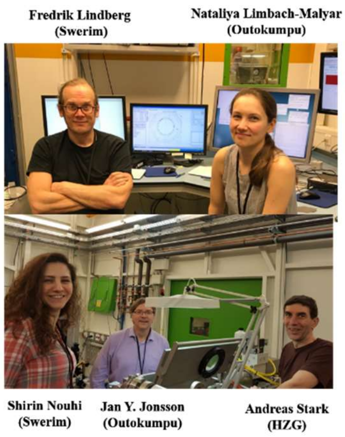
## HOW THE WORK WAS DONE

The experiments were conducted at the P07/HEMS beamline of Petra III (Hamburg) by expertise in diffraction techniques and materials experts from Outokumpu (Sweden and Germany). In-situ Wide-Angle X-ray Scattering was performed with a dilatometer in the beam to have accurate control over the temperature of the specimen during the phase transformation. Ex-situ Small-Angle X-ray Scattering was performed to quantify precipitates. Different heating and cooling cycles on three types of steels were tested to explore the effect of holding time at high temperatures and cooling rate on the final structure of the steels.

## THE RESULTS AND EXPECTED IMPACT

The results show how heat treatment or welding can alter the phase fractions and precipitate content of duplex steels. Experimental results were used to modify a simulation tool which allows prediction of phase transformations. The results are expected to be implemented directly by the manufacturers to minimize the formation of unwanted phases during the process. The experiment was a great demonstration of the power of synchrotron radiation techniques for industrial process development, showing both advantages and limitations of the techniques for addressing similar challenges.

The project brought together partners from the academy (KTH), research institute (Swerim), steel manufacturers (Sandvik and Outokumpu), material users (Alfa Laval) and staff from a large-scale facility (Petra III). This promoted extensive discussion and collaborations to design the experiment, resulting in increased knowledge/skills for all partners.

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**Vinnovas No:** 2018-03260 **Duration:** October 2018 – October 2019

Funded by Sweden's Innovation Agency, Vinnova, in order to build competence and capacity regarding industrial utilisation of large-scale research infrastructures such as MAX IV and ESS.