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Magnetic and thermodynamic properties of a ternary metal nanoisland: A Monte Carlo study

Dan Lv [a,b,*], Yi Yang [a], Wei Jiang [a], Feng Wang [b], Zhong-yue Gao [a], Ming Tian [a]

[a] School of Sciences, Shenyang University of Technology, Shenyang, 110870, China
[b] School of Materials Science and Engineering, Shenyang University of Technology, Shenyang, 110870, China

HIGHLIGHTS

- The mixed-spin (1, 3/2, 2) ternary metal nanoisland in the longitudinal magnetic field has been studied.
- Magnetization, susceptibility, internal energy and blocking temperature have been discussed.
- The triple and double hysteresis loops behaviors have been found in the nanoisland for certain physical parameters.

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ABSTRACT

Using the Monte Carlo simulation, the magnetic and thermodynamic properties of a ferrimagnetic mixed-spin (1, 3/2, 2) ternary metal nanoisland with core–shell structure in external magnetic field have been researched detailedly. The effects of crystal-field, exchange coupling and temperature on magnetization, susceptibility, blocking temperature and internal energy as well as hysteresis loops behavior of the system have been exhibited. Some interesting phenomena such as multiple saturation magnetizations and rich hysteresis loops behaviors have been found. The results can be comparable with some theoretical and experimental researches.

1. Introduction

In recent years, along with the development of nano-science and technology, it is raising the upsurge of researching nano-materials in domestic and foreign due to their outstanding physical and chemical performances in many domains. Different from the bulk materials, nano-materials have remarkable magnetic and thermodynamic properties because lots of atoms exist at the surface, which make a great contribution to the physical properties. Up to now, nano-materials are used widely in many technology fields such as solar cells [1], sensors [2], light-emitting diodes [3], linear magneto resistance [4] and ultra-high-density magnetic recording media [5,6] and so on.

Among all nano-materials, nanoisland has attracted wide attention because of its large specific surface area, excellent magnetic and electric properties, which has potential engineering applications such as in magnetic storage, light electric detector, etc. [7–10]. At present, a great number of unitary, binary and ternary metal nanoislands have been produced in experiment, such as $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) nanoisland [11], Fe nanoisland [12,13] and FeRh nanoisland [14]. The LSMO nanoisland with average size is 160–720 nm has been prepared [15]. The physical performance of the triangular FePt nanoisland has been observed and regular FePdCu nanoisland arrays with steerable size and position have been obtained by

* Corresponding author.
E-mail address: ludan1977918@163.com (D. Lv).

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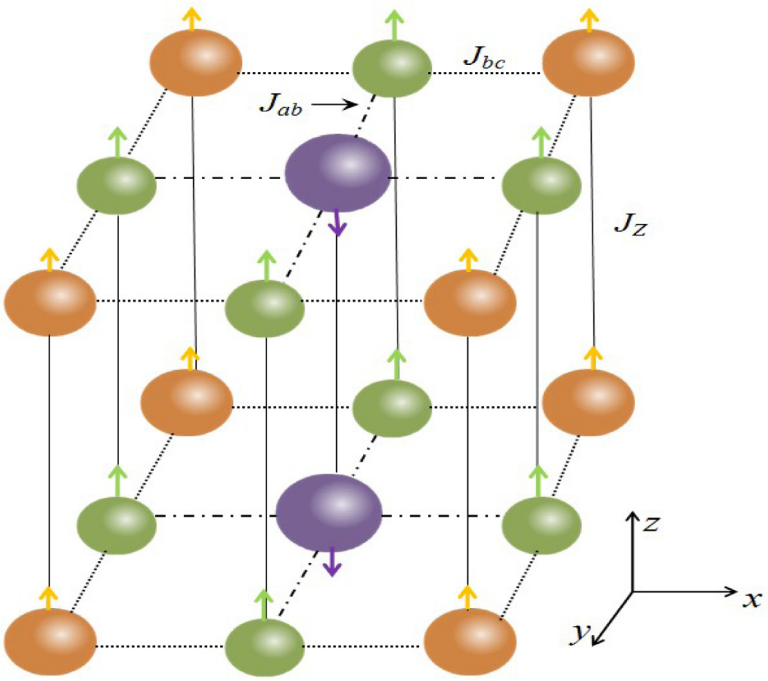

