Technische Universität Berlin
Fachgebiet Technische Akustik
Akustik-Prüfstelle
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Test Report

Sound absorption of fabric articles

CLEO

Customer: rohi Stoffe GmbH
Schoenlinderstrasse 1
D-82538 Geretsried
Germany

Test Report No.: 22008

Date: March 11, 2022

Technische Universität Institut für Strömungsmechanik u. Technische Akustik Berlin

Person in charge:
Dr.-Ing. Roman Tschakert

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Contents

1. Scope of measurements

The sound absorption of fabric articles were evaluated in the reverberation room at the Department of Engineering Acoustics. These objects were tested:

a1) CLEO plane
95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
1 curtain size 3.00 $\times$ 3.50 m, plane,
type G-100 mounting with 100 mm distance from the wall

a2) CLEO gathered
95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
2 curtains size 3.00 $\times$ 3.50 m, gathered, 100 % gathering,
type G-100 mounting with 100 mm distance from the wall

Photos of the test setup are given in Figure 1.

2. Procedure

The sound absorption was determined in one-third-octave bands according to the ISO 354 [5]. The practical sound absorption coefficient according to ISO 11654 [6] for each octave band was calculated by averaging the three one-third-octave absorption coefficients whithin the octave. By shifting a reference curve the weighted sound absorption coefficient and the sound absorption class were determined.

The mounting of each test object, the measurement procedure and the climatic conditions are given in the test certificates in the appendix A.

Person in charge:	Roman Tschakert (TU Berlin)
Assistant:	Johannes Scheyerle (TU Berlin)

2.1. Measuring equipment

Measuring devices:

- four NTi XL2 sound level meter, firmware 4.10 ,S.-No. A2A-02022-C0, S.-No. A2A-03724-D1, S.-No A2A-10886-E0, S.-No. A2A-11273-E0 [1] [2] ,
- eight ½" microphones PCB Piezotronics Inc. type 378B2, S.-No. 112513 to 112518 and S.-No. 112521 to 112522 [1] ,
- calibrator Norsonic type 1251, S.-No. 20833 [3] ,
- dodekaeder loudspeaker Norsonic type K100/12, S.-No. 534,
- dodekaeder loudspeaker Schalltechnik Süd & Nord type DO12-S,
- amplifier Norsonic type 215, S.-No. 511,
- noise generator NTi Audio type Minirator MR-PRO, S.-No. G2P-RAFXW-GO .

Test lab:

The measurements were done in the reverberation room at the Department of Engineering Acoustics, which complies to the ISO 354 [5]. Its volume is 200.9m^3 and it is equipped with 13 diffusors.

Software:

The sound absorption was calculated with Gnu Octave version 6.2.0 [1]. The atmospheric absorption was evaluated with acoustics.standards.iso_9613_1_1993 of the python-acoustics module [7].

3. Test results

The test results are documented in the certificates in the appendix A.

References

[1] EATON, John W. ; BATEMAN, David ; HAUBERG, Søren ; WEHBRING, Rik: *GNU Octave version 6.2.0 manual: a high-level interactive language for numerical computations*. `https://www.gnu.org/software/octave/doc/v6.2.0/`. Version: 2021

[1] Class 1 according to EN 61672 part 1 [3]
[2] Class 1 according to EN 61260 part 1 [2]
[3] Class 1 according to EN IEC 60942 [4]

[2] Standard EN 61260-1 June 2014. *Electroacoustics - Octave-band and fractional-octave-band filters - Part 1: Specifications (IEC 61260-1:2014)*

[3] Standard EN 61672-1 December 2013. *Electroacoustics - Sound level meters - Part 1: Specifications (IEC 61672-1:2013)*

[4] Standard EN IEC 60942 March 2018. *Electroacoustics - Sound calibrators (IEC 60942:2017)*

[5] Standard ISO 354 May 2003. *Acoustics - Measurement of sound absorption in a reverberation room*

[6] Standard ISO 11654 April 1997. *Acoustics - Sound absorbers for use in buildings - Rating of sound absorption*

