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(5) ポスター発表

# 高機能鉄鋼材料の開発～Thermo-Mechanical Processing Simulator の導入による鉄鋼材料の圧縮プロセスの構造変化の観測～

## Development of high-performance steels ~ a real time observation of microstructure evolution during thermo-mechanical controlled process in steels ~

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Mechanical properties, as the principal properties of structural metallic materials, are mainly governed by the microstructures. Thermo-mechanical controlled process (TMCP) is an efficient method to control the microstructures through various routes. Such microstructure evolutions occurred at elevated temperature with deformation are nearly impossible to be directly analyzed by the conventional techniques. Neutron diffraction with high penetrability can track the bulk averaged crystallographic information such as phase fraction, lattice strain, texture, dislocation density, etc. which is an appropriate technique to probe the microstructure change in real-time under various environments. In 2014, a physical simulator for TMCP, has been installed on the engineering neutron diffractometer 'TAKUMI' at J-PARC supported by the Elements Strategy Initiative for Structural Materials (ESISM) project. The simulator can perform TMCP at elevated temperatures up to 1200°C, strain rate up to 10 $s^{-1}$ and with a rapid cooling rate. Therefore, variant phenomena occurred in TMCP are possible to be clarified by *in-situ* neutron diffraction.

Quenching and partitioning (Q&P) process is an effective approach to control the amount and stability of retained austenite in steels [1]. As we known, retained austenite plays crucial roles in mechanical properties of the product through a transformation-induced plasticity (TRIP) effect. On the other hand, ausforming, i.e. plastic deformation of austenite prior to phase transformation from austenite in steels, affects subsequent phase transformations significantly [2]. However, the effect of ausforming on phase transformation kinetics and carbon partitioning in Q&P process is still not fully understood. In the present study, we conducted *in-situ* neutron diffraction experiments to examine phase transformation behavior during Q&P process after ausforming in a 0.30C-2Mn-2Si (wt%) steel. Cylindrical specimens of the steel with height of 11 mm and diameter of 6.6 mm were prepared. The specimens were austenitized at 900°C for 300 s, rapidly cooled down to 550°C to carry out a 30% reduction compression, and then rapidly cooled to various temperatures (230°C, 250°C, 280°C, 300°C and 330°C) for an 1.5 hours isothermal holding followed by quenching to room temperature. The real time neutron diffraction profiles were analyzed to evaluate the phase transformation and carbon partitioning behaviors.

Figure 1 shows the evolution of diffraction profiles and the corresponding TMCP route. A rapid martensite transformation appeared when the full austenite cooled down to 280°C and the phase transformation from austenite continue progressed in the subsequent holding process. An apparent peak shift can be observed in austenite during isothermal transformation, which implies the occurrence of carbon partitioning. The quantitative comparison of phase transformation and carbon partitioning behaviors at various quenching and partitioning temperatures between the processes with or without ausforming will be discussed in the presentation.

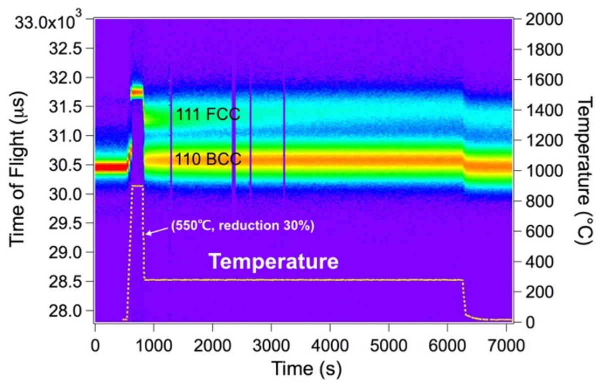


Figure 1. Thermal histroy and corresponding evolution of 111 FCC and 110 BCC profiles.

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**Corresponding project:** Elements Strategy Initiative for Structural Materials (ESISM)

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