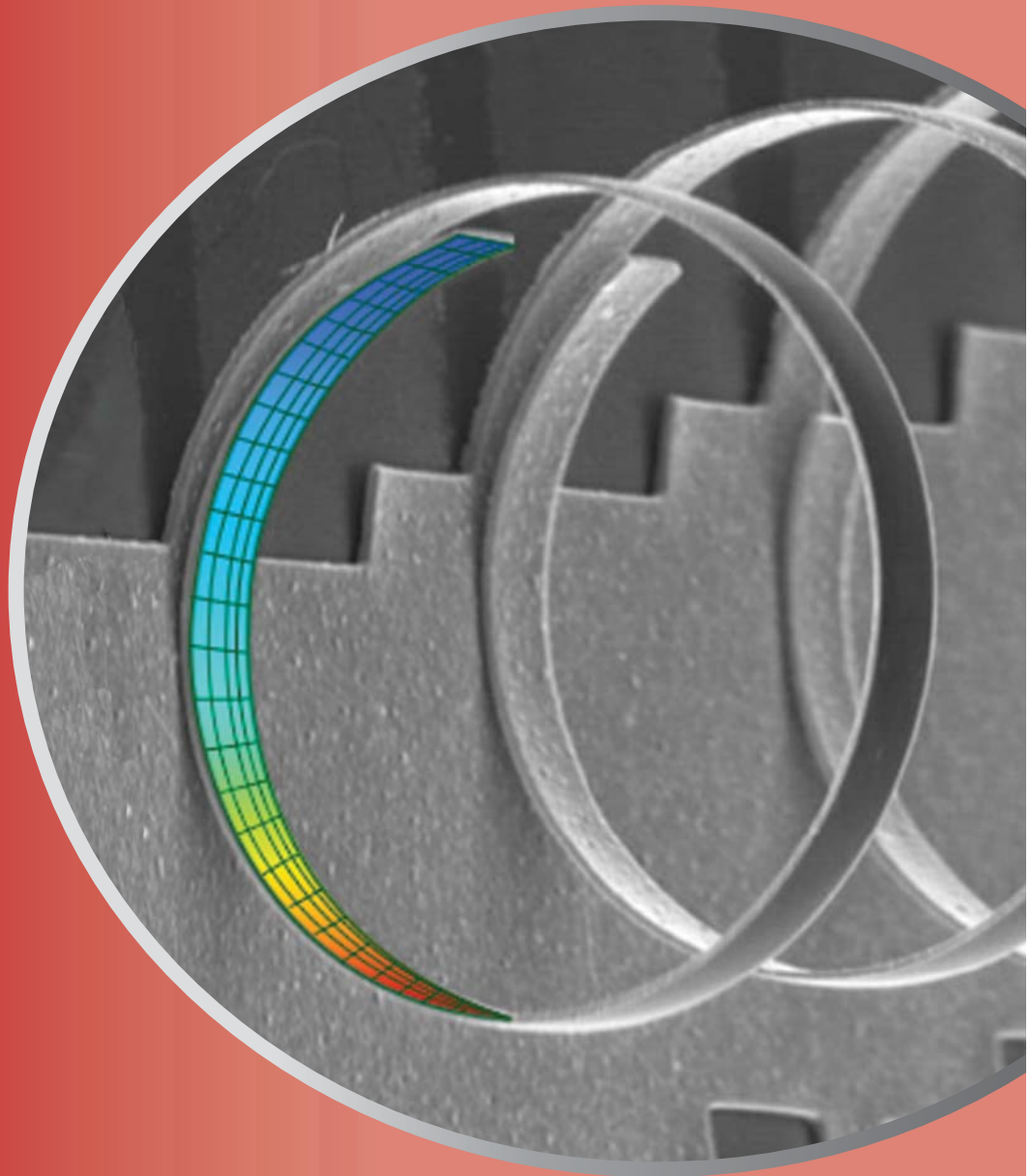


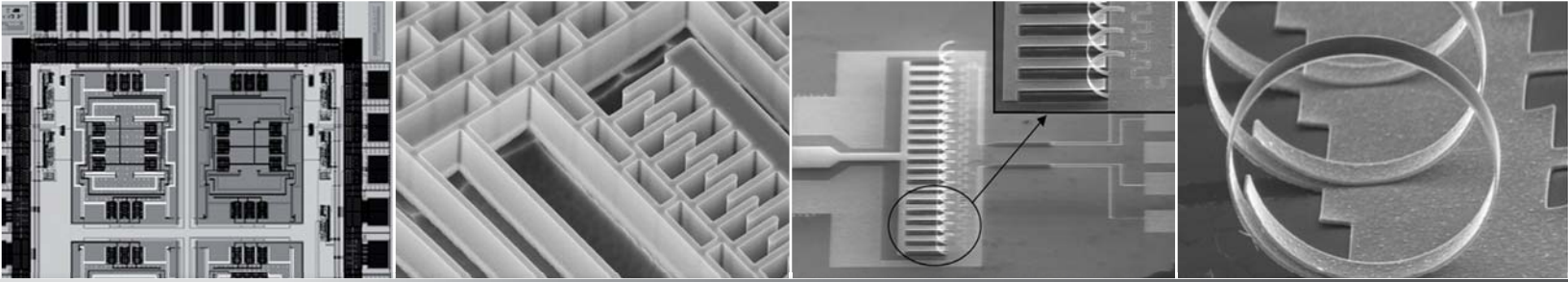


Open Engineering: Industrial Multiphysics Solutions

# Oofelie

## MEMS



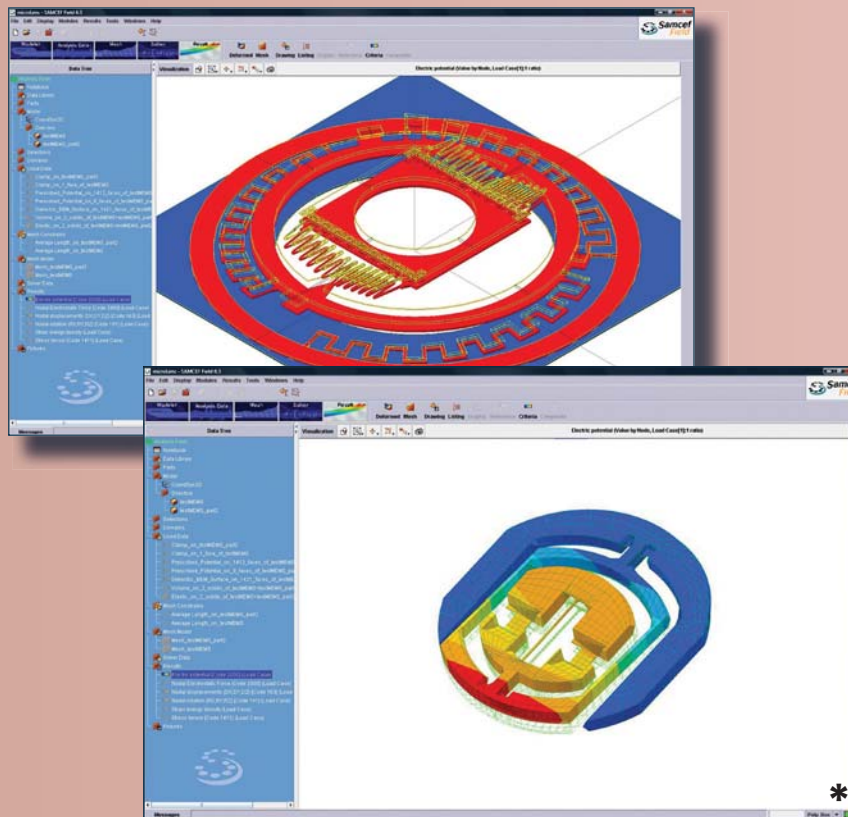


Micro Electro Mechanical Systems, MEMS (Micromachines, Micro System Technology) revolutionize the transducer industry regarding the very small component size, product reliability and cutting production costs.

The continuously reducing sizes make a strongly coupled multiphysics simulation approach mandatory to obtain accurate and fast results!

Oofelie::MEMS is your solution! It's an industrial level CAE modeler offering a built-in, simultaneous solver for the whole system, providing you accuracy for strongly coupled multiphysics cases.