[7] PYTHON ACOUSTICS 0.2.3: *The python-acoustics module is a Python module with useful tools for acousticians.* `https://github.com/python-acoustics/python-acoustics`, 2019

A. Appendix

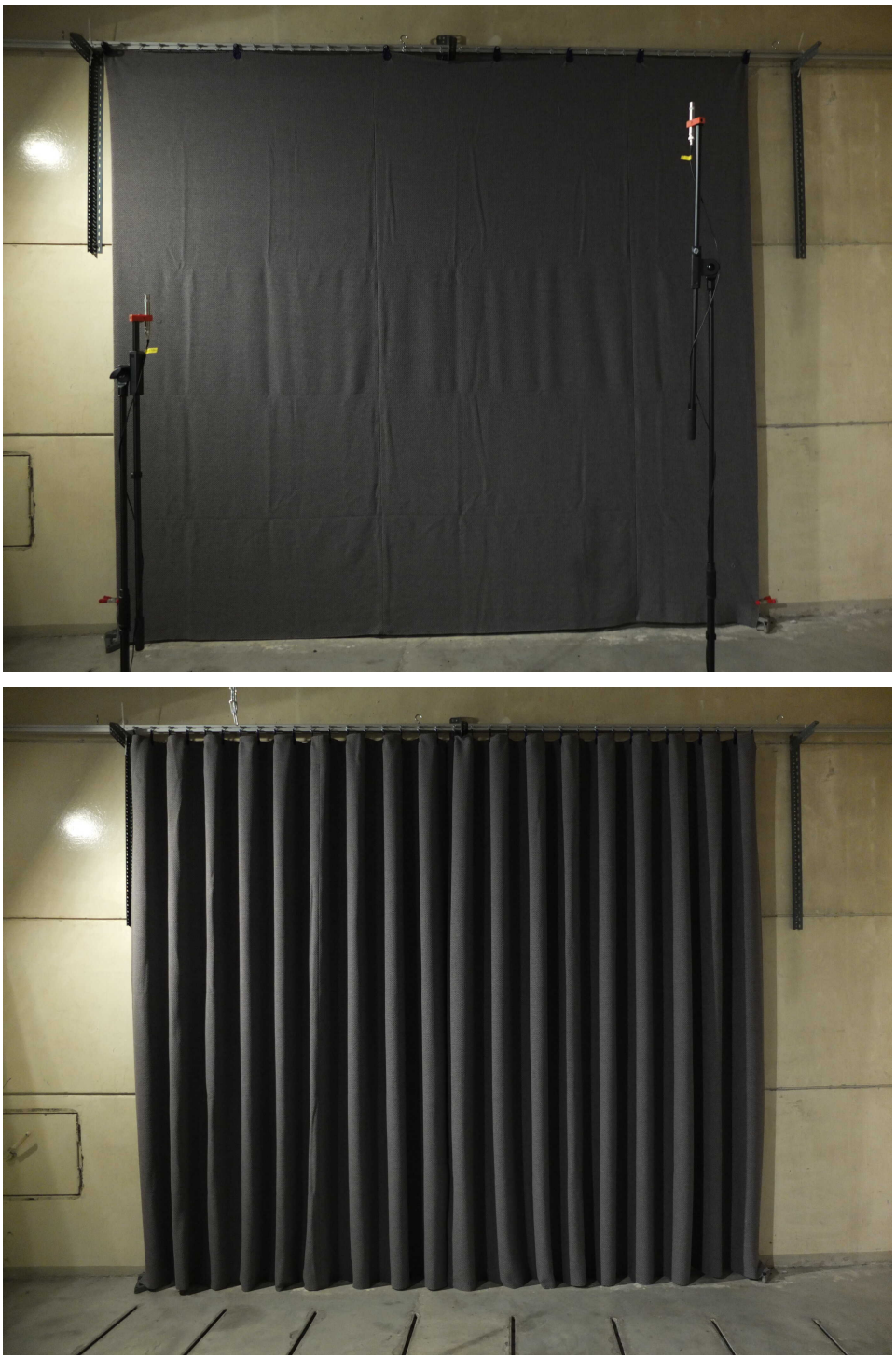


Figure 1: Test setup CLEO plane (top) and CLEO gathered (bottom).

