Microstructural Modeling and Dynamic Recrystallization of sintered Al-4%Cu-0.5%Mg alloy during Hot Extrusion Process

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ABSTRACT

The grain size directly control the mechanical properties and performance of any material so the grain size control is prime important in secondary processed material. Al-4%-0.5%Mg (2xxx) alloys are extensively used in aerospace and industrial applications. Therefore, the present work is aimed to study the grain size distribution and dynamic recrystallization (DRX) of sintered Al-4%Cu-0.5%Mg alloy during extrusion at elevated temperatures. Extrusion tests are performed on selected sintered composition (Al-4%-0.5%Mg) at different Initial Relative Densities (IRD) of 70%, 80% and 90% over a range of temperature (450 °C-550 °C) and strain rate of 0.1-0.3 s^{-1}. All the extrusion tests are performed with a low extrusion ratio of 4, die approach angles of 30° to produce uniform distribution of grains after extrusion. The evolution of microstructure during extrusion at different parameters (i.e. temperature, strain rate and IRD) is analyzed by optical microstructure and Scanning Electron Microscopy (SEM). The DRXed grain size has increased with increasing temperature and decreasing strain rate. Arrhenius constitutive model is used to calculate the Activation Energy (Q) and Zener-Hollomon (Z) parameters of sintered Al-4%-0.5%Mg alloy at various temperatures, strain rates and IRDs. The mathematical model is developed to predict the DRX grain size as a function of Z and IRDs. It is concluded that the activation energy is decreased with increasing temperature and strain rate. The DRX grain size is affected with Z parameter which is decreased with increasing Z value. The results indicate that the formulated microstructural modeling is reliable and accurate after verifying the best fit line drawn between measured and calculated DRX grain size for different IRDs. The highest absolute error (δ) and mean absolute error (δ_m) is not exceeded than 10% which shows the accuracy of the model.

Keywords: Sintering, Hot extrusion, Constitutive modeling, microstructure, Zener-Hollomon parameter