# A STUDY OF SMART FOAM FOR NOISE CONTROL APPLICATIONS

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(ABSTRACT)

Smart foam is a composite noise control treatment that consists of a distributed piezoelectric actuator, known as polyvinylidene fluoride (PVDF), embedded within a layer of partially-reticulated polyurethane foam. The principal function of smart foam is to yield broadband sound attenuation. Passive acoustic foams are a very reliable high-frequency sound reduction method. With regard to smart foam, the embedded piezoelectric actuator is introduced to overcome the limitations of the passive foam in the low-frequency region. The piezoelectric actuator excites the structural and acoustic phases of the foam when driven by an externally supplied control voltage. This generates a secondary acoustic field which destructively interacts with the acoustic field created by a primary noise source. Initial experiments employ the composite “active/passive” treatment to yield attenuation of piston sound radiation. For this simple source, the global farfield pressure is minimized according to the feedforward, Filtered-x LMS control algorithm using one error sensor. Significant broadband sound attenuation is obtained. A more advanced noise control problem is investigated which minimizes plate radiation. The vibrating plate has a distributed modal response requiring a collective array of independently-phased smart foam actuators to yield reduction of the radiated sound power. This is accomplished by minimizing the sound pressure at an array of nearfield microphones. Good broadband sound power reduction is obtained using a MIMO (multiple-input/multiple-output) Filtered-x LMS control scheme. Various techniques for improving smart foam’s acoustic control authority are identified during manufacturing and finite element modeling. of the actuator. These improved smart foam actuators are employed as an active/passive liner to suppress the transverse propagating acoustic modes within an anechoically-terminated rectangular duct. A section of a duct wall is lined with an array of smart foam and the sound downstream of the control actuators is minimized at

several error microphones. Successful harmonic and broadband noise control is achieved. A full-scale numerical model of the duct acoustic control application is presented based on the finite element method. The purpose of the model is to study the sensitivity of this active/passive control approach relative to the spatial distribution of control channels and error sensors. A comparison of the numerical and experimental results yields similar trends.

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