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FINITE ELEMENT SUPPORTING THERMOELECTRIC EFFECTS IN FGM MATERIALS

Juraj Paulech[1]*, Juraj Hrabovský[1] , Justín Murín[1] and Vladimír Kutiš[1]

[1] Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava, Ilkovičova 3 Bratislava 812 19 Slovakia, www.fei.stuba.sk, juraj.paulech@stuba.sk, juraj.hrabovsky@stuba.sk, justin.murin@stuba.sk, vladimir.kutis@stuba.sk

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Nowadays, many advanced 3D finite element models are available in modern commercial FEM codes. These elements are suitable for simple as well as for coupled physical problems. But models containing composite or Functionally Graded Materials (FGMs) need to be modelled using relatively very fine mesh of these classic elements.

The aim of the paper is focused on the derivation process of FEM equations for new link finite element used for calculation of coupled electro-thermal and thermo-electric problems like Joule heating, Seebeck, Peltier and Thomson effect where FGM material properties of the link element are considered.

The derivation of FEM equations is based on semi-analytical calculation [1] of static differential equations describing two-way coupled electro-thermal problem [2]:

$$\mathbf{q} = [\Pi].\mathbf{J} - [\lambda].\nabla T$$
$$\mathbf{J} = [\sigma].(\mathbf{E} - [\alpha].\nabla T)$$

considering also governing equations for electric and thermal fields. Iterative procedure is used for calculation static results.

Two nodal 1D link element has two degrees of freedom – electric voltage and temperature. All the inputs described by functions (like material properties) must have polynomial form or need to be converted into that form.

The most important benefit of our new approach is efficiency of our approach, i.e. just only one new link element is necessary for calculation of coupled thermal-electric problems for whole FGM link.

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