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Analysis of Microwave Assisted Magnetization Switching in Magnetic Material

Shuangmei Li

(Department of Preparatory Courses, Shenyang Institute of Engineering, Shenyang, 110136, China)

Abstract

The minimum switching field threshold and switching speed are key parameters for the magnetic recording in writing. This paper presents the dynamic precession of the moments of the grains based on LL equation.Under microwave-assisted reversal conditions, the influence of loading speed of reversal magnetic field in two interacting particles is investigated.

Keywords: Microwave assisted magnetic recording; Exchange interaction; Dipolar interaction; LL equation.

1. Introduction

With the rapid increase of recording density, more and more signal problems are bringing to write the signal magnetic recording .Facing of so many contradictions, scholars gradually adopt a variety of technical means to mitigate the contradictions, which are heat-assisted magnetic recording, perpendicular magnetic recording and study in this paper, namely microwave-assisted magnetic recording [1-2]. In the high-density magnetic recording media, because the signal recording unit is affected by high anisotropy energy to keep thermal stability, so the signal for the write head needs a magnetic field to make the magnetic moment of the signal upside down to be able to writing the signal. Microwave Assisted Magnetic Recording is to add a microwave field to assist magnetization switching [1-2].

For a single particle magnetic moment in the microwave field characteristics, the majority of the literature have shown that the microwave field can assist magnetic moment reversal [3-4]. This paper studies the effect of the microwave-assisted magnetization reversal in two-particle magnetic moment system. Based on the LL equation, this paper considers the exchange interaction and dipole interaction among the magnetic moment switching and analyses the effects of the loading speed of reversal magnetic field in two interacting particles.

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2. A theoretical model

We mainly consider the magnetic moment in the case of interaction of the particles microwave assisted magnetization reversal dynamics.

Usually the magnetic field roles on the particles of magnetic moment are following: dipole field, exchange field, anisotropy field, the microwave field and the reversal field, the formula is as follows:
Dipole field:

E-mail address: lsm621216@sina.com

$$\vec{h}_i^{dipole} = \frac{\mu_0 M_s}{4\pi D^3} \sum_{j \neq i} \vec{m}_j (\nabla\nabla(\frac{1}{\vec{r}_{ij}})) = \frac{\mu_0 M_s}{4\pi D^3} \sum_{j \neq i} [\frac{3\vec{r}_{ij}(\vec{m} \cdot \vec{r}_{ij})}{r_{ij}^5} - \frac{\vec{m}_j}{r^5{}_{ij}}] \quad (1)$$

The exchanging field:

$$\vec{h}_i^{exchange} = J \sum_{j \neq i}^{NN} \vec{m}_j \quad (2)$$

The Anisotropy energy corresponding to the field can be written as:

$$E_A = k \sin^2 \theta, \ \vec{H}_A{}^k = \frac{2k(\vec{m} \cdot \vec{H}_k)}{M_s} \cdot \vec{H}_K \quad (3)$$

In summary, all the particle magnetic moment of the field should be expressed as:

$$\vec{h}_i = \vec{h}_i^{dipole} + \vec{h}_i^{exchange} + \vec{H}_{dc}, \ \ \vec{h}_i^{total} = \vec{h}_i + \vec{H}_k + \vec{h}_{ac} H_k \quad (4)$$

so LL equation can be written as:

$$\frac{\partial \vec{m}}{\partial t} = -\gamma \vec{m} \times \vec{h}^{total} - \frac{\alpha\gamma}{M_s} \vec{m} \times (\vec{m} \times \vec{h}^{total}) \quad (5)$$

Where γ is the gyromagnetic ratio, α is the damping coefficient.

For the two-particle magnetic moment system,compared with the single-particle magnetic moment, more than a dipole field and the role of exchange interaction, LL equation in the direction of the component X can be expressed as: