Sound absorbing, translucent, lightweight curtains

Materials Science & Technology

R. Pieren; K. Eggenschwiler
Empa, Laboratory of Acoustics / Noise Control, CH-8600 Duebendorf, Switzerland

Introduction

Noise is annoying. It interrupts communication, reduces productivity and tires people out – in extreme cases it can even make them ill. Sound absorbing surfaces are therefore needed in rooms where people work, talk to each other or are trying to relax. They reduce reverberation and so make rooms quieter. Heavy curtains made of material such as velvet are often used to absorb sound. On the other hand, conventional lightweight, translucent curtains are acoustically almost useless.

Objective

The objective of an interdisciplinary project at Empa together with industrial partners was to develop new multifunctional curtains which are:

- Sound absorbing
- Lightweight
- Translucent
- Designed
- Flame-retardant (B1)
- Haptically soft

Main challenges

The main challenges were to find compromises between, or solutions to many different and apparently contradictory demands such as:

- Sound absorption vs. light transmission
- Sound absorption vs. lightweight
- Physical properties vs. design

Measurements

Within the optimization process, several acoustical and optical measurement on prototype fabrics have been performed. Absorption coefficients of various textiles have been measured with an impedance tube and in the reverberation chamber (Figure 1).

***Figure 1:** Reverberation chamber at Empa with a curtain mounted with 100% fullness*

The obtained experimental data was used to adjust and improve our developed calculation models.

From macro photographs geometrical parameters for the prediction of the absorption coefficient were extracted (Figure 2).

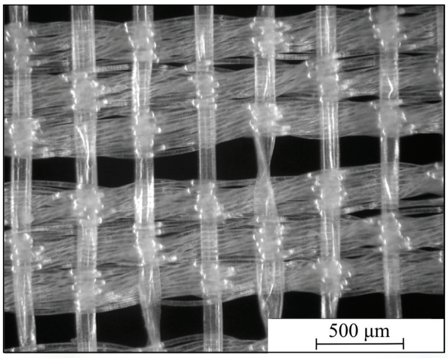

***Figure 2:** Macro photograph of a woven synthetic fiber fabric*

Acoustical model

In order to systematically optimize the fabric structure, a calculation model for the statistical absorption coefficient of lightweight, woven fabrics was developed. The model is based on an electro-acoustical-mechanical analogy where acoustical and mechanical phenomena are mapped to an equivalent electrical circuit (Figure 3). In the model the microscopic structure of the fabric as well as its macroscopic composition are considered.

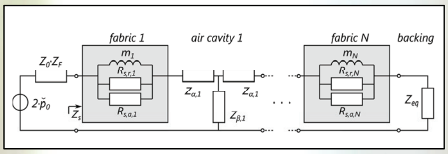

***Figure 3:** Visualization of the acoustical model by an equivalent electrical circuit*

The model to predict the absorption coefficient based on microscopic geometrical parameters of the fabrics showed good agreement with measurements, with mean value and standard deviation of the differences of 0.01±0.05 (Figure 4).

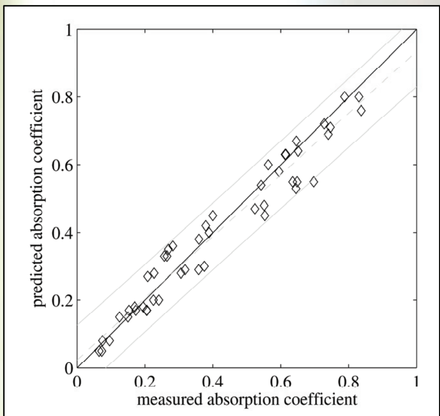

***Figure 4:** Comparison of measured and predicted absorption coefficients of 24 fabric types. The predicted values are calculated based on macroscopic geometrical parameters. The straight black line represents the identity line. The gray lines show the linear regression (R^2 = 0.95) and the 95% prediction interval band for future estimates.*

Results

While its weight is only 130 g/m^2 the developed curtain features a weighted absorption coefficient α_w of 0.60(H). Figure 5 shows that the new curtain absorbs up to five times more sound energy compared to a conventional translucent curtain.

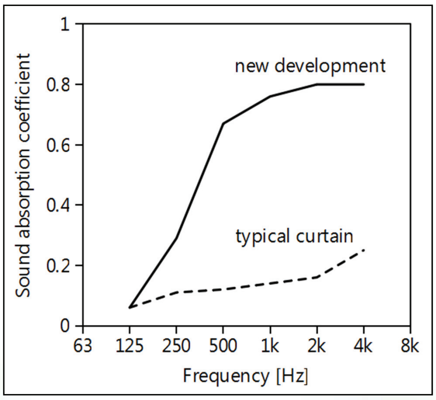

***Figure 5:** Sound absorption coefficients of the new curtain (with only 130 g/m^2) compared to a typical translucent curtain. Reverberation chamber measurements with 15 cm distance to the wall and 100% fullness are shown.*

Conclusions

Together with industrial partners, Empa researchers have developed a new curtain collection that is translucent and lightweight but still absorbs sound. This innovation was possible thanks to a successful combination of our scientific knowledge, computer modelling, acoustic measurement and specialised textile knowledge.

Since 2012 the new collection is on the market and obtained the prestigious «Swiss Textile Design Award 2011» and other awards.

***Figure 6:** Annette Douglas receiving the «Swiss Textile Design Award 2011»*

Project partners

- Empa: research (www.empa.ch/akustik)
- Annette Douglas Textiles: textile design (www.douglas-textiles.ch)
- Weisbrod-Zürrer AG: weaving company (www.weisbrod.ch)

The project was supported by the Swiss Innovation Promotion Agency (CTI).

References

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Contact: Reto Pieren, Email: reto.pieren@empa.ch

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