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OPTIMIZATION OF PULSED THERMOELECTRIC THROUGH NON-LINEAR FINITE ELEMENT ANALYSIS

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This paper presents a study on the influence of pulse electric signals applied to the over-cooling of thermoelectric devices. To this end, an experimental setup taken from the literature is simulated using a complete, previously developed special finite element. The electro-thermal coupling is extended to include the elastic field, demonstrating that the increment of cooling can produce thermal breakdown and in some cases mechanical failure. Preliminary numerical results are developed and the distribution of cooling versus pulse intensity is validated with experimental data. For a single thermoelement, thermal, electric and elastic trends are presented using constant and variable material properties. While the former results are similar to those of published analytical formulae, the latter present non-negligible differences and are closer to those of the laboratory experiments, [1].

The FE formulation, partially developed in [2], is implemented into the research code *FEAP* [3] from the University of California at Berkeley.

Several parametric investigations are performed, including the study of different pulse shapes, durations and intensities, and of the thermoelement geometry and length. The results permit to find optimal configurations, some of them logical and already used in the experimental references but others unexpected and needed of a complete model to be developed.

REFERENCES

[1] J.L. Pérez-Aparicio, R. Palma, P. Moreno-Navarro. Elasto-thermoelectric non-linear, fully coupled, and dynamic finite element analysis of pulsed thermoelectrics. *Applied Thermal Engineering*, submitted, 2014.

[2] J.L. Pérez-Aparicio, R. Palma and R.L. Taylor. Multiphysic and thermodynamic formulations for equilibrium and non-equilibrium interactions: non-linear finite elements applied to multi-coupled active materials. *Archives of Computational Methods in Engineering*, submitted, 2014.

[3] R.L. Taylor. *FEAP, A Finite Element Analysis Program: User Manual, University of California, Berkeley*. http://www.ce.berkeley.edu/feap, 2010.