ABSTRACT

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TITLE:- DEVELOPMENT OF GENERAL ELECTRO-MAGNETIC RESPONSE FUNCTION OF DIELECTRIC MATERIAL

Submitted by:-ANANYA BANERJEE

The electrical conductivity of ion-conducting solid is mostly dependent on dielectric behavior of the material. The nature of frequency dispersion of electrical conductivity of the solid may be determined by a.c. dielectric function or dielectric response. The simplest form of the linear response is the pioneering Debye response theory. Later many prominent phenomenological non-Debye responses have been proposed. A simple nonlinear non Debye form of dielectric response function is proposed in this work. The proposed form is an extension of Debye linear response and simple one following L-C-R electric analogue of material to depict a non-Debye response function. The function of dielectric response is capable to reproduce other existing response function along with some new features. Hence, following Maxwell Granett Theory (MGT) and using the modified Clausius-Mossotti relation, the effective relative permittivity of the composite medium is formulated. Effect of electromagnetic coupling in case of dielectric composite like Dilute Magnetic Dielectric (DMD) is introduced. It has been found that in magneto-electric, ferroic, and chiral materials the application of magnetic fields can produce a dielectric response and the application of an electric field can produce a magnetic response. These cross coupling behaviors can be found to occur in specific material lattices, layered thin films, or by fabricated composite materials. The origin of the intrinsic magneto-electric effect is from the strain-induced distortion of the spin lattice upon the application of an electric field. When a strong electric field is applied to a magneto-electric material such as chromium oxide, the lattice is slightly distorted, which changes the magnetic moment and therefore the magnetic response. Variation of real and imaginary part of dielectric constant as a function of frequency is measured at different d.c. Magnetic field (H). The results show that a substantial change in real and imaginary part of dielectric constant under variation of H in the measured frequency rage. The proposed theoretical formulation of DMD like composites (pearl and mica) and its comparison with experimental result by UV-VIS spectroscopy shows a good qualitative agreement. Magnetoresistance, which change under the application of an external magnetic field is also measured for DMD (NiO and CoO) systems. In this work another indigenous optical

experimental setup for investigation of magnetism in a DMD is designed. The technique exploited the Maxwell's EM theory. DMD with good reflecting surface to exhibit zero/ minimum reflectance of incident in plane polarized monochromatic light. The corresponding angle of incidence is the Brewster angle. The influence of external out of plane magnetic field is to cause the variation of the Brewster angle due change in magnetism of the specimen. Authors have investigated dielectric response for four DMD (sulfide) sample i.e. Gadolinium Nickel Sulfide Complex, Cobalt Sulfide, Nickel Sulfide and Titanium. All samples were synthesized following chemical and green techniques. Later process provides good stability of the nano clusters (NC) due to in-situ capping of sample NC. The experimental DMD specimens have found to exhibit Ferro-magnetic or super-paramagnetic nature at room temperature. The experimental analysis indicates that obtained magnetism is mostly due to the surface magnetism which may be very interesting for topological crystalline insulators. An improved version of the instrumentation could be a cost effective one for determination magnetism in such DMD specimens. Finaly, to investigate the magnetic nature of Dilute Magnetic Dielectrics (DMD) at low temperature, SQUID-magnetometry is used over the developed nano sized Gadolinium oxide, Gadolinium Sulfide and Gadolinium sulfide made by green synthesis. Gadolinium oxide nanoparticles play a central role in multimodal imaging, targeting the cancer cells and drug delivery in medical science. In this work bulk magnetic moment is measured and magnetocalcaloric effect is also shown. Further, simple synthesis, high chemical stability, absence of magnetic and thermal hysteresis and insulating nature suggest that they may be potential magnetic refrigerants below the liquid hydrogen temperatures. The overall results of the study of electromagnetic response over DMD system are found to be good and consistant.

Aloke Kumar Sarkar 25.4.19

Dr. Aloke Kumar Sarkar
Associate Professor, Physics
Bijoy Krishna Girls' College
5/3, M. G. Road, Howrah-711 101

Dr. Aloke Kr. Sarkar

Ex- Associate Professor

Department of Physics

Bijoy Krishna Girls' College

5/3, M.G. Road , Howrah-711 101

Ananya Banerjee 07.05.19

Full Signature of the Candidate

S. Tarafdar 07/05/2019

Prof. Sujata Tarafdar

Ex- Professor

Department of Physics

Jadavpur University

Kolkata-700 032

Professor
Department of Physics
Jadavpur University
Kolkata – 700 032