ACOUSTICS DEPARTMENT
Moscow State University

SCHMIDT INSTITUTE OF PHYSICS
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ACADEMY OF SCIENCES

Numerical simulation of the effect of absorption on the transmission of acoustic waves through 3D-printed ABS-plastic metamaterial

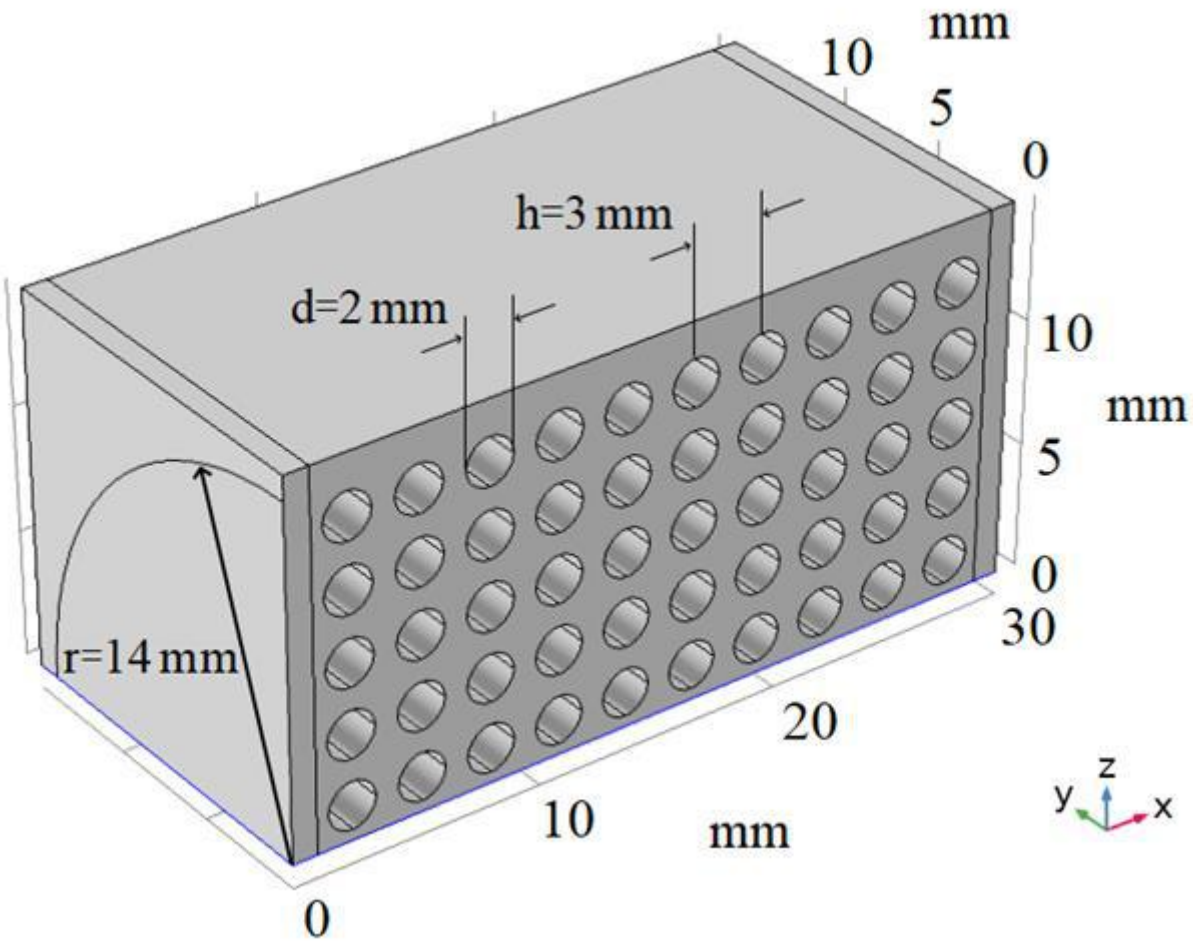
A.I. Korobov, A.I. Kokshayskiy, R.A. Zhostkov,
N.I. Odina, **M.Yu. Izosimova,**
A.B. Volodarsky

maria.izossimova@mail.ru

Summary

- Numerical simulation of the effect of sound attenuation on acoustic wave propagation through a metamaterial made of ABS plastic with a relatively simple geometry (a cube with a lattice of cylindrical holes filled with metal or without filling) in the frequency range 200-700 kHz
- Experimental study of acoustic longitudinal wave propagation in two samples of such a metamaterial (with and without filling) in the same frequency range, using the echo-pulse method
- Comparison of experimental and numerical simulation results

Sample (geometry)



Sample (material parameters)

ABS-plastic parameters:

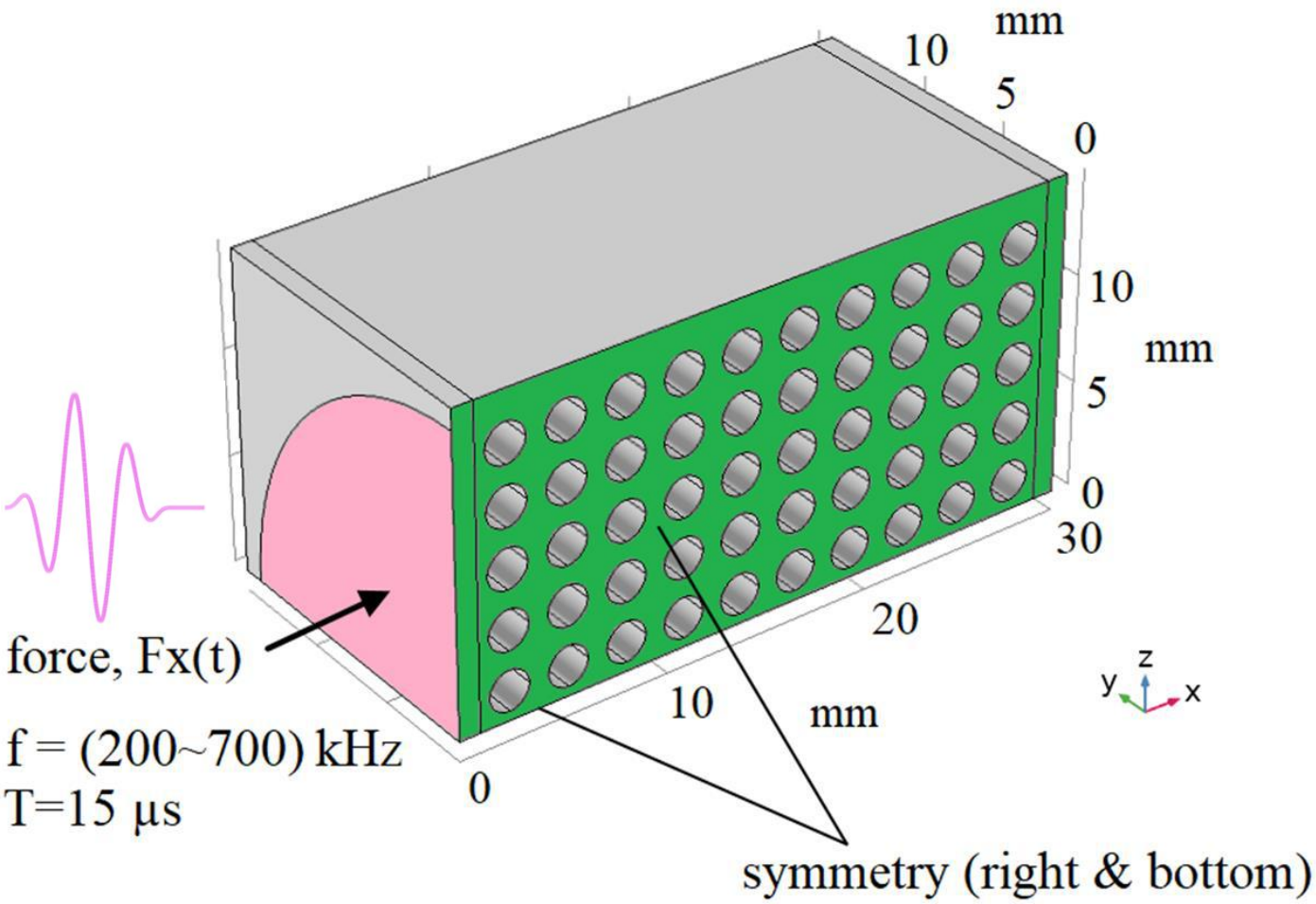
ρ=1000 kg/m

Vp=1690 m/s

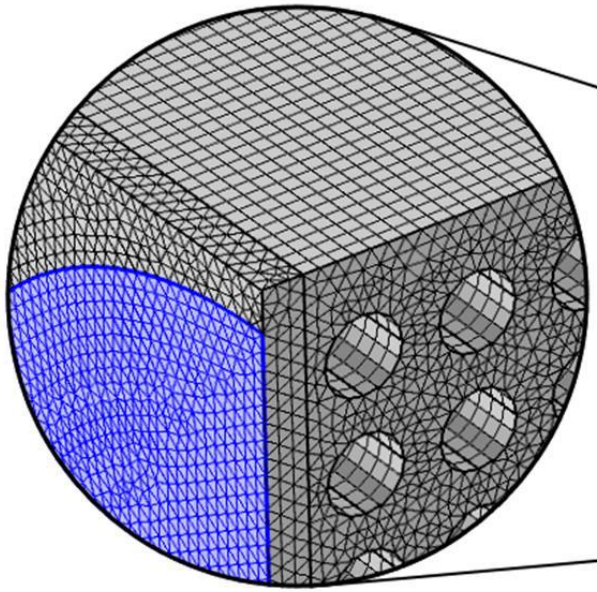
Vs=830 m/s

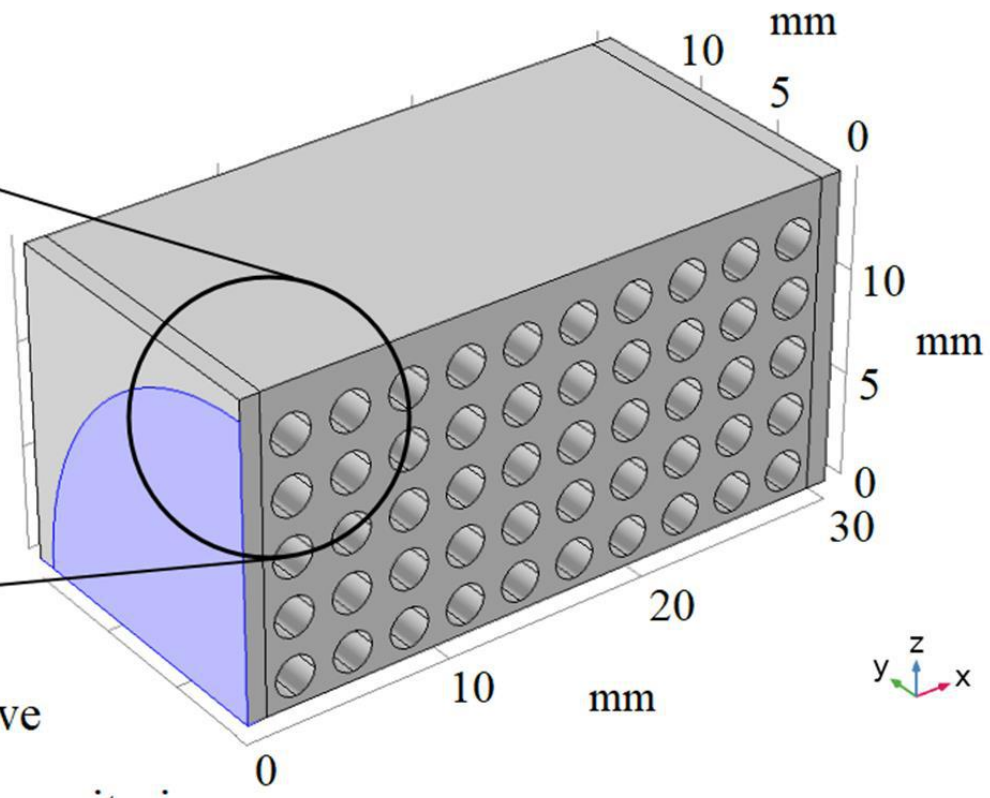
Attenuation coefficient [1/m]	f=1 MHz	f=2 MHz
Without absorption	0	0
Low absorption (model.)	1.6	3.2
High absorption (model. and experiment)	65	260

Numerical model (boundary conditions)



Numerical model (mesh)

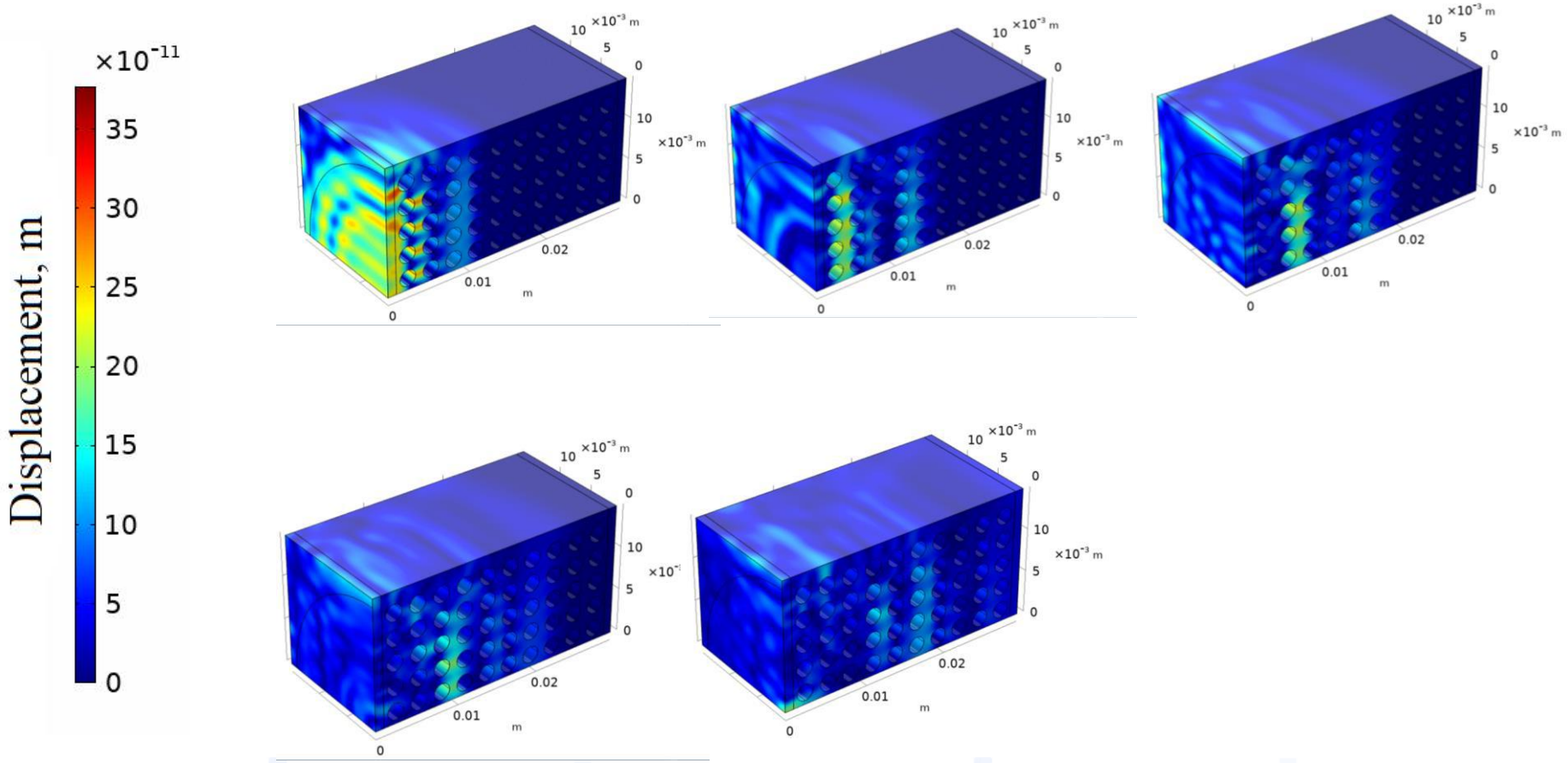




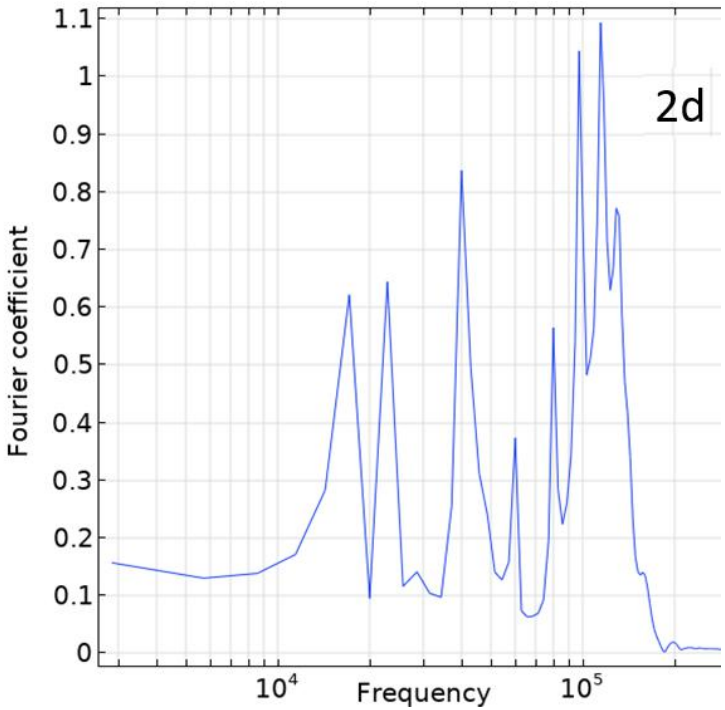
Δx = (0.05~0.1) wavelength of shear-wave

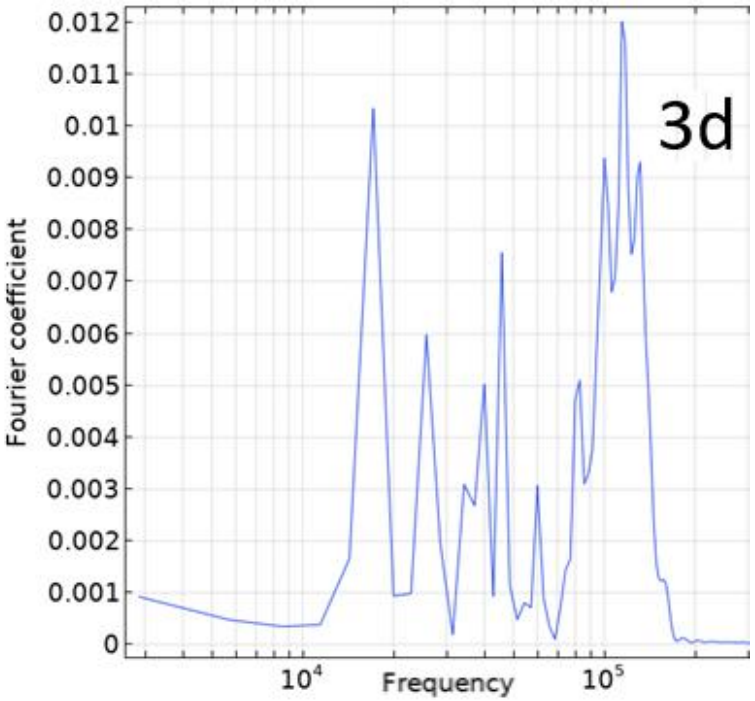
Δt satisfies the Courant - Friedrichs - Levy criterion

Numerical model (Result animation)

