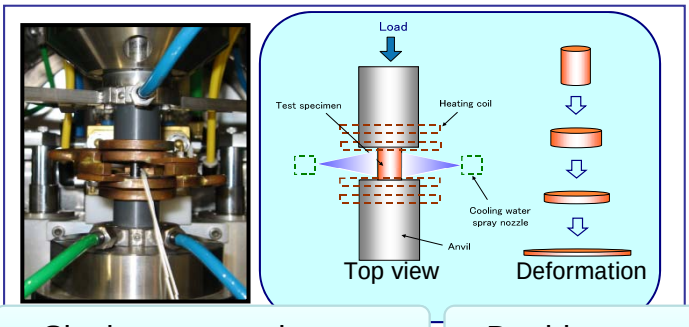
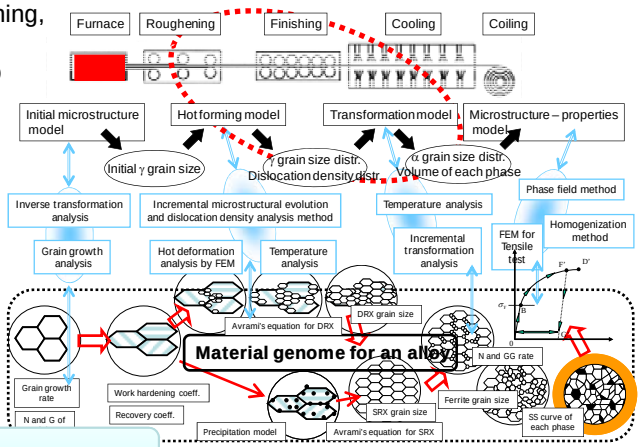
Acquisition of 'Material Genome' for Structural Metals under Hot Forming

Chair for Hyper-functional Forming
Institute of Industrial Science, The University of Tokyo
Prof. Dr.-Eng. Jun Yanagimoto

The material genome, that is, the empirical equation to describe, for example, work hardening, recovery and recrystallization as functions of strain rate, strain and temperature for each alloy composition, are missing in most of the structural steels. Deformation analysis to obtain the transient change in strain rate and temperature for the material being formed is in practical use in several rolling processes. A microstructure analysis method, such as the incremental dislocation density and microstructure evolution analysis method, is proposed and applied to estimate the microstructure affected by the transient change in strain rate and temperature, using the material genome as the boundary condition.

We lack the material genome to describe, for example, work hardening, recovery and recrystallization as functions of strain rate, strain and temperature for each alloy composition. Consistent investigations to acquire 'Material Genome' is summarized here.





Single compression test

Double compression test

Quenched structure

Inverse analysis to obtain flow curve, ref. 1).

Analysis of flow curve, ref. 3).

Polishing and etching
Image analysis by microscope

Analysis of flow curve, ref. 2).

Critical strain for DRX ε_c

Rate of DRX G^D

Rate of SRX G^S

DRX grain size d_γ^D

Work hardening coefficient c

Static recovery coefficient b^S

Rate of grain growth

Dynamic recovery coefficient b^D

SRX grain size d_γ^S

Transformation test, ref. 4).

(Residual dislocation density)

Quenched structure

Rate of nucleation I

(CALPHAD)

Polishing and etching
Image analysis by microscope

Ferrite grain size d_α

Rate of ferrite grain growth G_F

References **1)** A. Yanagida and J. Yanagimoto: Flow Curve Determination for the Metal under Dynamic Recrystallization using Inverse Analysis, *Materials Transactions*, 44-11(2003-11), 2303-2310. **2)** A. Yanagida and J. Yanagimoto: Novel Approach to Determine Kinetics for Dynamic Recrystallization by using Flow Curve, *Journal of Materials Processing Technology*, 151 (2004), 33-38. **3)** A. Yanagida and J. Yanagimoto: Formularization of Softening Fractions and Related Kinetics for Static Recrystallization Using Inverse Analysis of Double Compression Test, *Materials Science and Engineering A*, 487, (2008), 510-517. **4)** J.S. Liu and J. Yanagimoto: Incremental Formulation for the Prediction of Microstructure after Hot Forming, *ISIJ International*, 41-12(2001), 1510-1516.