Analysis of actuator system made of FGM using new electro-thermo-mechanical finite elements

Juraj Paulech*, Juraj Hrabovský*, Justín Murín* and Vladimír Kutiš*

* Department of Applied Mechanics and Mechatronics
Institute of Automotive Mechatronics
Faculty of Electrical Engineering and Information Technology
Slovak University of Technology in Bratislava
812 19 Bratislava, Slovak Republic
e-mail: juraj.paulech@stuba.sk, web page: http://www.stuba.sk

ABSTRACT

Actuator is a mechatronic system that transforms one type of energy (e.g. electric energy) into the mechanical displacement and mechanical force (mechanical energy). Nowadays, these actuators can be made of Functionally Graded Materials (FGM) to ensure simple shape of the actuator and to improve its effectiveness, particularly for micro systems. FGM is built as a mixture of two or more constituents which have almost the same geometry and dimensions. The variation of macroscopic material properties can be induced by variation of both the volume fractions and material properties (e.g. by a non-homogeneous temperature field) of the FGM constituents.

The paper deals with a new approach in analysing of the systems made of FGM using our new beam finite elements. Multiphysical analysis (coupled electro-thermo-mechanical analysis) and spatial continuous variation of material properties is supported.

The analysis of the micro actuator with constant cross section made of FGM is presented in the paper. This simple-shaped actuator is supplied by electric current and cooled by natural convection but the efficiency of the actuator is optimised. The solution results will be compared with those obtained by using solid elements of a FEM commercial program.

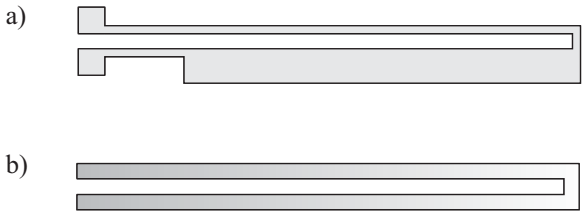

Fig.1 a) Classic shape of MEMS actuator, b) New shape of FGM actuator.

REFERENCES

[1] J. L. Pons, *Emerging Actuator Technologies - A Micromechatronic Approach*, John Wiley & Sons, 2005.

[2] V. Kutiš, J. Murín, R. Belák, J. Paulech, "Beam Element with Spatial Variation of Material Properties for Multiphysics analysis of Functionaly Graded Materials", *Computers and Structures*, Vol **89**, pp. 1192-1205, (2011).

[3] ANSYS, *Theory manual*, 2014.