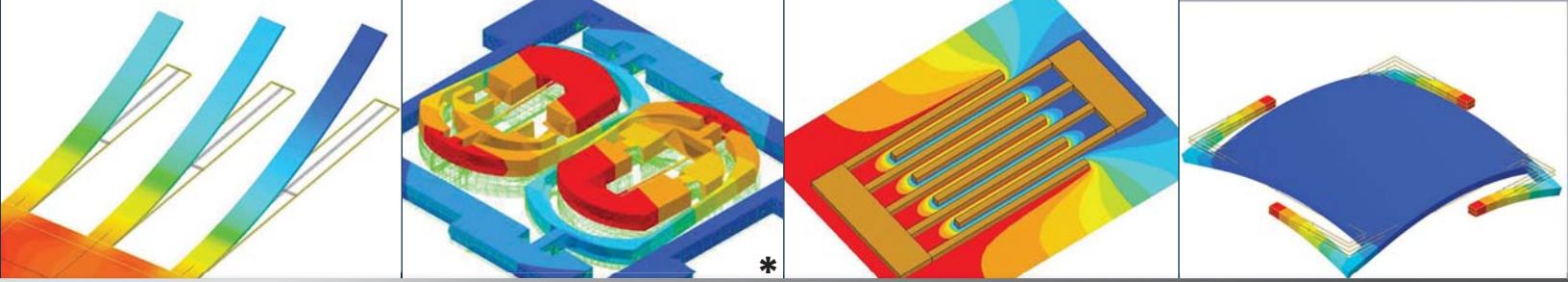
Open Engineering, part of the SAMTECH group, offers an over 15 years multiphysics expertise. Take a leap ahead of competition by using its latest technology!



## BENEFITS:

- **Solution for real life industrial problems:** You will be able to import, model, parameterize and mesh complex 3D structures;
- **Effective simulation in no time:** You will obtain a faster convergence and a shorter simulation time through strongly coupled simulations between relevant physical phenomena, which is mandatory to accurately design continually shrinking components;
- **Ability of handling 3D industrial problems:** You will be able to efficiently handle supersized problems using coupled FEM, BEM (with FMM) in simulation methods;
- **Reducing design cycles:** you will cut your design cycles thanks to a highly accurate result and a fast simulation in order to optimize your designs;
- **Modeling with accuracy and without effort:** You will benefit from an intuitive and smart tool with a pre-configured wide range of strong couplings between the main physical phenomena;
- **One conveniently integrated simulation package:** You will benefit from a wide sensors and actuators coverage.

(Capacitive/electrostatic, magnetic, thermal, piezoelectric, piezoresistive, peltier).



## APPLICATION EXAMPLE: VIBRATING INERTIAL ACCELEROMETER : DIVA, COURTESY OF ONERA\*.

Onera constructed a monolithic quartz sensor, sensitive to orthogonal acceleration. This design efficiently decouples the vibrating beam from the outside case through the framework. It permits to maximize the vibration quality factor of the beam, needed for frequency stability.

The whole device, including the sensor's package, is simulated using Oofelie because of the need of strongly coupled Piezo-thermo-elastic modeling.

### Objectives:

- Optimize the resonance quality;
- Minimize the effect of thermal stresses on resonance frequency to reduce temperature influence on device performance;
- Study energy losses through mounting parts and the main structure.

### Challenges:

- Activate the resonating beam through piezoelectricity;
- Minimize thermal stresses influencing the frequency behavior;
- Include Thermo-elastic damping effects, which are critical for space and vacuum applications.

### Requirements:

A real need for a **strongly coupled** Multiphysics approach:

- Time constants of governing phenomena reach similar magnitudes;
- Simulation of Piezo-thermo-mechanical effects on a complex 3D structure in combination with the electric measurement circuit.

### A complete modeling solution: Oofelie::MEMS

Prediction of the main sensor characteristics:

- Optimized quality factor (Thermo-elastic damping and package effect);
- Accelerometer scale factor (Evaluation of frequency shift due to acceleration);
- Optimized electric parameters of the driving circuit.

### An efficient modeling simulation:

- Good agreement between numeric and experimental results.

## KEY FEATURES:

### Simulation Engine Features

- **Materials:**
  - Linear and non-linear Multi-physics materials.
- **Physical Fields & Couplings:**
  - Piezoelectric analysis;
  - Piezo-resistivity;
  - Thermo-mechanical and pyro couplings;
  - Thermal radiation including view factors;
  - Peltier and Seebeck effects;
  - Electrostatic actuation.
- **Super Element Models (SEM) – reduced order models:**
  - Capacitive SEM's including electrostatic forces;
  - Export to Verilog-A and VHDL-AMS.
- **Solver:**
  - Static & Transient (linear and non-linear);
  - Harmonic & Modal;
  - FEM-BEM coupling;
  - Fast Multipole Method (FMM);
  - Extraction of mutual capacitance matrix.

