Evolution of microstructure and texture and numerical simulation of hot deformation of 304LN austenitic stainless steel

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Abstract

The austenitic stainless steel group is an important steel group because of its high corrosion resistance and high strength at elevated temperatures. This makes these steels to be an important material in nuclear, fertilizer and petro-chemical industries. Due to its wider applications, lot of research has been done on its hot deformation behavior. However, improvisation of its properties are still going on, which can be achieved by altering the chemical composition or by tailoring the thermo-mechanical process. One important aspect of improving the properties is by grain refinement which can be achieved during the thermo-mechanical processing of the material. The evolution of microstructure, at high temperature, is a complex process involving recovery, recrystallization and growth. Microstructure evolution in austenitic stainless steel during high temperature deformation is mainly dominated by dynamic recrystallization. However, for processing routes with large inter-pass time static recrystallization plays an important role. Along with the microstructure, texture evolution in the material is also affected by the temperature and processing route, as these two are closely inter-linked with each other. In the present work, all these phenomena has been studied for 304LN austenitic stainless steel through the axi-symmetric compression tests carried out at constant temperatures and constant strain rates. A considerable amount of grain refinement has been observed, though grain coarsening has also been seen in some processing conditions. The obtained microstructures were also compared to that obtained from the hot rolling process performed under similar environment. However, a significant difference in microstructure has been observed. These differences were correlated to the state variables like temperature, strain and strain rate calculated from the finite element (FE) modeling. Experimental rolling has also been performed by changing the rolling direction by 90^0 i.e. cross rolling, to study the microstructure and texture evolutions. Later on, the FE modeling has been performed for cross rolling process to study the effect of change in rolling direction on different state variables. The spreading of the material during the cross rolling process were analyzed through the computed spreading and elongation velocities. A good agreement between the predicted and experimentally obtained plate shapes has been obtained.

Keyword: Microstructure; Texture; EBSD; Finite element modeling; Cross rolling