INDUSTRIAL PILOT PROJECT

Diffraction studies of precipitate development of Nb/TiNb microalloyed steels aiming for analysis during hot rolling /cooling

THE INDUSTRIAL CHALLENGE

SSAB is a highly specialized steel company and a producer of HSLA steels. One of the key controls on the strength of HSLA steels is precipitates, nucleated both in the austenite and in the ferrite during hot strip rolling and cooling. To optimize the compositions and the rolling parameters it is crucial to have knowledge about the precipitation evolution.

WHY USING A LARGE SCALE FACILITY

It is challenging to investigate precipitation development during hot rolling because of the difficulty in acquiring samples during processing and maintaining the processing conditions/states. Generally, laboratory simulations are required that enable freezing (quenching) of samples at key stages of the process. However, the phase transformation and the possibility for precipitation to occur during quenching makes it impossible to know the size and fraction of precipitates at high temperature. In-situ measurements under processing conditions would provide a solution to this challenge. Due to the fast process times, scales of interest and challenging experiment conditions, this can only be performed with synchrotron X-ray scattering techniques. Simultaneous small (SAXS) and wide angle (WAXS) X-ray scattering measurements would provide invaluable information of precipitation during phase transformation.

HOW THE WORK WAS DONE

With the aim of performing rolling simulations in-situ with X-ray measurements, it was first necessary to establish that the size distribution of very small fractions of nano-sized precipitates could be sufficiently detected in samples of relevant thickness and at a rate of a minimum of measurements every second. Hence, ex-situ measurements of different states of precipitates were performed in 4 mm samples from laboratory simulations and full-scale industry tests, using high-energy X-ray scattering at the P21.2 beamline of the Petra III synchrotron in Hamburg. The possibility for rapid simultaneous acquisition of SAXS and WAXS at P21.2 also enabled a study of both precipitation and phase transformation with in-situ heating/cooling and measurements every second. The expertise of personnel at P21.2, Malte Blankenburg and Ulrich Lienert (DESY), is greatly acknowledged.

THE RESULTS AND EXPECTED IMPACT

It was established that the simultaneous acquisition with SAXS and WAXS can be used for microalloyed steels with low fractions of nano-sized particles. This is especially important in the foreseen next-step of the project to perform measurements during in-situ rolling simulations to investigate the key questions around the timing of the different processes. To perform measurements during rolling simulations, a dilatometer at P21.2 would be the perfect solution. The measurements so far provide SSAB with valuable information about Nb and TiNb rich precipitates. An example of the acquired data is shown in the figure.

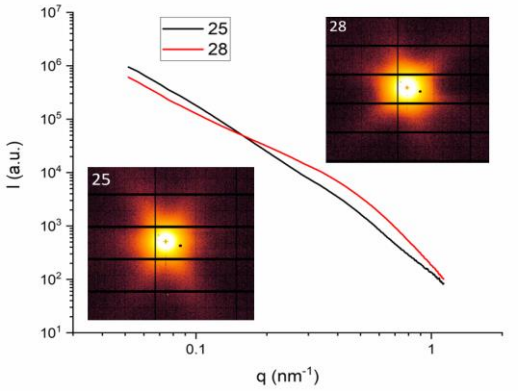

Figure. Ex situ 2d-images and scattering curves for two laboratory samples showing a difference in SAXS intensities (fraction and size of precipitates) for a quenched sample (25) and a sample soaked at 600°C (28).

"This work has provided us with important information about our materials and new contacts in the field of LSI." ***/Linda Bäcke, SSAB***

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