Project no.: 13-10365S
Provider: Czech Science Foundation
Realization period: 1st February 2013 – 31st December 2015

Project Title:

Planar Acoustic Metamaterials with Active Control of Acoustic Impedance

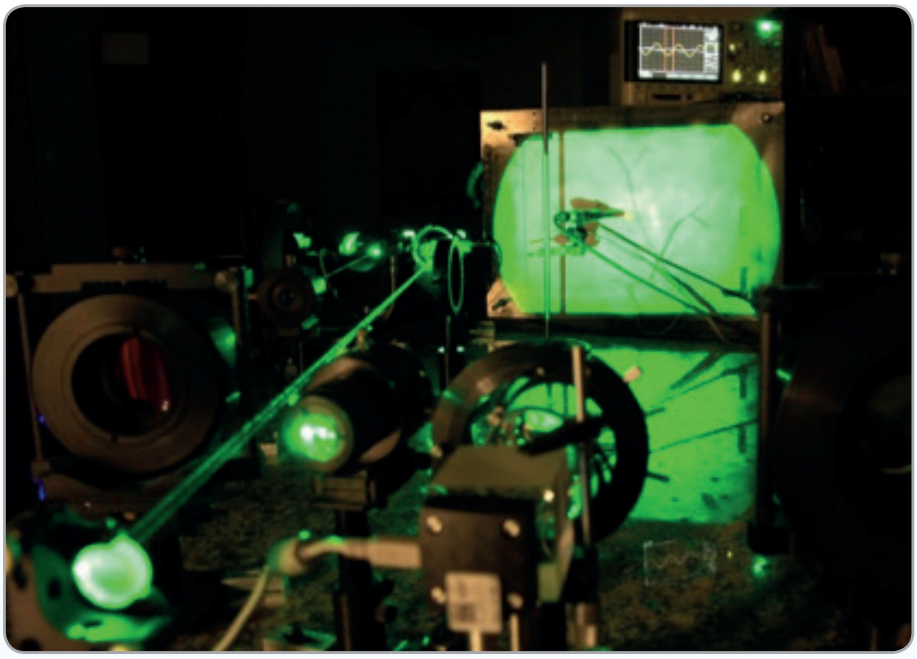


Figure 1: *Measurement of the acoustic transmission loss of sound transmitted through the active planar acoustic metamaterial using our novel method based on digital holographic interferometry.*

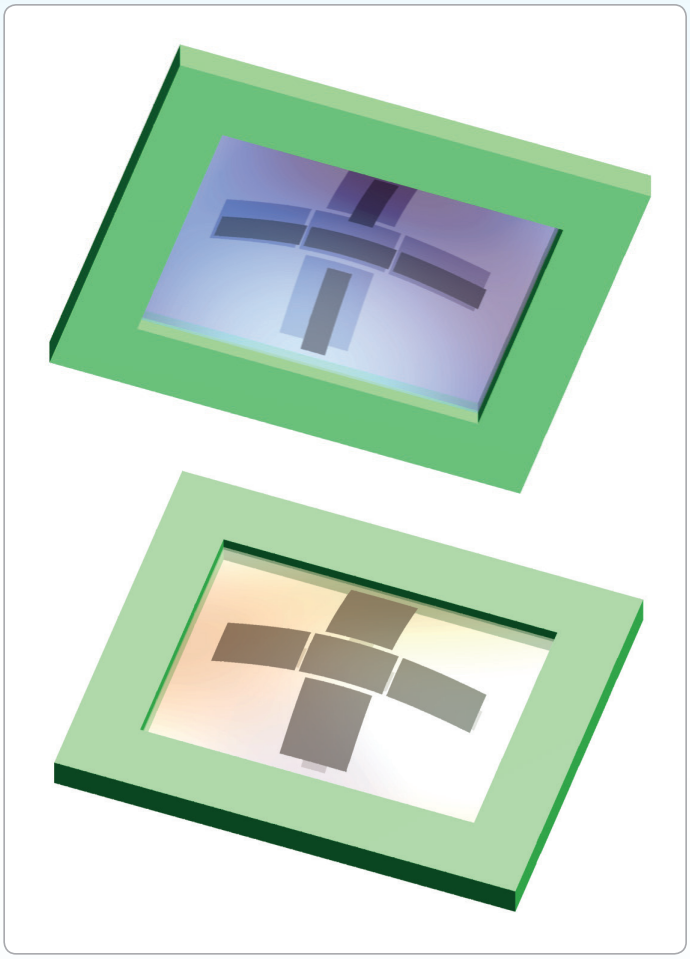
The project, on which the TOPTEC Centre collaborated with the Technical University in Liberec, focused on basic research into design tools and fundamental properties of planar acoustic metamaterials and on research of methods for the control of their acoustic impedance in changing operational conditions.

We implemented acoustic tunable metamaterials as multilayer composite shells with piezoelectric elements. Active control of their acoustic impedance was achieved by connecting the piezoelectric elements to active electric shunt circuits with negative impedance converters or gyrators. We developed methods of adaptive piezoelectric shunt damping and optimized the design of metamaterials with the required acoustic impedance using finite element method simulations. The acoustic properties of the realized metamaterials were evaluated using acoustic transmission loss and acoustic absorption coefficient measurements. Static and dynamic displacements of the metamaterials produced by electric voltage were measured using digital holographic interferometry.

The project results are applicable, for instance, in the design of noise shielding systems or sound-absorbing panels. The results have been published in scientific articles in international

journals, in the proceedings of major international conferences, and in two chapters of a Czech monograph. The results are:

- numerical models of active acoustic metamaterials, which are based on composite piezoelectric shells
- design and implementation of methods for active control of acoustic impedance of active acoustic metamaterials using digital electronic circuits implementing synthetic impedance
- development of methods for the measurement of acoustic parameters of planar structures based on digital holographic interferometry
- construction of the proposed active acoustic metamaterials and measurement of their acoustic parameters by means of the newly developed optical characterization methods (direct demonstration that active acoustic metamaterials achieve excellent sound insulation properties in the regime of negative elasticity)



Obrázek 2: *Top (a) and bottom (b) view of the planar acoustic metamaterial, which consists of the curved glass plate with attached piezoelectric actuators..*