Sound absorption coefficient according to ISO 11654

Laboratory measurements of sound absorption in a reverberation room

Client: rohi Stoffe GmbH Date of test: 4.3.2022

CLEO plane

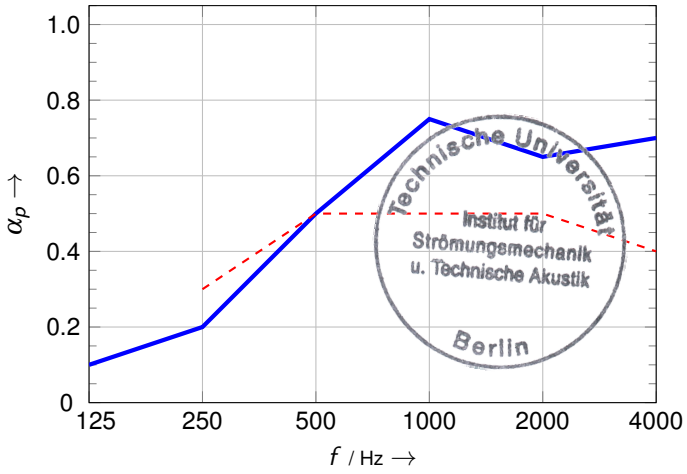
95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
1 curtain size 3.00 × 3.50 m, plane,
type G-100 mounting with 100 mm distance from the wall

Size of the specimen:	10.5 m^2
Volume of the reverb. room:	200.9 m^3

Empty reverberation room		Reverb. room with the test specimen	
Temperature:	15.4 °C	Temperature:	15.6 °C
Air humidity:	39.1 %	Air humidity:	38.7 %
Atmospheric pressure:	1020.2 hPa	Atmospheric pressure:	1020.1 hPa

Legend
α_p practical sound absorption coefficient
f frequency octave bands in Hz
---- shifted reference curve

f / Hz	α_p
125	0.10
250	0.20
500	0.50
1000	0.75
2000	0.65
4000	0.70



Evaluation based on laboratory measurements. Results obtained with a standard procedure: Interrupted noise method with 3 measurements averaged at each microphone/loudspeaker position. 2 Loudspeaker positions each with 8 microphone positions. Practical sound absorption coefficients calculated from measurements according to ISO 354 in one-third-octave bands.

Weighted sound absorption coefficient α_w = 0.50 (MH) Sound absorption class: D

Test cert. No.: 22008a1 Testing institute: Akustik-Prüfstelle der TU Berlin

Date: March 11, 2022 Signature:

Figure 2: Certificate ISO 11654 22008a1, CLEO plane.

Sound absorption coefficient according to ISO 11654

Laboratory measurements of sound absorption in a reverberation room

Client: rohi Stoffe GmbH Date of test: 4.3.2022

CLEO gathered

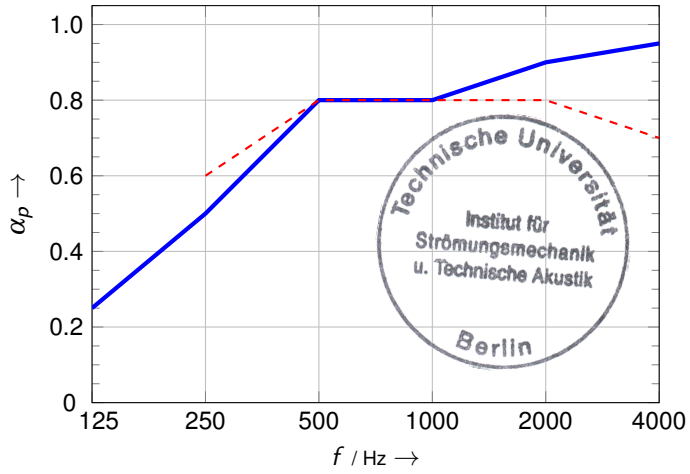
95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
2 curtains size 3.00 × 3.50 m, gathered, 100 % gathering,
type G-100 mounting with 100 mm distance from the wall