Fig. 1. Schematic illustration of a ferrimagnetic nanoisland consisting of three kinds of atoms. The core sublattice a with spin-3/2 (purple balls) are surrounded by sublattice b with spin-2 (green balls) and sublattice c with spin-1 (orange balls). The dash dot line, dash line and solid line symbolize the nearest-neighbor exchange couplings J_{ab}, J_{bc} and J_Z respectively. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

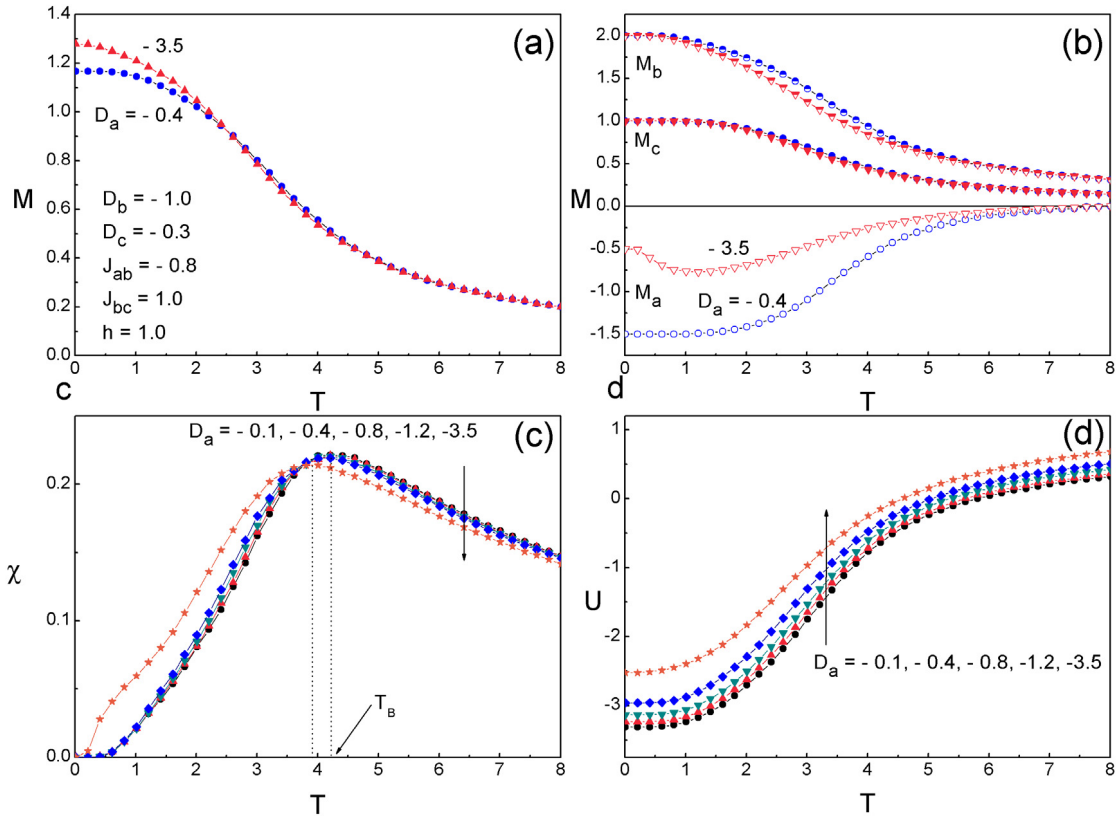

Fig. 2. Temperature dependences of the M, M_a, M_b, M_c, χ and U for various values of D_a with $D_b = -1.0$, $D_b = -0.3$, $J_{ab} = -0.8$, $J_{bc} = 1.0$ and $h = 1.0$.