INDUSTRIAL PILOT PROJECT

Using synchrotron radiation to study TRIP effect in AHSS

THE INDUSTRIAL CHALLENGE

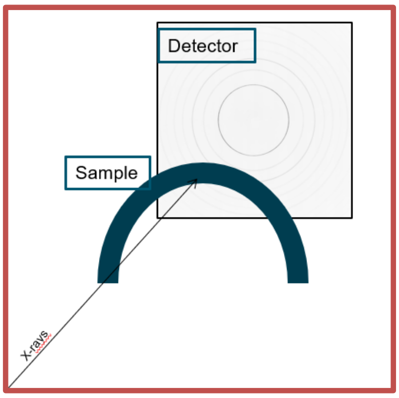
The 3rd generation advanced high strength steels (AHSS) in which major constituents are the steel phases martensite and austenite, show an attractive combination of high strength and good ductility. These properties are beneficial especially for the automotive sector and are achieved by the TRIP (transformation induced plasticity) mechanism when austenite transforms to "fresh" martensite upon deformation. The challenge of developing these steels is to control the stability of the austenite to make it transform at the right stress/strain.

WHY USING A LARGE-SCALE FACILITY?

Both the phase fraction of austenite and the residual stress can be analysed using laboratory methods but not at the required spatial resolution or with the geometrical aspects required in this specific case. With a synchrotron source, it is possible to map the material with a resolution of 50 μm in transmission mode. This could result in a new method for simultaneous mapping of the strain and stress, as well as the amount of transformed austenite.

HOW THE WORK WAS DONE

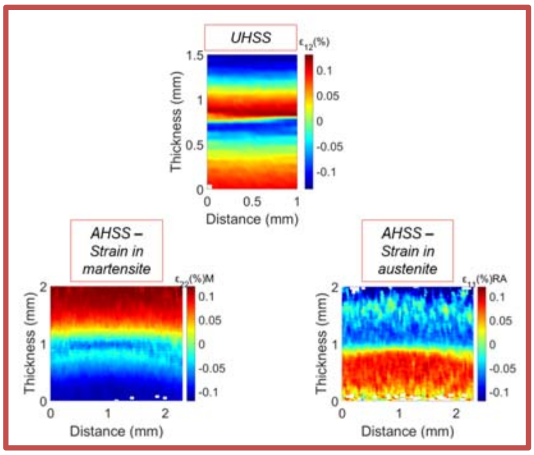
The matrix consisted of two different 3rd generation steels with different austenite contents, as well as an ultra-high strength, fully martensitic steel (UHSS) for reference. Synchrotron high energy X-ray diffraction measurements were performed in transmission mode on thin sections of bent and undeformed steel sheet (see illustration) using the P21.2 experimental station of Petra III in Hamburg.



THE RESULTS AND EXPECTED IMPACT

From the X-ray diffraction data, it was possible to extract both macro and micro strain introduced by bending as well as the austenite fraction.

An interesting finding was the effect of spring-back on the residual stresses in the AHSS. In the single-phase UHSS material, the spring-back after bending leads to compressive strains and stresses on the outside of the bend and tensile stresses on the inside. This is indicated by, respectively, blue and red color in the strain map bellow. The 3rd generation AHSS material show the opposite behavior of the martensite (majority) phase, tensile strain on the outside and compressive strains on the inside of the bend. This while the remaining austenite is affected by the spring-back as expected.



These findings open-up several interesting questions both in fundamental aspects and for the application of 3rd gen AHSS. What is the microstructural basis of the strain behaviour, and how will the strain behaviour of the two phases affect the material's properties in case of for example fatigue and hydrogen embrittlement?

"A strong in-house knowledge of synchrotron techniques gives SSAB a stronger ability to refine materials and properties" / ***Sven Erik Hörnström, SSAB EMEA AB***

SSAB SWERIM DESY.

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Vinnova's project No: 2019-05289 **Duration:** March 2020 -- January 2021

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.