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Validation of simulation platform for modeling of RF MEMS contacts

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ABSTRACT

For the DC contact RF MEMS, it has been identified that most of the limitations are related to the quality and the repeatability of the contact that drive the RF performance (insertion losses, isolation, power handling) and the reliability [1]. In order to propose new generation of RF MEMS devices, it is important to get a deeper insight on the physic of contact in order to choose appropriate materials, topology and architecture. It has to be furthermore outlined that the insertion of RF MEMS into real architecture will necessitate reduced actuation voltage, dimensions and a better control of the electrical and electromechanical behavior that will give more importance to surface effects.

The testing and development of contact material or contact topology can be addressed with a dedicated experimental set up for monitoring test structures. However, it is difficult to perform the tests under realistic conditions and in particular to duplícate the switch geometry, the contact geometry and the contact force. Moreover, the fabrication process must be optimized and it may take many months to fabricate a set of switches to test a single candidate contact material or contact bump shape.

In order to tackle these issues advanced simulation tools are needed. These tools for finite element analysis allow us to model assembly structures quickly and accurately with a minimal amount of effort. Then, they offer precious guidelines to choose appropriate design parameters and contact material.

As part of our study on the electrical contacts of RF MEMS micro switches, the need of multiphysics software offering a well developed solver to simulate many mechanical contact problems coupled with other physics, with a reduced time of calculation and good accuracy on the results is under investigation. Contact problems are highly nonlinear and require significant computer resources to solve. In addition, many contact problems must also address many physics domains effects, such as the conductance of heat or electrical currents in the areas of contact. This need to combine mechanical simulation with other physical behaviours implies the need to use multiphysics software.

As a first step, we need to validate the results of the numerical platforms existing in our laboratory. To do so, a static Hertz contact problem is simulated and we compared the

results of the simulation with the analytical model (Table 1). The contact simulations are performed on an industry standard tool for finite element analysis, ANSYS 10, and a more recent and easy to learn multiphysics tool, COMSOL 3.3 [2, 3]. The second step consists of comparing the capabilities of each software to model interaction between objects and solve a variety of contact problems. Then we compare the facilities for the user to fit the contact parameters in the model in order to obtain an accurate solution of our problem. A list of advantages and disadvantages for each software, and a summarizing table of what both softwares can do will be created.

This study permits us to choose the software the most efficient for our application. The accuracy of ANSYS, the various methods available to solve the wide variety of contact problems and with a minimum effort from the user, makes of ANSYS's solver an excellent candidate to be used in our project. Especially, the real topography of the contact surfaces can be included in finite element simulations, allowing us to investigate the impact of roughness on the quality and the repeatability of the RF MEMS contact (figure 1).

	Contact length (mm)	Maximal contact pressure (MPa)	Calculation time (s)
ANSYS	7.3	4510	10
COMSOL	7.47	4363	122
THEORY	7.43	4285	

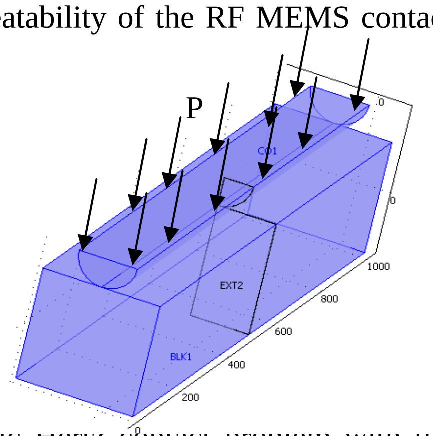

Table 1: simulated and analytical results for a static Hertz contact problem with the same degrees of freedom

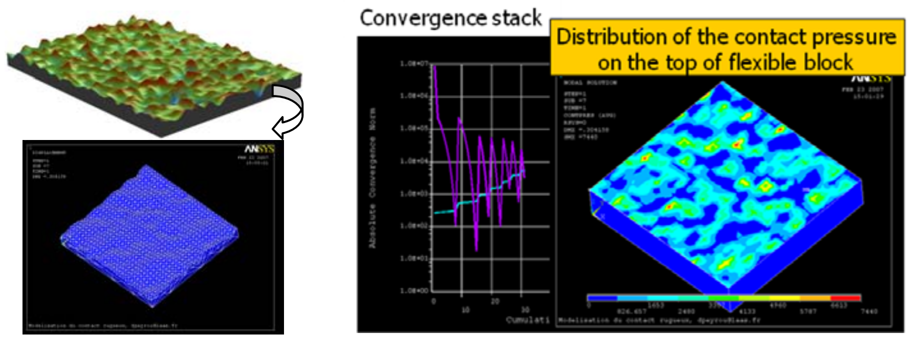

Figure 1. Generation of the real contact surface shape in ANSYS and results in post processing

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