

A new set-up to measure the viscoelastic properties of porous media using a specific electrodynamic transducer

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A new method for measuring viscoelastic properties of sound absorbing materials is presented. This method is derived from the quasistatic method [1,2] using a loudspeaker as actuator and sensor. Previous results carried out with a traditional electrodynamic loudspeaker were limited to 100 Hz because of transducer nonlinearities [3,4]. In this paper, viscoelastic properties are determined up to 500 Hz due to the design of a specific loudspeaker devoid of the main nonlinearities.

The proposed set-up is presented in Fig. 1. The porous sample is compressed in the top cavity using a specific electrodynamic transducer. The use of a cavity allows to carry out measurements in ambient conditions: it avoids a lateral airflow which can induce an overestimation of the porous material loss factor [5,6,7]. In opposition to the electrodynamic shaker used in the quasistatic method [1,2], the use of a loudspeaker as an actuator allows to excite the porous sample in the relevant frequency range for noise control applications. Indeed, such transducers are originally designed to radiate in the audible frequency range.

In the proposed method, the viscoelastic properties of the frame are derived from the mechanical impedance of the porous sample by inverse method using the Biot's model. This impedance is estimated from the measurement of the transducer electrical impedance and a model of its electro-mechanic behaviour [3,4]. The experimental set-up is thus considerably simplified but it requires in exchange a transducer as linear as possible to fit the Thiele and Small model [8].

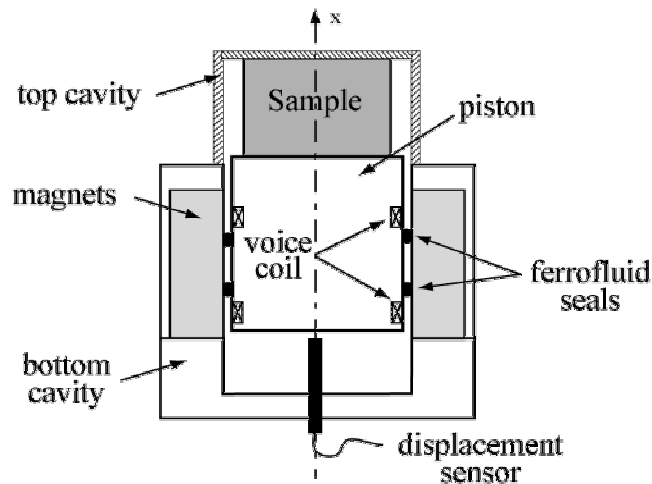


Fig. 1: set-up to measure the viscoelastic properties of porous materials

Thereto, the transducer presented in Fig. 1 is made of a voice-coil motor such as those used in traditional electrodynamic loudspeakers but with major improvements [9]:

- the magnetic structure is ironless and is designed to vanish the major electrical nonlinearities,
- the viscoelastic suspension is replaced by two ferrofluid-seals which help avoid nonlinearities in the movements of the piston.

The method has been applied to a polymer foam. Results obtained with this method are presented in Fig. 2. Results are given up to 500 Hz (square) and are compared to the results given by the classical compression quasistatic method (cross). Except around resonances in the system that mostly affect the estimation of the loss factor (void square), results are in good agreement. The optimization of the set-up will be performed from the evaluation of the uncertainties that will be presented further.

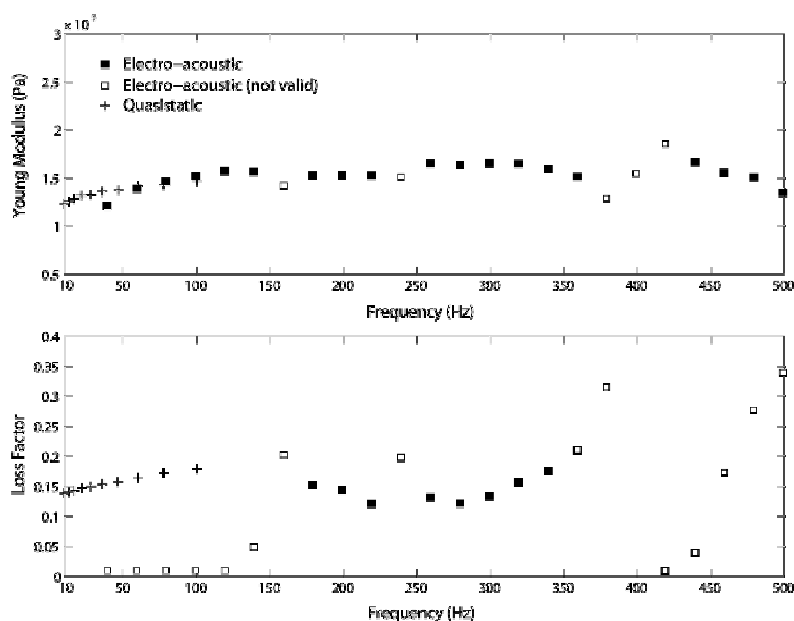


Fig. 2: Viscoelastic properties of a polymer foam estimated by a quasistatic and electro-acoustic techniques.

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