

ACOUSTO DICT

ACOUSTIC SIMULATION

1 *Acoustic measurement
in a passenger cabin*

2 *Microstructure model of
a synthetic fiber material*

3 *Microstructure model of
a natural fiber material*

4 *Cross section of the
microstructure of a fiber
reinforced material*

Our well-being in everyday life is strongly influenced by the sounds of our environment. In particular in rooms with bad acoustic properties, sounds grow louder due to their reflection by smooth, hard surfaces. This reverberance results in a deterioration of

articulation. Noise reduction in combination with a simultaneous improvement of articulation helps to decrease noise-induced stress. A respective design of, e.g., the interior acoustics of a car, is an important contribution to driving safety.

Modeling

Currently, porous absorbers are used for the improvement of room acoustics. These may consist of different materials, such as glass or mineral wool, felts, natural or polyester fibers, open or closed-cell foams or fiber reinforced plastics. The essential property of porous absorbers is a resistance to the incident sound wave, resulting in a damping effect. From a physical point of view, the damping results from the friction between air molecules and absorber skeleton. Hence, the acoustic absorption can be computed on the basis of a flow problem, where the flow resistance is determined by the solution of the Stokes equation

for the complicated microstructure. The computation of the acoustic properties on the basis of the micro-structure leads to completely new possibilities of material optimization. First, the measured microstructure is reconstructed by a stochastic model with the software package **GeoDict** (www.geodict.com), which has been developed at the ITWM. The complicated absorber structure can now be specifically varied on the computer, in order to study the influence of different parameters on the acoustic properties, such as fiber diameter, orientation, or compression.

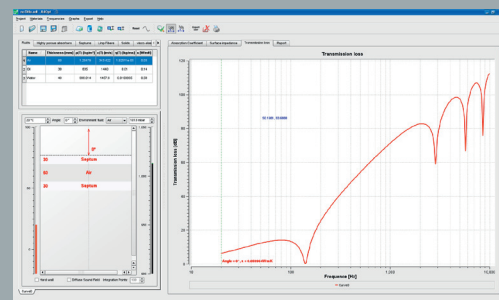
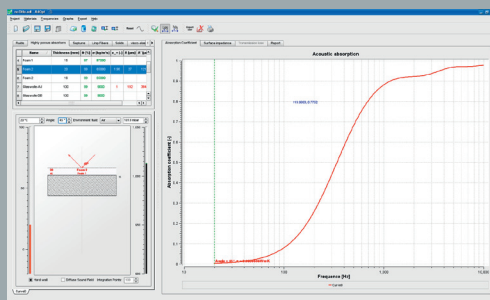
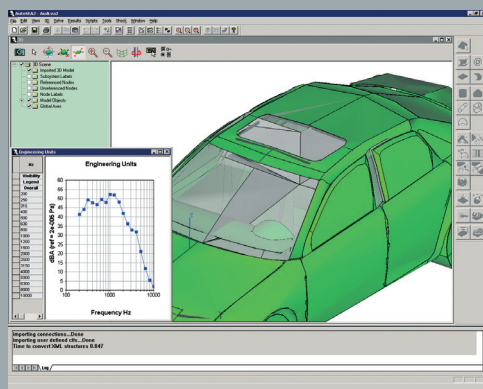
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Transferability

Which influence does a component consisting of the absorber material have on the room acoustics? The answer to this question is provided by a statistical energy analysis (SEA) of the entire system which includes the microscale results as parameters. A large potential for acoustic optimization is provided by so-called layer absorbers. The selection of appropriate material parameters and layer thicknesses allows for an al-

most arbitrary variation of acoustic properties. Hence, the computer simulations assist the selection of an optimal material. Another type of porous absorbers are viscoelastic foams. The acoustic behavior of these materials is additionally determined by the mechanical properties of the solid matter. These properties, e.g., the elastic modulus, can also be computed at the ITWM if the microstructure is given.

Example: Optimization of a PETP interior roof lining

Currently, series production roof linings consist of a mixture of different natural and synthetic fibers. The recycling of these components according to the new EU Directive on End-of-life Vehicles (2000/53/EC) is very complex. Within the project ISTWIPP (ipp.itwm.fraunhofer.de), a cooperation of the

ITWM with the companies Audi, Faurecia, and Sandler, the optimization cycle described above was applied to pure PETP nonwovens. The use of computer simulations resulted in the production of an optimized PETP roof lining with better acoustic properties than a series production roof lining.

1 Simulation of the sound level in a passenger cabin

2 Simulation of the acoustic absorption for a open cell foam

3 Simulation of the sound transmission loss for a double panel

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We offer

- modeling of acoustic properties of
 - porous sound absorbers and layered systems of porous absorbers
 - viscoelastic absorbers and layered systems of viscoelastic absorbers
- parameter studies on the basis of stochastic models
- acoustic simulation (room acoustics) by statistical energy analysis
- a web-based software tool including
 - data base for the management of acoustic measurement data (individually configurable)
 - simulation of acoustic absorbers
 - optimization tool for a material selection (desired absorption, material thickness, price, etc.)