# Macromodeling of Microdevices: Virtual Prototyping by Predictive Simulation

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The rapid progress in microsystems technology is increasingly supported by MEMS-specific modeling methodologies and dedicated simulation tools. These do not only enable the visualization of fabrication processes and operational principles, but they also assist the designer in making decisions with a view to finding optimized microstructures under technological and economical constraints. Currently strong efforts are being made towards simulation platforms for the predictive simulation of microsystems, i.e. the *virtual fabrication* and *virtual experimentation and characterization* on the computer.

We discuss the most important aspects and practicable methodologies for setting up physically-based consistent microdevice and full system models for the effort-economizing and yet accurate numerical simulation of mechatronical microsensors and actuators and microsystems built up of them. In this framework, we demonstrate the consistent treatment of coupled fields and coupled energy and signal domains required for deriving micromechatronical acromodels from the continuous field level, leading to the concept of *full system mixed-level simulation*, and we also address some important issues to be focussed on for the reliable validation and accurate calibration of the models.

The adequate formal representation of the full system description is provided in terms of a finite network description in combination with an appropriate analog hardware description language such as VHDL-AMS or Verilog-A. This makes it possible to code the models of all the individual system components in a generic and uniform way and to assemble the full system model by linking the constituent parts on the same descriptional level.

A multitude of computational results obtained for elementary and complex microstructures such as highly perforated plates are in excellent agreement with accurate 3D-Navier-Stokes FEM calculations and, thus, corroborate the practicality and quality of this approach to predictive simulation.