Size of the specimen:	10.5 m^2
Volume of the reverb. room:	200.9 m^3

Empty reverberation room		Reverb. room with the test specimen	
Temperature:	15.4 °C	Temperature:	15.6 °C
Air humidity:	39.1 %	Air humidity:	38.5 %
Atmospheric pressure:	1020.2 hPa	Atmospheric pressure:	1020.1 hPa

Legend
α_p practical sound absorption coefficient
f frequency octave bands in Hz
---- shifted reference curve

f / Hz	α_p
125	0.25
250	0.50
500	0.80
1000	0.80
2000	0.90
4000	0.95



Evaluation based on laboratory measurements. Results obtained with a standard procedure: Interrupted noise method with 3 measurements averaged at each microphone/loudspeaker position. 2 Loudspeaker positions each with 8 microphone positions. Practical sound absorption coefficients calculated from measurements according to ISO 354 in one-third-octave bands.

Weighted sound absorption coefficient α_w = 0.80 (H) Sound absorption class: B

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Figure 3: Certificate ISO 11654 22008a2, CLEO gathered.

Sound absorption coefficient according to ISO 354

Laboratory measurements of sound absorption in a reverberation room

Client: rohi Stoffe GmbH Date of test: 4.3.2022

CLEO plane

95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
1 curtain size 3.00 × 3.50 m, plane,
type G-100 mounting with 100 mm distance from the wall

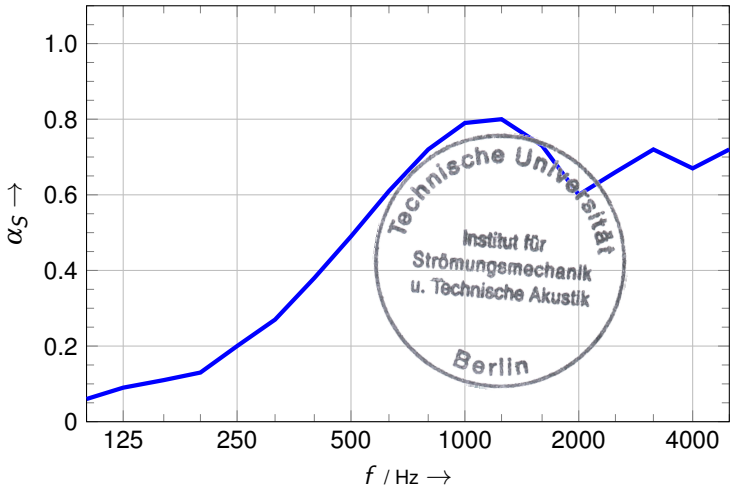
Size of the specimen:	10.5 m^2
Volume of the reverb. room:	200.9 m^3

Empty reverberation room		Reverb. room with the test specimen	
Temperature:	15.4 °C	Temperature:	15.6 °C
Air humidity:	39.1 %	Air humidity:	38.7 %
Atmospheric pressure:	1020.2 hPa	Atmospheric pressure:	1020.1 hPa

f / Hz	α_S	T_1 / s	T_2 / s
100	0.06	7.9	6.9
125	0.09	8.0	6.4
160	0.11	7.6	6.0
200	0.13	7.4	5.7
250	0.20	8.0	5.3
315	0.27	7.9	4.7
400	0.38	8.0	4.1
500	0.49	7.9	3.5
630	0.61	7.5	3.0
800	0.72	7.3	2.7
1000	0.79	6.9	2.5
1250	0.80	6.1	2.4
1600	0.73	5.3	2.4
2000	0.60	4.3	2.4
2500	0.66	3.4	2.0
3150	0.72	2.9	1.7
4000	0.67	2.4	1.6
5000	0.72	1.9	1.3

Legend

α_S sound absorption coefficient
f frequency one-third-octave bands in Hz
T_1 reverberation time, in seconds, of the empty rev. room
T_2 reverberation time, in seconds, with the test specimen



Evaluation based on laboratory measurements. Results obtained with a standard procedure: Interrupted noise method with 3 measurements averaged at each microphone/loudspeaker position. 2 Loudspeaker positions each with 8 microphone positions.

