High induction soft magnetic Fe-Co-B cores

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High-induction nanocrystalline materials represent a significant advancement in the field of electrical engineering, particularly in the development of electric motors. This study explores the application and benefits of these materials in enhancing motor performance and efficiency. Nanocrystalline materials are characterized by grain sizes typically less than 100 nanometers, contributing to their high saturation magnetization, permeability, low coercivity, and minimal energy loss at high frequencies. These properties are essential for efficient operation of electric motors, especially under variable speed conditions and high frequencies. The focus is on FeCoB-based nanocrystalline materials, examining the processes of melt spinning and subsequent heat treatment used to achieve optimal magnetic properties. The findings highlight the potential of FeCoB-based nanocrystalline materials to significantly improve the performance and efficiency of electric motors, marking a crucial development in electrical engineering.

Keywords: High induction soft magnetic materials, ultra rapid annealing, soft magnetic properties

1. Introduction

Soft magnetic materials based on Fe-Co-B alloys have emerged as promising candidates for high-efficiency energy conversion systems, thanks to their exceptional saturation induction, low coercivity, and favorable high-frequency performance. These properties make them particularly attractive for use in electric traction systems, high-speed motors, and advanced power electronic converters.

Traditionally, thermal treatment of Fe-Co-B alloys has been performed on ribbon prior to core assembly using ultra rapid annealing and continuous ultra rapid annealing methods (1). This approach imposes significant limitations on scalability of core production. Moreover, post-assembly heat treatment of complete cores has been largely avoided due to challenges associated with uniform heating, stress management, and preserving magnetic integrity.

In this work, we present a novel methodology for **ultrafast heat treatment** applied directly to fully assembled Fe-Co-B cores. The proposed approach allows for rapid structural relaxation and partial nanocrystallization within seconds, eliminating the need for separate processing steps and unlocking the potential for streamlined, high-throughput manufacturing of magnetic components. This breakthrough enables direct optimization of final magnetic properties at the component level, marking a significant advancement in the processing of Fe-Co-B-based materials.

(1). AIP Advances **12**, 035316 (2022); doi: 10.1063/9.0000274