GATAN

Experiment Brief

Murano Heating Stage

Title

Murano heating stage used in the characterization of advanced high strength steel

Gatan instrument used

The Murano™ heating stage, a compact stage specifically designed for use with electron backscatter diffraction (EBSD), allows high-resolution *in-situ* observation of dynamic changes within a sample. The experiment utilized the Nordlys detector from Oxford Instruments.

Background

Automotive industries are always seeking to develop materials that offer the combined advantages of being lightweight, having a high strength, and extended ductility. Advanced high-strength steels (AHSS) present one of the most promising group of materials that allow a high volume, low-cost production of sheet steel with an ultra-high strength that is unmatched by other engineering materials. A limitation during development is that AHSS have a relatively high yield strength due to the precipitation of nano-sized carbides or carbon nitride (V, Nb, Ti) during the austenite to ferrite transformation, and therefore offer only moderate formability. The addition of Mo can refine these precipitates, although characterization of the transformation kinetics is complete. The Murano heating stage was used to better understand the role of Mo during the steel forming process.

Materials and Methods

Tata Steel provided two samples of low-carbon V-bearing steel, one with and one without 0.2 wt.% Mo addition. The steel samples were heat-treated and transferred to a Murano hot stage mounted inside a Zeiss Gemini FEG-SEM. A heating rate of 100 °C/min and a target temperature of 925 °C was set; at which point the austenitic grain growth was confirmed via the Oxford Instruments EBSD Nordlys system. With the Murano stage maintaining a stable target temperature of 925 °C, a series of high-resolution EBSD maps for the two samples were collected after holding times of 600, 1800, and 4200 s.

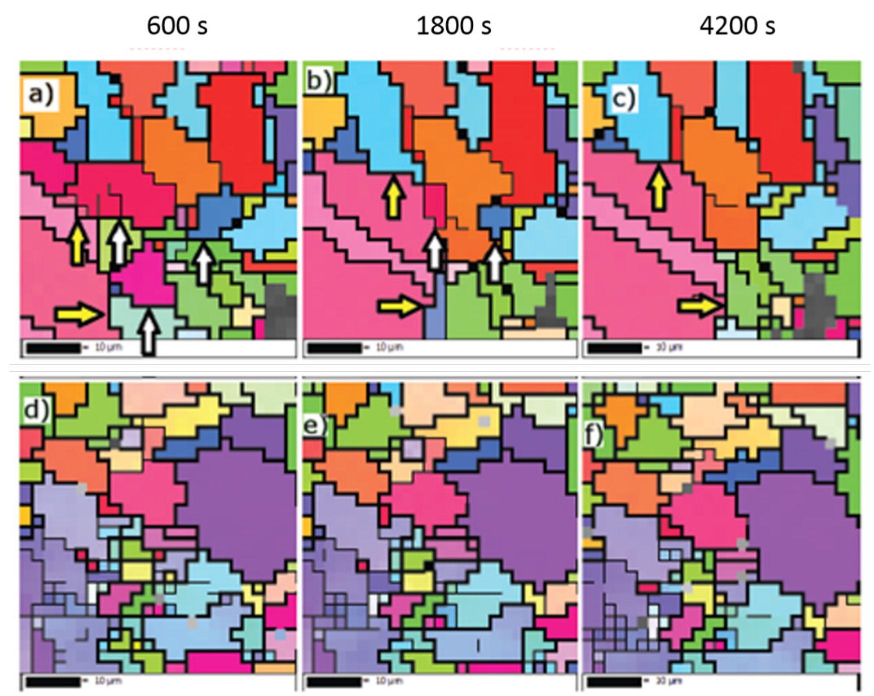

Figure 1. Maps a – c show the steel sample without Mo, maps d – f show steel with added Mo. White arrows in maps show grains that were at later stages of treatment consumed by a progressing high angle boundaries of large neighbouring grain that is growing selectively (yellow arrow). No such events were observed in the sample that included Mo.

Summary

In-situ characterization by hot-stage EBSD allows direct evaluation of the role of Mo in the austenitic grain growth and the kinetics of austenite to ferrite transformation. The addition of 0.2 wt.% Mo to V-bearing low carbon steel restricts austenitic grain growth, and thus provides insight into how the inclusion of Mo provies AHSS.

Credit(s)

A special thanks to Vit Janik, WMG, University of Warwick. For further information see Janik, Vit, et al. "Application of *In-Situ* Material Characterization Methods to Describe Role of Mo during Processing of Vbearing Micro-Alloyed Steels." *HSLA Steels 2015, Microalloying 2015 & Offshore Engineering Steels 2015: Conference Proceedings*. John Wiley & Sons, Inc., 2015.

Gatan is the world's leading manufacturer of instrumentation and software used to enhance and extend electron microscopes—from specimen preparation and manipulation to imaging and analysis.

WMG is establishing the world-class Advanced Steel Research Centre for studying process and physical metallurgy of iron and steel manufacturing. The focus of the activities is on the physical-chemistry aspects, e.g., thermodynamic criteria and kinetics of reactions and precipitations including mass and heat transfer, properties of melt and how these impact processes. Additionally, advanced materials characterization including *in-situ* microscopy is applied extensively to understand transient stages during metallurgical processes.

EB-Murano-Steel-CA-FL1-DEC16