Single and Multi-stage Compression Test for Forming of Structural Metals

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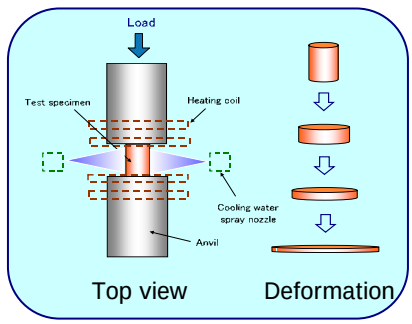
The flow stress of metals under forming is the most important parameter for research and development of forming technology. Flow stress is measured by tensile test or compression test. Compression test is more suitable for obtaining flow curve of structural metal under forming by heavy deformation as rolling, forging and extrusion. The hot compression test is made not only for obtaining the flow curve but also for measuring softening between forming stands, thus multi-stage compression test is needed. Measured data should be formularized as 'flow stress formula' to cover wide range of temperature and forming conditions, or 'materials genome' which include the metallurgical effect during forming.

First step: Obtain compression force – Deformation curve

1. Hot compression testing machine up to strain rate of 300/sec

Outer view

Inside chamber

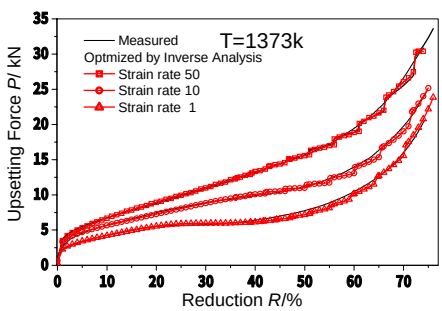


2. Conventional THERMECMASTOR-Z

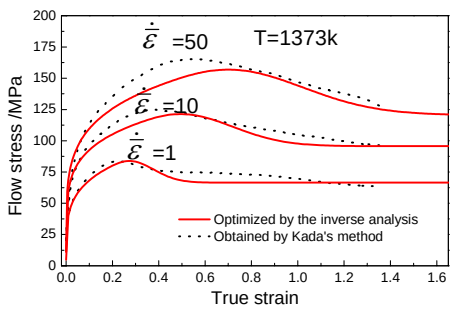
Second step: Inverse analysis to obtain flow curve

Results

S20C

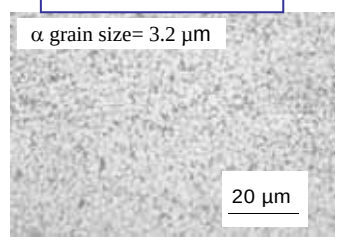


Measured force and fitted force during inverse analysis

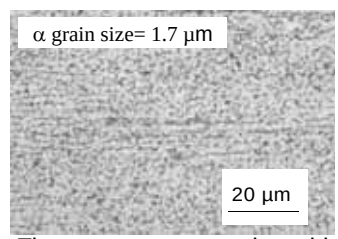


Flow stress obtained by inverse analysis

Grain structure



Single compression



Three-stage compression with cooling

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: Regression Method to Determine the Generalized Description of Flow Curve of Steel under Dynamic Recrystallization, *ISIJ International*, 45-6(2005), 858-866. **4)** J. Yanagimoto, Y. Kobayashi and A. Yanagida: Multi-stage High-speed Compression Test to Obtain the Material Data for Kinetics of Microstructure Change in Micro-scale Analysis of Large Stain Working Technologies, *Steel Research International*, 78-10/11(2007), 812-817. **5)** 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.