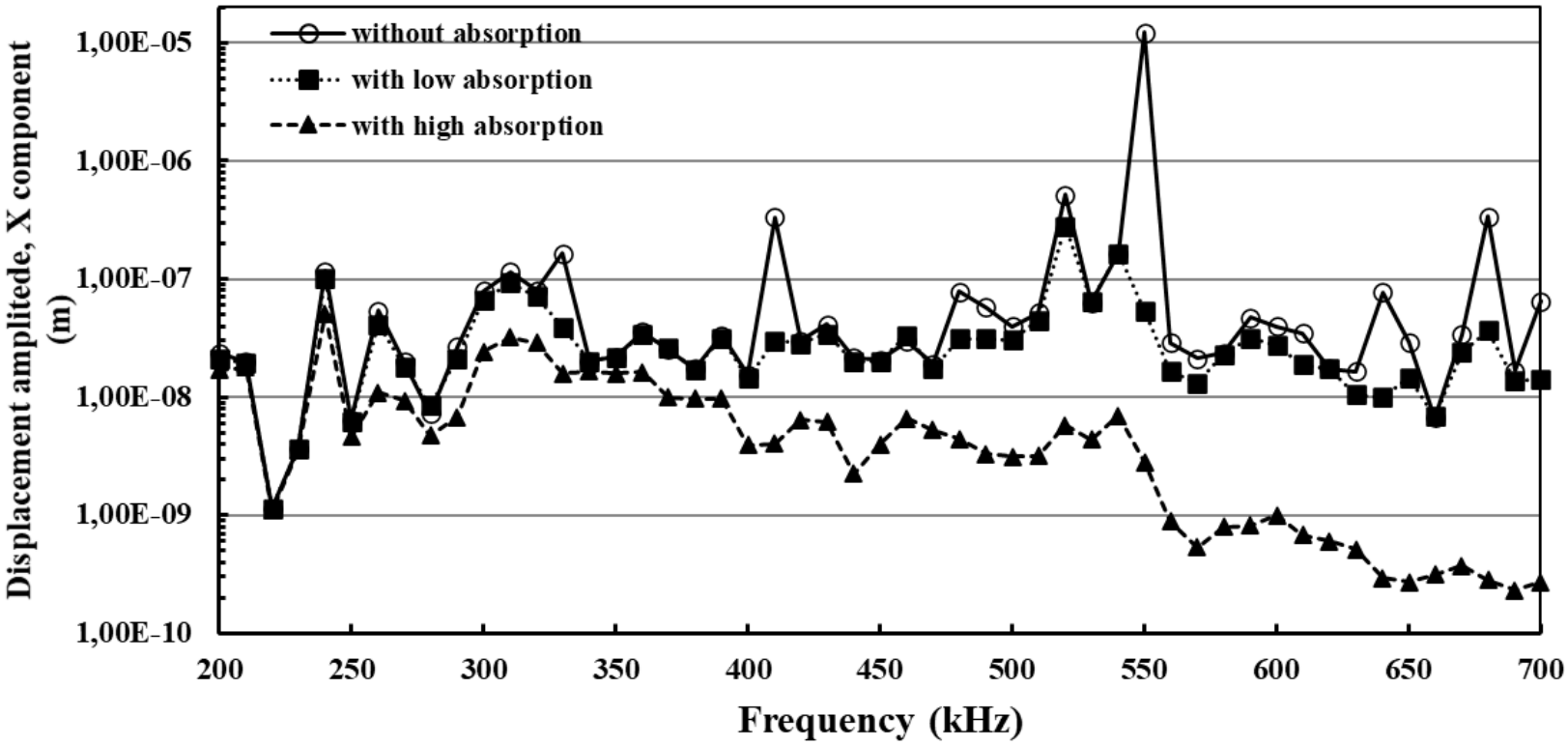


Modeling results (2D and 3D, 200 kHz)

