Design of Controllers for Microstructure Development

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Abstract

In this paper, a new strategy for systematically calculating optimal process parameters for microstructural control during hot extrusion process is presented. Modem control theory has been applied to the microstructure development during hot extrusion. In the present study, an attempt has been made to control the microstructure evolution during extrusion using the conventional PI Control, Generalised Predictive Control (GPC) and Linear Quadratic Regulator (LQR) approaches. This approach treats the deforming material as a dynamical system and involves developing state space models from available material behavior and hot deformation process models. The final grain size and volume fraction of recrystallisation after extrusion are considered as the optimal criterion and the grain size is expressed in terms of strain, strain rate and temperature. The steps involved in conventional PI Control and GPC approach include process modelling and controller design. LQR approach is based on optimal control theory and involves developing of state space models to describe the material behavior. The trajectories of the independent variables to achieve the desired grain size are obtained and the strain values are further utilised to optimise the dimensions of the extrusion die profile to achieve the required grain size. Also, the performance of PI, GP controllers and LQR are compared through ISE and IAE values. Simulation studies are carried out using MATLAB software.

Keywords: Microstructure control, extrusion, PI control, Generalised Predictive Control and Linear Quadratic Regulator