### User Interface Features

- **Geometric Modeling Features:**
  - Industrial 3D CAE environment;
  - Integration & Import from leading CAD tools;
  - CAD healing technology;
  - Parameterized entry;
  - Bi-directional EDA flow integration.
- **Meshing:**
  - 0D to 3D linear & quadratic Mesh Elements;
  - Global & local mesh refinement;
  - Incompatible Mesh Stitching;
  - Mesh Quality Verification;
  - Mesh Import from NASTRAN, ANSYS, IDEAS...
- **Results Display:**
  - State-of-the-art graphic outputs (i.e. X-Y plots, isovalues, animations);
  - Tabular forms.
- **Scripting & Customization:**
  - C-like command interpreter.
- **Supported Platforms:**
  - Windows and Linux.



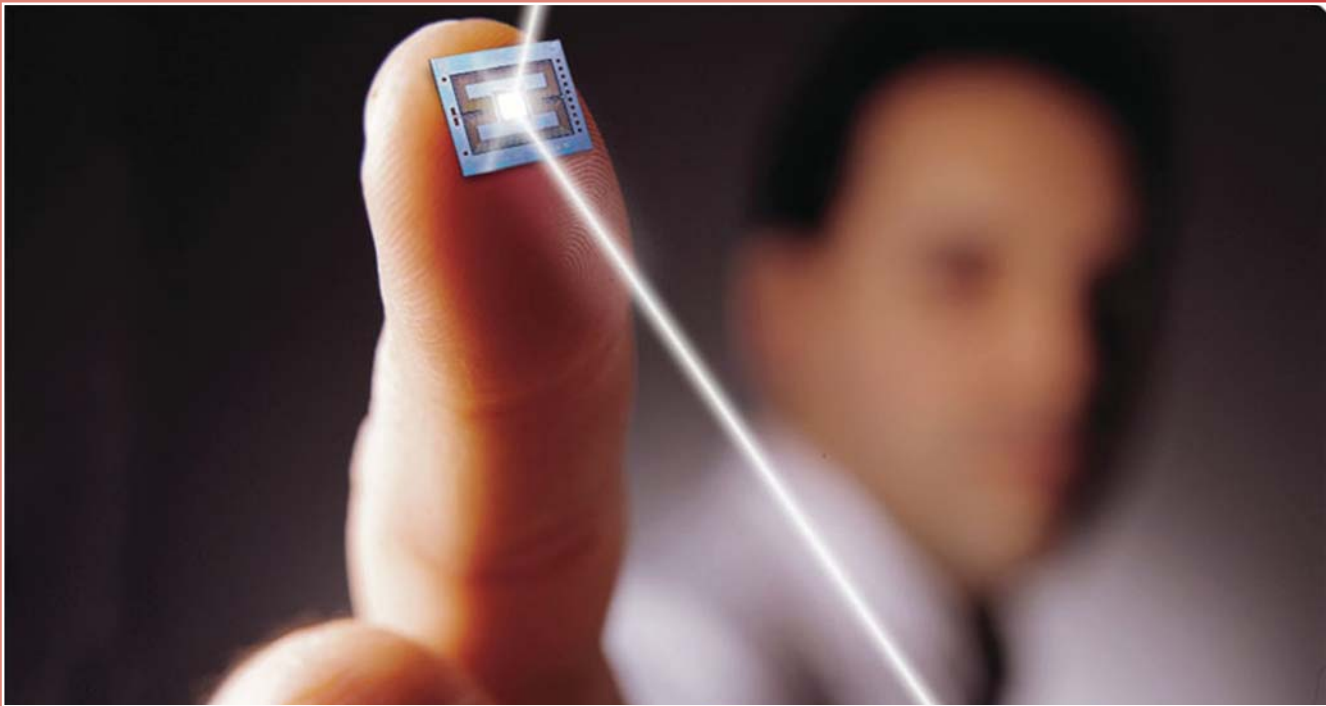
## SERVICES

We offer a complete and reliable service range to guarantee the success of your projects:

- Hotline support by experienced engineers;
- Training sessions covering MEMS theory, design and Oofelie usage;
- Design Consultancy services to get your R&D work up to speed;
- Customization of our solutions to your design flow needs.

All these services are provided by an experienced and dynamic team of experts. At the same time they assure that our developers are continuously exposed to the latest design technology. They incorporate this edge-breaking knowledge into the software simulation tool so that your MEMS design outranges the competition.

For more information, please contact our world-wide sales & services network.



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