A Multi-Physics Study of the Wave Propagation Problem in Open Cell Polyurethane Foams

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Abstract

Flexible and semi-rigid polyurethane foams are widely used as noise and vibration damping materials. Their porous random microstructure is composed of a visco-elastic frame structure with an interstitial fluid, normally air, filling the voids. The viscoelasticity of the foams is due to the polymer morphology in the foam skeleton structure, which can be adapted depending on application requirements. The energy transport is carried both through the air-borne flow in the pores as well as through the solid frame structure-borne vibration transmission. The mechanical and acoustic waves are strongly coupled; for this reason, to study the wave propagation in porous foams, a solution of fluid-structure interaction problem is required.

In this work, the COMSOL Multiphysics® software is used to study the wave propagation problem in porous foams; CFD, Acoustics and Structural Mechanics Modules are used to model the air-borne transmission, the structure-borne one, and their multi-physics coupling. Different degrees of strain level are applied to the foam structure, in order to study their influence on the fluid-structure interaction. The CFD, acoustics and structural mechanics COMSOL Multiphysics® model is exploited to link the lower length scale effects with full scale material properties. All material properties are based on existing polyurethane foams used in various vibration damping applications.

Figures used in the abstract

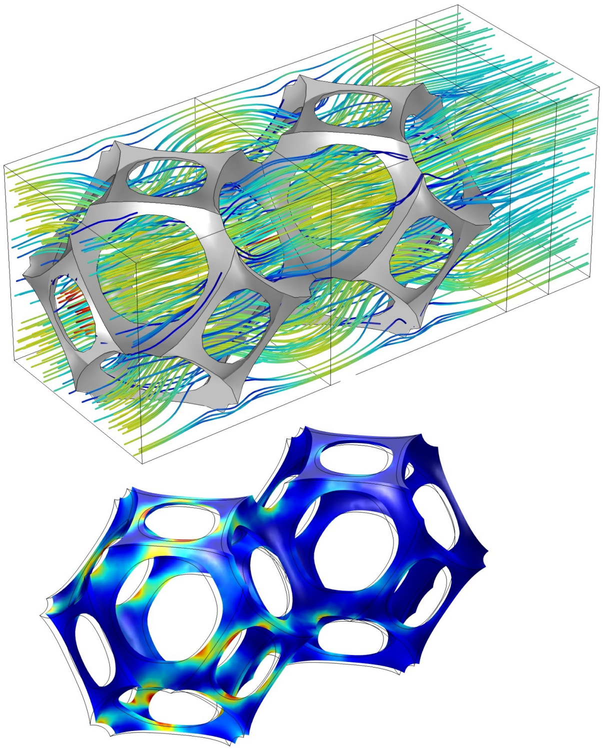

Figure 1: Model of two Kelvin cells. The solutions of the air-borne (upper part) and structure-borne (bottom part) transmission problems are shown.