

RESUMO N° 226

## **NON-LINEAR FINITE ELEMENT FORMULATION OF ELASTOTHERMOELECTRIC BEAMS APPLIED TO MODEL THERMOELEMENTS IN PELTIER DEVICES**

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Thermoelectric materials couple thermal and electric fields by four non-equilibrium interactions: Fourier, Ohm, Peltier and Seebeck. The variation of the thermal field generates stresses that must be taken into account in the design of thermoelectric devices.

Commonly, Peltier devices are composed of hundreds of thermoelements electrically connected in series and thermally in parallel. From a mechanical point of view, each thermoelement can be modeled as fixed-ends beam, reducing the numerical calculation time. This model could be useful, for instance, to design thermoelements with variable sections.

The motivation of the present work is to develop a numerical tool in the Finite Element (FE) framework to model elastothermoelectric beams. For this purpose and in order to reduce the order of the Partial Differential Equations (PDEs), the linear momentum balance is expanded into three balance equations: axial, shear and bending momentum. In addition, the energy balance to take into account the temperature and the balance of the electric charge (voltage) are incorporated to the formulation. Finally, the set of five PDEs is transformed into a FE model that uses standard isoparametric shape functions. Non-linearities emerging from the Joule term (quadratically depending on the electric field) are solved by using the Newton-Raphson algorithm.

The present numerical algorithm is validated comparing the current results with those obtained by a 3D FE formulation developed by some of the authors of this work. Several practical examples are presented, monitoring errors and calculation times between both formulations.