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Effect of magnetic and electric fields on electrical and magnetic properties of multiferroic BiMnO₃ films

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Abstract

The effect of magnetic and electric fields on the electrical and magnetic properties of BiMnO₃ films within the framework of Landau-Ginzburg theory had been investigated. We also calculated and discussed the hysteresis loops of polarization and magnetization as a function of electric and magnetic fields. The results reveal that, the possibility of electric-field control of magnetization switching, and vice versa. By decreasing the film thickness of BiMnO₃ film, it is shown that the coercive fields and remnant order parameters are suppressed.

1 Introduction

There exist some new materials in nature known as magnetoelectric multiferroics, in which their magnetic spin are coexistent with electric dipole and mutually coupled. This phenomenon could lead to the electric-field control of magnetization or magnetic field control of polarization. It should be noted that not all magnetoelectric materials are multiferroics [1]. Although the ferroelectricity and ferromagnetism can coexist in multiferroics, both of polarization and magnetization are not necessarily required by magnetoelectric coupling effect. For instance, the magnetoelectric effect may occur in paramagnetic ferroelectrics without magnetic ordering [2].

The research of multiferroic materials have started in 1960s and 1970s. Over the past decade, the multiferroics have been misconstrued as rare materials in nature and the coexistence of ferroelectricity and ferromagnetic is scarcely possible [3]. This is due to the “ d^0 vs d^n problem” [4], where the covalent bonding in ferroelectric perovskite between oxygen and transition metal ions contains empty d -shells, d^0 , whereas the magnetism required partially filled d -shells, d^n , of transition metal or rare-earth ions. Recently, multiferroics become no longer rare materials and many new achievements in both aspects in theory and experiments have been done. The theoretical investigations have provided an explanation for the general problem of scarcity of multiferroics in nature and caused the revival of its research field [1, 3, 4]. In addition to,

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