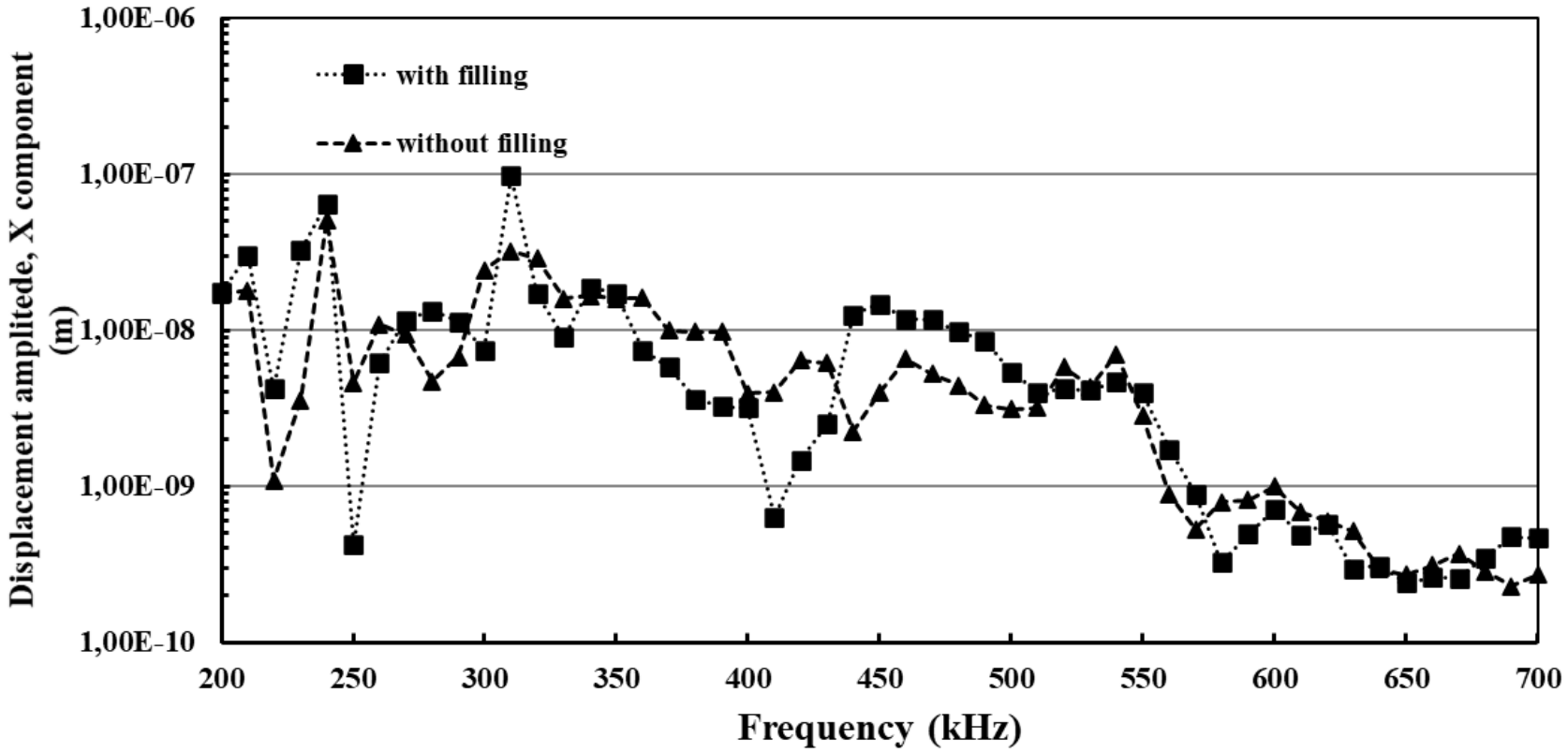




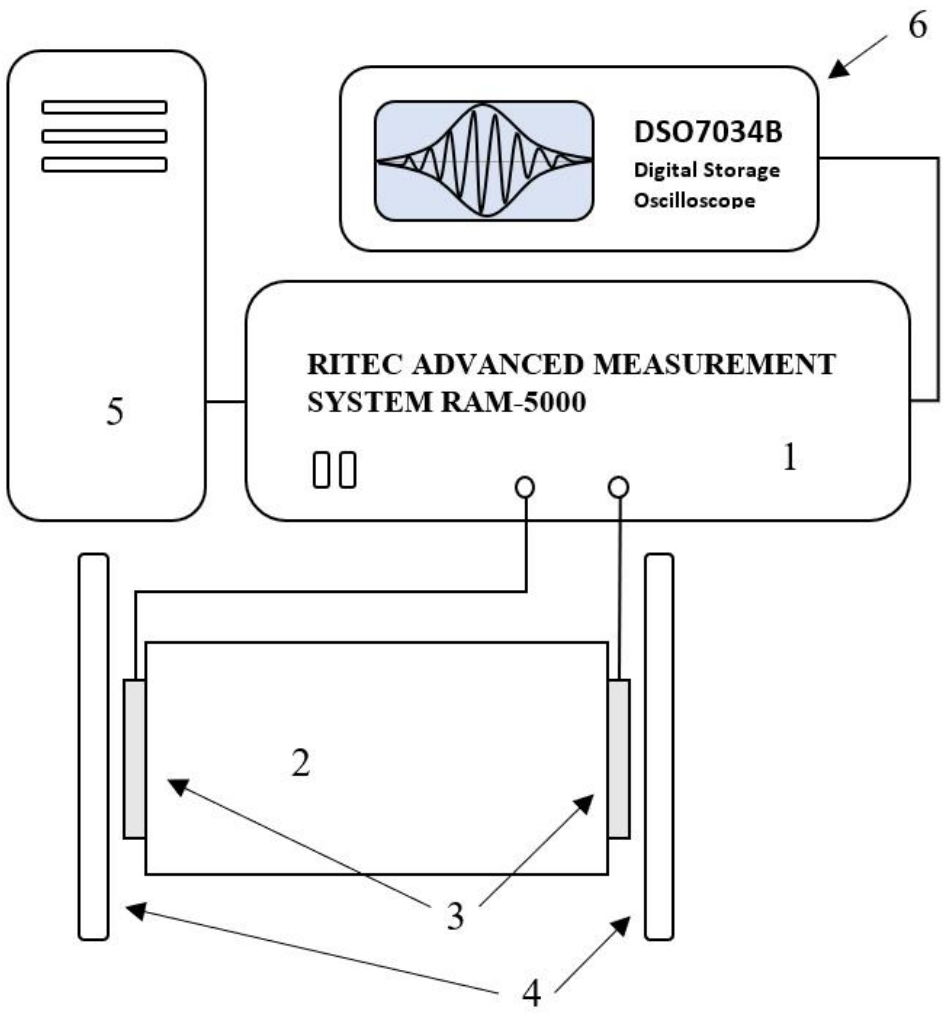
Modeling results (frequency domain, 2D, no filling)



Modeling results (frequency-domain, 2D, with and without filling)



