INVESTIGATION OF LOCALLY RESONANT ABSORPTION OF PHONONIC GLASS

Meng Chen, Meng Dan, Yuren Wang\(^(*)\), Heng Jiang, Yafei Feng

Key Laboratory of Microgravity, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, People’s Republic of China
\(^(*)\)Email: yurenwang@imech.ac.cn

ABSTRACT

This work experimentally studied locally resonant absorption mechanism in phononic glass. From these results, we attributed its strong sound attenuation to its locally resonant units and its broadband absorption to its networked structure. These experiments also indicated that the porosity of the phononic glass must be tuned to achieve the best sound absorption at given frequencies.

Keywords: Phononic glass, locally resonant absorption, networked structure, porosity.

INTRODUCTION

Phononic glass, a new sound-absorbing material, which was fabricated by networks of locally resonant phononic crystals (LRPCs), exhibited good sound absorption over a wide frequency range as well as good compressive properties (Jiang, 2009; Jiang 2012). The band gaps of these materials, calculated using lumped-mass methods, suggest that their wideband absorption originates from multiple locally resonant modes (Jiang, 2009; Jiang 2010). However, it has been difficult to identify the absorption mechanisms in this complex composite. In phononic glass, a metal skeleton is substituted for the spherical scattering centers, and the three component materials are connected in a network (Jiang, 2009; Jiang 2012). The mechanism of locally resonant absorption is more complicated in phononic glass than in LRPCs (Jiang, 2010; Zhao, 2006). Thus, further experimental studies are needed to investigate these absorption mechanisms of phononic glass.

In the present paper, we further investigated the mechanism of locally resonant absorption in phononic glass by experiments. The composites of the aluminum foam filled with one kind of PU and phononic glasses using different porosities aluminum foams were fabricated to do the comparison experiments.

RESULTS AND CONCLUSIONS

Figure 1(a) shows the acoustic absorption coefficients as a function of frequency of the phononic glass and the two-component materials, which were only filled with one kind of PU. The phononic glass exhibited excellent acoustic absorption in the tested frequency range, exhibiting an average absorption coefficient greater than 0.9 for 12-30 KHz. In contrast, neither two-component material exhibited a sound absorption coefficient greater than 0.6 at any frequency. The two kinds of two-component materials had similar sound-absorption curves: smooth with small fluctuations. All three materials exhibited the wideband effect; however, the underwater acoustic absorption of the phononic glass was much better than
those of the two-component materials over the measured frequency range. The results suggested that the strong sound attenuation was caused by analogous LRPC units, while the broadband effect was caused by the network structure.

Figure 1(b) shows the acoustic absorption coefficients of the phononic glass with varying porosity as a function of frequency. As the porosity decreased, the maximum acoustic absorption coefficients tended to shift to lower frequencies and the acoustic absorption at high frequencies degraded. Note that the samples with many different porosities (except 50%) achieved broadband absorption at the measured frequencies. Because of the limitations of the preparation technology used to make the metal skeleton, the samples with higher porosity had more LRPC units in the direction of thickness. More LRPC units in the thickness direction led to more LRPC modes capable of dissipating energy at different frequencies. Thus, the porosity of the phononic glass must be tuned to achieve the best sound absorption at given frequencies.

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REFERENCES