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A 3 dimensional finite element modeling of "smart foam" and its experimental validation

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The "smart foam" concept and design originate from the combination of passive dissipation of acoustic foams in the medium and high frequency range and the active absorption ability of piezoelectric actuators (generally PVDF) in the low frequency range. This results in a passive/active absorption control device that can efficiently operate over a broad range of frequencies. In this paper, a 3D finite element model of smart foam and its experimental validation are presented. The finite element model uses quadratic poroelastic elements with a (u,p) formulation, as well as elastic, fluid and piezoelectric elements. The weak integral formulation of the different involved domains and their coupling conditions are presented. In particular, an isotropic and a simplified orthotropic model of poroelastic media are presented and compared. The fabrication of a prototype smart foam based on melamine foam with a curved, bonded PVDF film is discussed. Passive absorption and acoustic radiation of this prototype are measured in an impedance tube. The measured data are in good agreement with the numerical results, thereby validating the finite element model. This modeling tool constitutes a powerful platform to simulate and optimize various configurations of smart foams.