Test cert. No.: 22008a1 Testing institute: Akustik-Prüfstelle der TU Berlin

Date: March 11, 2022 Signature:

Figure 4: Certificate ISO 354 22008a1, CLEO plane.

Sound absorption coefficient according to ISO 354

Laboratory measurements of sound absorption in a reverberation room

Client: rohi Stoffe GmbH Date of test: 4.3.2022

CLEO gathered

95 % WV / 5 % PA, various colors, mass per unit area 690 g/m^2,
2 curtains size 3.00 × 3.50 m, gathered, 100 % gathering,
type G-100 mounting with 100 mm distance from the wall

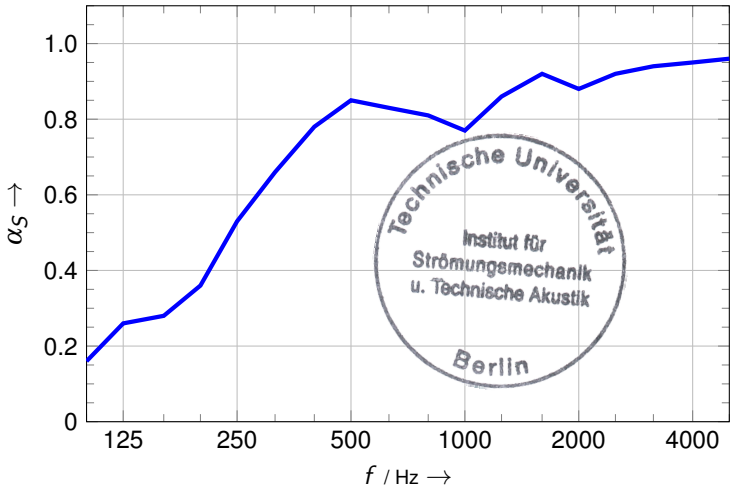
Size of the specimen:	10.5 m^2
Volume of the reverb. room:	200.9 m^3

Empty reverberation room		Reverb. room with the test specimen	
Temperature:	15.4 °C	Temperature:	15.6 °C
Air humidity:	39.1 %	Air humidity:	38.5 %
Atmospheric pressure:	1020.2 hPa	Atmospheric pressure:	1020.1 hPa

f / Hz	α_S	T_1 / s	T_2 / s
100	0.16	7.9	5.6
125	0.26	8.0	4.8
160	0.28	7.6	4.5
200	0.36	7.4	4.0
250	0.53	8.0	3.4
315	0.66	7.9	3.0
400	0.78	8.0	2.7
500	0.85	7.9	2.5
630	0.83	7.5	2.5
800	0.81	7.3	2.5
1000	0.77	6.9	2.6
1250	0.86	6.1	2.3
1600	0.92	5.3	2.1
2000	0.88	4.3	1.9
2500	0.92	3.4	1.7
3150	0.94	2.9	1.5
4000	0.95	2.4	1.4
5000	0.96	1.9	1.2

Legend

α_S sound absorption coefficient
f frequency one-third-octave bands in Hz
T_1 reverberation time, in seconds, of the empty rev. room
T_2 reverberation time, in seconds, with the test specimen



Evaluation based on laboratory measurements. Results obtained with a standard procedure: Interrupted noise method with 3 measurements averaged at each microphone/loudspeaker position. 2 Loudspeaker positions each with 8 microphone positions.

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Figure 5: Certificate ISO 354 22008a2, CLEO gathered.

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