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Large Parameters and Giant Effects in Electronic Materials[1]

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Abstract—Interpretations of large electromagnetic parameters and giant effects in electronic materials are presented. Conductivity, permittivity and permeability of certain materials can be hundred times higher than normal values. Physical phenomena of magnetoresistivity, nonlinear resistivity, electrostriction, magnetostriction, magnetocaloric and thermistor effects in some materials appear to be giant. Often, but not always, these anomalies are due to the proximity of a substance to its phase transitions. Original explanations of the listed phenomena are given, particularly, the effect of polarization on a huge change of conductivity.

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1. INTRODUCTION

It is well known that main electrodynamic parameters of materials are their electrical conductivity σ, characterizing the charge movement in electrical field, dielectric permittivity ε, describing the separation of electrical charges in electrical field, and magnetic permeability μ, determining the magnetic induction in magnetic field. In recent years, it has been discovered that these parameters in some materials can assume very large values. It requires explanation and can find important applications in electronics.

In some materials used in electronics, such electrophysical effects are found to be hundreds of times stronger than previously known phenomena. Researchers call these changes in parameters as "giant effects". A number of such effects already has found important applications in science and technology allowing the design of high performance technical devices.

Below, it is shown that very large changes of conductivity in some electronic materials are due to the influence of electrical polarization on the conductivity of non-centrosymmetric materials. This phenomenon manifests itself differently in the ordinary and elevated electrical fields. Besides, a very strong influence of internal polarity is seen on both the temperature dependence of conductivity (in critistors and posistors) and the large field dependence of conductivity (in varistors). It should be noted that the understanding of polarity impact on electrical charge movement could be important for improving the relevant material parameters.

In the polar-sensitive material, both the electrical and magnetic fields may shift the temperature of "insulator-conductor" phase transformation leading to an enormous change in resistivity. Moreover, the phase with reduced resistivity can be located both at elevated temperature and at lower temperature.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ADDITIONAL INFORMATION

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