Experimental Setup



1 - RITEC RAM-5000 Ultrasound Measurement System

2 – Sample

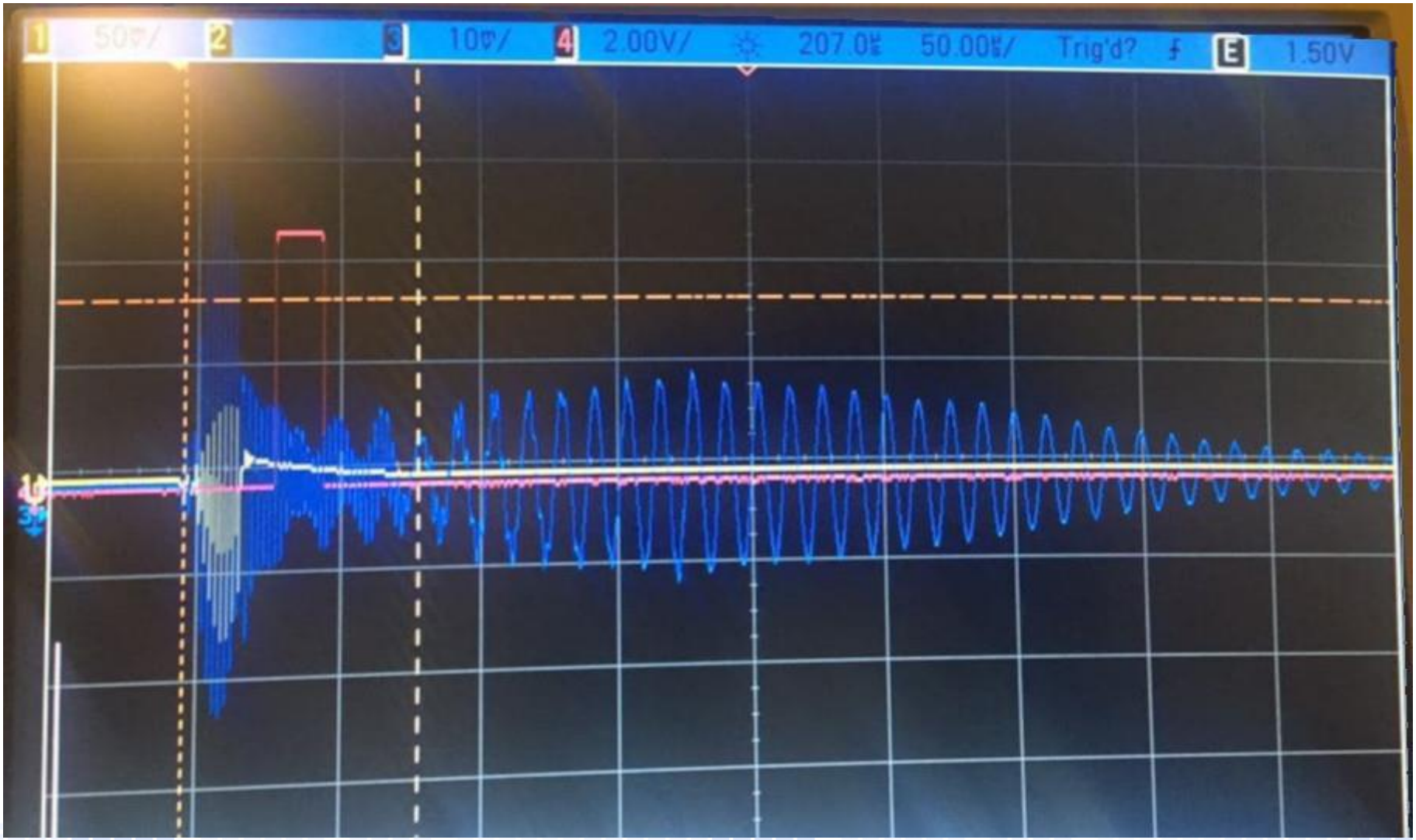
3 - Emitting and Recording Piezo Transducers

