Mechanically Strong Polymer Aerogels as Acoustic Insulation

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Mechanically strong polymer aerogels combine the strength and durability expected of engineering materials with the low thermal conductivity, low density, and acoustic impedance of traditional aerogels. In automotive and aerospace applications, for example, the properties of mechanically strong polymer aerogels enable several disparate functions to be combined into a single material envelope, allowing for a reduction in the weight and complexity of system designs. Vibroacoustic insulation is a functionality of particular interest that polymer aerogels can bring to such systems. Indeed, the ultrafine pore structure and high mass-normalized stiffness of polymer aerogels impart unusual and extreme sound-reflecting and sound transmission loss properties unto these materials, but existing characterization and reporting standards are often ill-suited for characterizing them as a result. Accurate characterization of the acoustic properties of mechanically strong polymer aerogels is critical in order to meaningfully convey their value proposition over incumbent materials such as foams and composites. A number of reports in the literature have examined the acoustic properties aerogels, in some cases proposing that aerogels behave differently than other low-density acoustic materials as that they do not obey the expected mass law for sound transmission loss. Despite this intriguing phenomenon, the acoustic properties of aerogels are still poorly understood and as a result have not been characterized to nearly the same extent as the thermal or mechanical properties of new aerogel formulations have been. In this presentation, a theory of acoustic impedance specific to aerogels along with a review of classical acoustic theory will be discussed. A comparison of measurement techniques and experimental results compiled from the literature is presented. Finally, development and characterization of mechanically strong polymer aerogels for use in acoustic insulation applications will be presented along with real-world example of how such materials are being used today.