NUMERICAL STUDY FOR THE INFLUENCE OF MAGNETISM ON HYSTERETICAL LOOP RESPONSE OF THERMOELECTRIC MATERIALS

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ABSTRACT

In classical thermoelectricity five interactions must be considered: Fourier, Ohm, Peltier, Seebeck, Thomson and Joule; the first pair represent classical vectorial fields, the second pair couples both fields and Thomson an additional coupling induced by the variation of material properties with temperature. The last interaction is an unavoidable consequence of coupled electric fluxes.

A further refinement in the study of thermoelectric materials uses the Extended Non-Equilibrium Thermodynamics, incorporating two relaxation times (parameters to be measured) and, consequently, four new interactions: Cattaneo, Drude, visco-Peltier and visco-Seebeck. All these interactions have been partially studied by the authors in recent publications, see [2], [3]. Also, the coupling with a mechanical field is a must in meso- or nano-devices under increasing limit conditions: very high frequency or temperature, stress concentrations etc.

In addition, in many Micro-Electro-Mechanical sensor/actuators the presence of strong magnetism is increasingly found. A transverse (to the electrical and thermal fluxes) magnetic field creates further effects that have to be studied: Righi-Leduc, Hall, Nernst and Ettinghausen, see [1].

A Finite Element numerical formulation that includes the previous interactions is necessarily complicated due to the non-linearities, multiple couplings and time integration. For the last issue the method developed in the current work use convolution integrals similar to the ones applied in viscoelasticity.

Finally, some modern materials of high thermoelectric performance present a strong hysteretic behavior. The main aim of the present work is then to study the influence of magnetic fields to the loop-shape response of thermoelectric materials.

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