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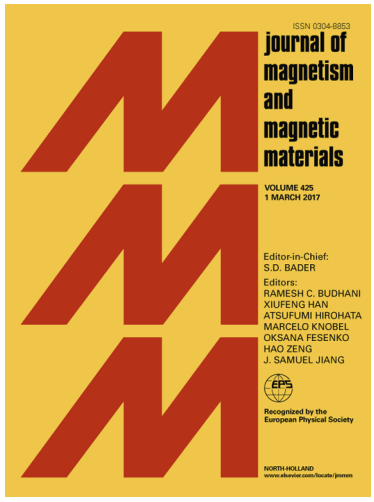

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Study on the rare-earth giant magnetostrictive actuator based on experimental and theoretical analysis

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Abstract: The rare-earth giant magnetostrictive material has received considerable attention in recent years and is known as a new type of high efficient magnetic - mechanical conversion material. Its performance is far superior to that of other materials such as piezoelectric ceramic and so on. Giant magnetostrictive actuator has been widely used in precise driving occasions for its excellent performance. The experimental analysis system for giant magnetostrictive material is designed. Several important parameters have been discussed separately by static and dynamic experiment. Further, the nonlinear magnetic hysteresis characteristic is analyzed by theoretical method. The turning machining analysis model is established and the analytical solution is verified by comparison with the test result. The influence of various parameters is discussed at the same time. Obviously, the research results and methods provide a basis for giant magnetostrictive actuator.

Keywords: giant magnetostrictive material, giant magnetostrictive actuator, experimental analysis, nonlinear magnetic hysteresis characteristic, analytical solution

1 Introduction

Giant magnetostrictive material is the core driver of giant magnetostrictive actuator. Magnetostrictive effect was first found by Joule in the 1840s. It says that the size of magnetic body will elongate or shorten when the magnetization state changes. People had been trying to explore practical magnetostrictive material. But the magnetostriction of most material was only about 10^{-6}~10^{-5} and just the equivalent of thermal expansion. It got practical progress until polycrystalline material appeared. Its magnetostriction could be 40ppm and it is mainly used in actuator. Magnetostrictive material research had been made a further development when Alfer Fe-13%Al was found in 1950. At that time the magnetostriction had reached to 100ppm (Nan C W 2008, Ryu J 2002).

People began to devote to the study of rare-earth magnetostrictive material in the 1960s. A. E. Clark found that binary rare-earth alloys such as TbFe2 and DyFe2 had large magnetostrictive coefficients at room temperature and under low magnetic field in 1972. The magnetostrictive coefficients of ternary rare-earth alloys were found to be 10^{-3} and magnetic coupling coefficients were greater than 0.6 in 1974. C1ark applied for a patent of US3949351 and put it into practical utilization in 1976. The commercialization of rare-earth giant magnetostrictive material began to appear in the mid-1980s. The typical composition is $Tb_xDy_{1-x}Fe_{2-y}$, where x is 0.27~0.35 which is the ratio of Tb and Dy, y is

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