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On the enhancement of energy storage density in $Bi_{0.9}Ho_{0.1}FeO_3$ ceramics

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Abstract. Polycrystalline $Bi_{1-x}Ho_xFeO_3$ (x = 0, 0.05, 0.1) samples are prepared by conventional solid state route. The XRD pattern shows *R3c* phase. The maximum electrical polarizations in the above three materials are found to be 0.067μC / cm^2, 0.329μC / cm^2 and 0.565μC / cm^2 respectively. Here the holmium is chosen for the reason that the leakage current can be reduced very much thereby the multiferroic property can be enhanced. Based on this experience it is decided to study the energy storage density in these ceramic materials with Ho as dopant. It is found that there is a good enhancement from 12% to 30% efficiency on energy storage density.

1. INTRODUCTION

In the present era of alternative energy resources like solar energy, wind energy, hydropower, atomic energy, nuclear energy etc., energy storage becomes inevitable. For example, the people now work on solar cells particularly in dye sensitized solar cells (DSSC) look for good materials for energy storage. That is why the materials for hydrogen storage are of much importance. Since multiferroic activities are also going in a faster pace, the researchers devote time to look at those materials for energy storage because both magnetism and electricity consequently magnetoelectric effect and magnetocapacitive effect will prevail, and this capacitive effect can be of effective use in energy storage.

There are lot of works reported in literature to use multiferroic materials particularly the pervoskite materials for the energy storage. Here, we could not list out all the literature for want of space. In this regard, a good review brought out by *Xihong Hao* in 2013 [**1**] is noteworthy. This deals with many pervoskite materials which are found to be potential dielectrics for high energy storage. Infact relaxor ferroelectrics and antiferroelectrics can be effectively used for energy storage

Recently we have studied multiferroic activities in Sm and Ho substituted bismuth ferrite [**2**] in which we found when holmium is substituted, the leakage current can be very much controlled thereby increasing the ferroelectric and magnetic properties. Saturation magnetization and maximum polarization are enhanced when the holmium is substituted in $BiFeO_3$ ($Bi_{1-x}Ho_xFeO_3$ (x = 0, 0.05, 0.1)). Since electric polarization increases it is expected that this material can be effectively used for energy storage devices. For the first time, it is reported here, the energy storage in this material as far as our survey of literature is concerned.

2. EXPERIMENTAL DETAILS

The polycrystalline samples of $Bi_{1-x}Ho_xFeO_3$ (x =0, 0.05, 0.1) were prepared by high temperature solid state reaction. High purity materials of Bi_2O_3, Fe_2O_3 and Ho_2O_3 are the starting materials which were taken in the stoichiometric percentage and ground vehemently. Formerly the mixtures were calcined at 600°C for 2 hours and subsequently quenched at ambient temperature. Then the mixtures were sintered at 835°C for 2 hours. The residues of mixture were pelletized using a fresh poly vinyl alcohol as a binder. Cylindrical pellets having dimensions of 10mm diameter and 1mm thickness were prepared by a hydraulic press of 30MPa. The pressed pellets were

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