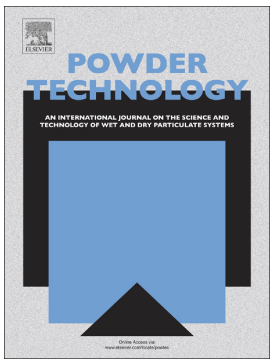

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Modeling of stress relaxation kinetics of amorphous $Fe_{0.7}Nb_{0.1}Zr_{0.1}Ti_{0.1}$ alloy powder: a novel approach based on differential thermal analysis

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Abstract

In this study, the stress relaxation of amorphous $Fe_{0.7}Nb_{0.1}Ti_{0.1}Zr_{0.1}$ alloy was investigated by differential thermal analysis (DTA) to enhance the soft magnetic properties. Amorphous $Fe_{0.7}Nb_{0.1}Zr_{0.1}T_{0.1}$ alloy was produced by mechanical alloying technique using the mixture of pure elements and without adding metalloids. It was found that the stress relaxation process follows the Johnson-Mehl-Avrami model and the mechanism was volume diffusion control with three dimensional growth of the nuclei. The relation of stress relaxation progress (α), with time was proposed as: $\frac{d\alpha}{dt} = \beta \frac{d\alpha}{dT} = 3.04 exp\left(-\frac{4312}{RT}\right)(1-\alpha)\{-ln(1-\alpha)\}^{0.37}$. The final achieved microstructure leads to higher saturation magnetization and lower coercivity that are favorable for soft magnetic applications.

Keywords: Amorphous Fe based alloys; Magnetic materials; Mechanical alloying/milling; Recovery; Magnetic properties; Relaxation kinetics

1. Introduction

1.1. Amorphous Fe based alloys

The amorphous Fe based soft magnetic materials have a great interest since the first ferromagnetic amorphous material, i.e., $Fe_{80}P_{13}C_7$, was discovered in 1967 [1]. Amorphous and nanocrystalline Fe based alloys not only provide good soft