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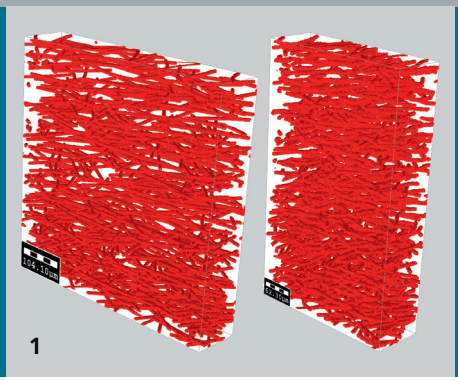

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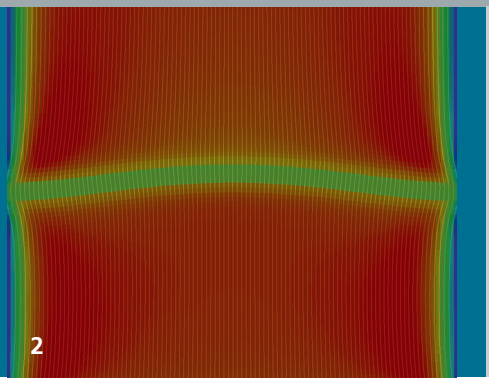

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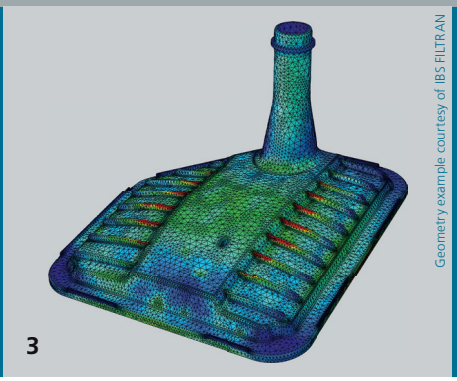

Geometry example courtesy of IBS FILTRAN

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1 *In-plane compression of an orthotropic filtering medium*

2 *Fluid-Porous-Structure Interaction (FPSI): Flow velocity profile for a flat filtering medium deformed by channel flow*

3 *Stresses induced by fluid pressure on a filter housing*

MODELING AND SIMULATION OF ELASTICITY EFFECTS IN FILTRATION

Today's quality requirements on innovative filtering media and filter elements involve more than the classical criteria like low differential pressure, high filtration efficiency and dirt holding capacity. In more and more fields of application, the mechanical stability of the medium and the influence of its deformation on the filtration process cannot be neglected any longer. Depending on the application area and the corresponding operating conditions, deformations of the housing can become relevant, too.

A lot of research and development activities at Fraunhofer ITWM are dedicated to a better understanding, appropriate modeling and realistic numerical simulation of poroelastic phenomena. By taking the flexibility of filtering media into account, computer simulations are able to cover a much wider range of real-world scenarios.

The main benefit for designers and media manufacturers is the reduction of developmental time, in particular:

- Identification of suitable filtering materials for more stable filtering media
- A priori study of effects like pleat crowding and pleat collapse
- Computer-aided design and arrangement of supporting structures such as meshes and ribs
- Optimization of the housing's shape with respect to both stability and flow resistivity

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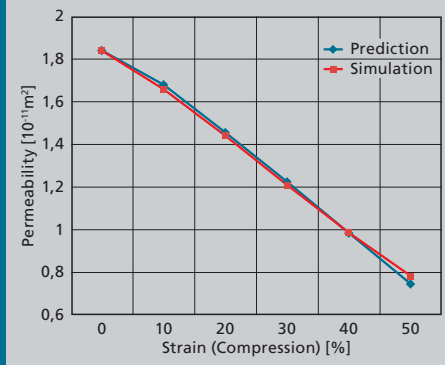

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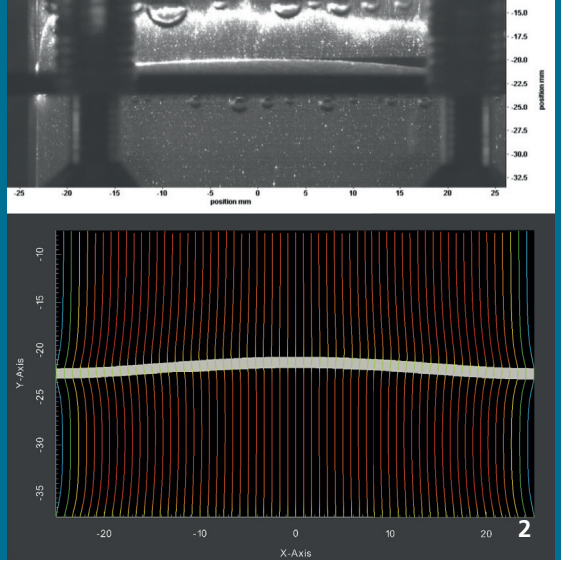

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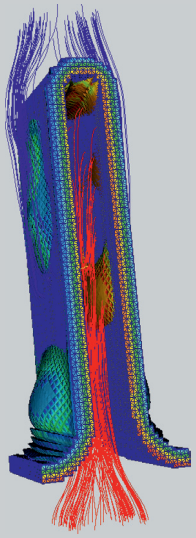

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1 *Comparison of permeability vs. strain: Values predicted by theoretical model and simulated permeabilities*

2 *Comparison of real and simulated deformation of a flat medium in a channel flow (Experiment by LFMA, Lyon)*

3 *Fluid-Porous-Structure Interaction (FPSI): Flow pressure-induced deformation of a filter pleat*

Modeling and simulation of Fluid-Porous-Structure Interaction (FPSI)

Having chosen suitable media, filter element designers are confronted with the challenge to find a favorable way to fixate and stabilize the filtering media in the element's housing and/or choosing an optimal pleat count. One of the major goals is to identify an optimal trade-off between low flow resistance, large filtration area and high mechanical robustness of the design.

In order to assist filter element designers in this difficult task, the interaction of the deformable porous/mesh with the fluid can be simulated using specialized mathematical models and numerical algorithms.

The research related to this matter such as experimental investigation, modeling and principal development of numerical algorithms has been carried out in the "Programme Inter Carnot Fraunhofer: FPSI_Filt". These achievements form the scientific basis for the development of effective and precise simulation tools for dealing with FPSI.

Combined approach for the simulation of flow, efficiency and robustness of filtering devices

Fraunhofer ITWM offers the following services for an integrated computer-aided optimization of filter elements and/or their components:

- Import of CAD geometries or generation of filter pleat shapes, entire panels or cartridges; import of CAD geometries of filter element housings
- Simulation of the fluid flow through housing and filtering media with filtration efficiency prediction
- Computation of effective elasticity properties of filtering media
- Fluid-Porous-Structure Interaction (FPSI) simulations for advanced studies of the deformation of the filtering media
- Stress-strain analysis of the filter element's housing based on the flow-induced pressure distribution
- Visualization of the results and export to worksheet formats for post-processing