Abstract

The nickel based superalloy IN718 is used in manufacturing of launch vehicle components, military equipment, and other high performance related critical applications due to its inherent properties such as high strength at elevated temperatures, good creep resistance, oxidation and corrosion resistance properties. Obtaining a product with sound mechanical properties is a critical issue in manufacturing industries. It demands extensive experimental studies for identifying the safe processing region(s). However, these safe processing region(s) can be identified through analysis of true stress-true strain curves.

The present communication has identified the said regions, wherein the thermomechanical process induces dynamic recrystallization to obtain fine grain microstructure within the product. Accordingly, hot isothermal uniaxial compression tests were conducted in the temperature range of 900°C to 1150°C and strain rates in the range of $0.001s^{-1}$ to $10s^{-1}$ using a Gleeble 3800 Thermomechanical Simulator. The instrument provided flow stress data, to study hardening behaviour of the material and identify critical stress for DRXI and DRXT within the temperature and strain rate range. The Microstructure evolution was studied to validate the above investigation and tested prediction capabilities of constitutive models such as Sellars and Tegart's, mJC, Cingara, and hansel spittle.

Variation of strain hardening exponent and the activation energy were found to be within 3.25 to 4.5 and 475 kJ/mol to 560 kJ/mol. Cingara's constant was calculated to be around 0.564. The heat flow curve was evaluated to find out the phase change during high-temperature processing, and also identifying the critical temperature. The results were validated and concluded from processing maps. The same will help to know the stable and unstable regions of processing. Based on the processing data, safe thermomechanical processing regions having excellent power dissipation efficiency were suggested. Non-conventional thermomechanical processing pertaining to severe plastic deformation portrayed improved grain structure and mechanical properties over conventional techniques. The study can be extended to explore the better processing parameters for ECAP and FSP techniques.