4 - Fixing System

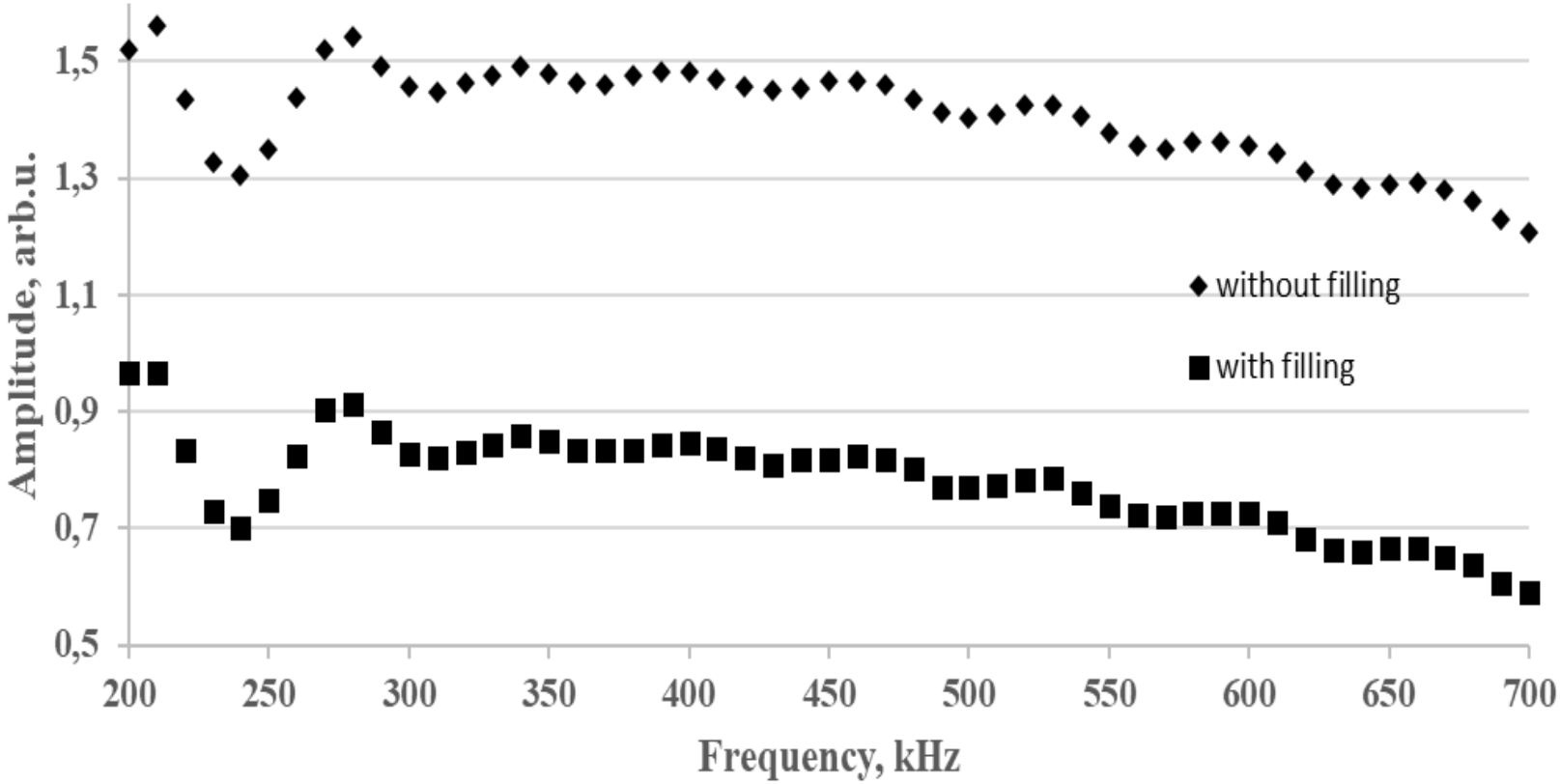
5 – Personal Computer

6 – Oscilloscope

Experimental results



Experimental results (60kHz, with and without filling)

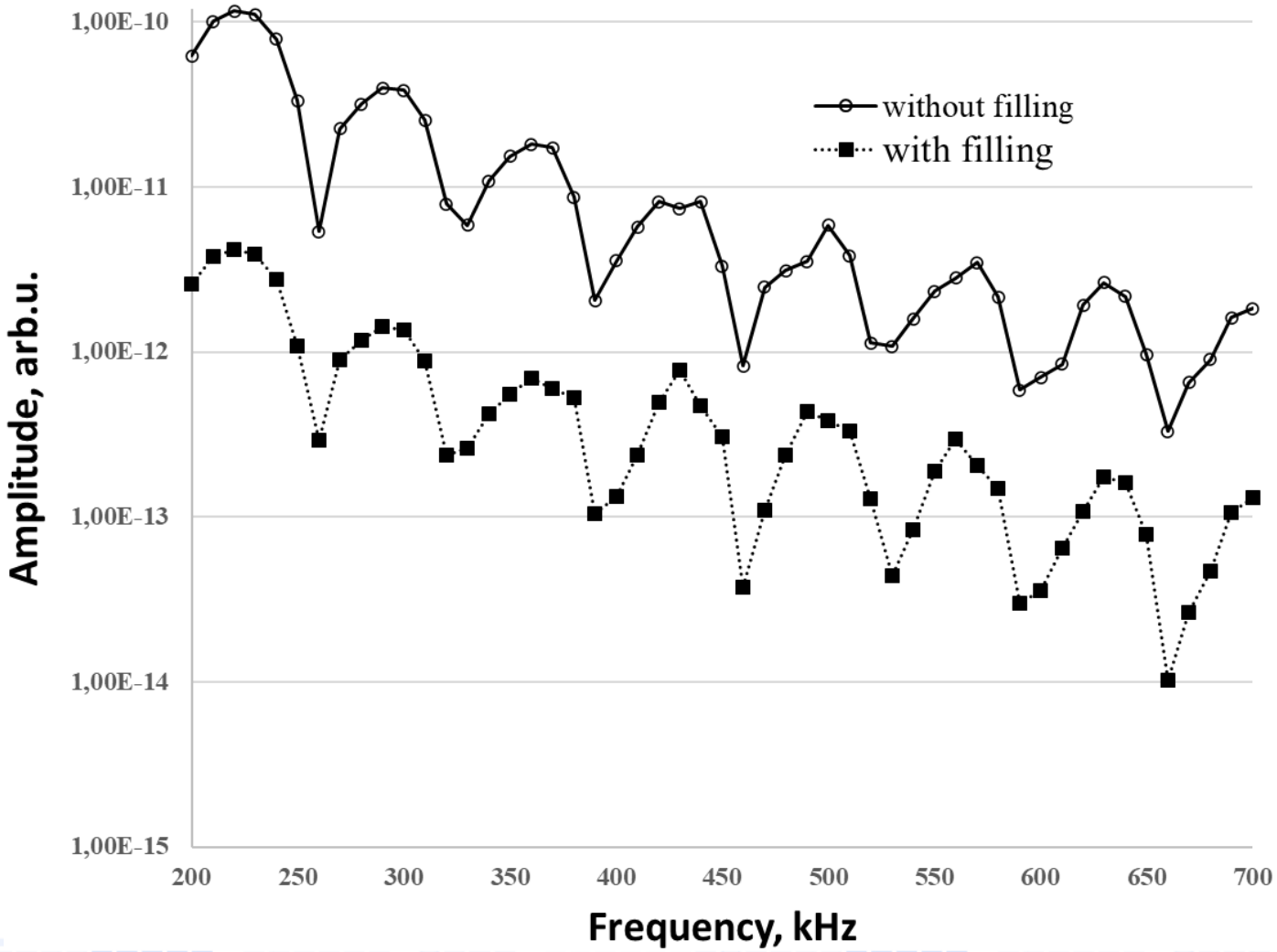


Data processing (results of the time-domain 2D modeling)

1. Fourier transformation in a fixed long time window corresponding to the time of the "tail“

2. Plot dependence of the amplitude of the spectral component with a frequency of 60 kHz on the excitation frequency of the probe pulse

Modeling results (with absorption, with filling and without filling)



Conclusions

1. For samples of model metamaterials with a simple geometry (with and without filling), it was shown that absorption results in a smoothing and decreasing of transmission bands in high-frequency region.

2. 2D-modeling in the frequency and time domains with absorption made it possible to correctly describe several effects observed experimentally in our samples.

Thanks for your attention!

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Maria Izosimova

maria.izossimova@mail.ru