論 文 の 内 容 の 要 旨

論文題目　Quantification of Flow Stress and Microstructure Change for Duplex Stainless Steel
（二相ステンレス鋼の流動応力および内部組織変化の定量化）

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Duplex stainless steels are widely applied for their exceptional corrosion resistance and high strength. They have both the face-centered cubic (FCC) austenite and the body-centered cubic (BCC) ferrite, even elevating temperature. The balanced Fe-Cr-Ni system with Mo and Mn allows making the coexistence balance of austenite and ferrite. These two different phases may cause heterogeneous and complicated hot deformation behavior. Especially, flow behaviors, which are one of the important process information, are significantly affected by dissimilar plastic flow and microstructural behaviors of these two phases.

The difference of stacking fault energies (SFE) between two phases plays an important role in the heterogeneity of annihilation and restoration process during hot deformation. In FCC austenite, dynamic recrystallization (DRX) is a dominant process of flow stress decreasing. On the contrary, in BCC ferrite, dynamic recovery (DRV) is more predominant than DRX. To follow these heterogeneity, a new constitutive model is proposed by a combination of DRX and DRV types of equations of flow stresses.

A combination of new constitutive models of the flow stresses is proposed to obtain flow stresses of duplex stainless steel (SUS329J4L) by inverse analysis to compensate for inevitable inaccurate data resulted from internal–external heat transfer, friction, and heat generation originating from the deformation of the specimen under hot working. The relationships λ_{sat} and λ_{ss} of two stresses (austenite and ferrite) are proposed when two stresses reach an equilibrium state of saturated or steady-state. To confirm the validity of the proposed model and new inverse analysis method, hot compression experiments were performed at deformation temperatures of 1050, 1150, and 1250 °C and strain rates of 0.1, 1, and 10 s^{-1} with SUS329J4L for a dynamic event. In addition, experiments of double-compression tests of 1050, 1150, and 1250 °C and strain rates of 0.1 and 1 s^{-1} with inter-pass time of 1, 10, 100, and 200 seconds.

Material genomes of dynamic and static events for SUS329J4L is obtained by inverse analysis and regression methods, which are performed to estimate important material parameters during the hot deformation. The obtained material parameters could be regarded as ‘material genome’, which can predict dynamic and static kinetics, and it explains microstructural evolutions during the hot deformation such as forging or rolling. At the dynamic events, to verify dissimilar microstructural evolutions, electron backscattering diffraction (EBSD) is performed for the dynamic events at reduction ratios of 25% and 50% and strain rates of 1 and 10 s^{-1}. At the static events, based on the obtained flow curves of double compression test, a set of softening fraction were calculated, and microstructure observation was performed to verify the obtained results.