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A WIDE BAND UNDERWATER STRONG ACOUSTIC ABSORBING MATERIAL

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

Key Laboratory of Microgravity, Institute of Mechanics, Chinese Academy of Sciences, 100190 Beijing, China

(*)*Email*: yurenwang@imech.ac.cn

ABSTRACT

To meet the demand of underwater acoustic absorbing material for wide band strong acoustic absorption, we introduced network structure into locally resonant phononic crystal and fabricated a new kind of metal-polymer composites. Experimental and theoretical results showed that excellent underwater acoustic absorption capability and strong mechanical strength could be obtained simultaneously.

INTRODUCTION

In the past decade, locally resonant phononic crystal (LRPC) has inspired great interest because it can exhibit an obvious phononic band-gap in the acoustic spectrum with crystal lattice constants two orders of magnitude smaller than the relevant sonic wavelength (Liu, 2000). Recent theoretical calculation has indicated that the maximum viscoelastic energy dissipation is generated at locally resonant frequency when considering viscoelastic deformation in LRPC (Zhao, 2006). It means that the LRPC can also be employed to expand the content of acoustic absorbing materials study. However, contrary to the aim of producing a strong absorption just at ertain narrow frequency in LRPC, acoustic absorbing material is usually need to be designed to have a strong absorbance in a wide range of frequencies. To solve this conflict, some anomalous structures need to be introduced into LRPC. We introduced interpenetrating network structure into LRPC unit, developed a modern underwater acoustic absorbing material (Jiang, 2009;Jiang, 2010).

The most striking difference between the LRPC and the new material is different resonant unit structures. Resonant units in the LRPC have the same size and distribute discretely in the polymer matrix. Those resonant units in the new material have different sizes and physically connected by the porous metal and the filled polymers. It is reasonable to deduce that a broad size distribution and multiple morphologies of resonant units are helpful for the realization of the wide band acoustic absorption. In this paper, we report the strong underwater acoustic absorption of a new composite material. It should be noticed that these resonant units and interpenetrating network structure are different from the traditional structure of anechoic materials.

RESULTS AND CONCLUSIONS

Fig.1 (a) is that strong underwater acoustic absorbance with the absorbing coefficient over 0.9 can be achieved in a wide frequency range for the new material, while sound absorbing coefficients for any component materials have the values not higher than 0.9. The underwater acoustic absorption capability of the new material is much better than that of traditional acoustic absorbing materials from the measured spectrum. The strong acoustic absorption characteristic of the new material is not originated from its component or simple linear superposition of the component materials. It is reasonable to deduce that the combination of LRPC structure units and cooperative effect from the interpenetrating network plays an important role in achieving strong wide band acoustic absorbing material.

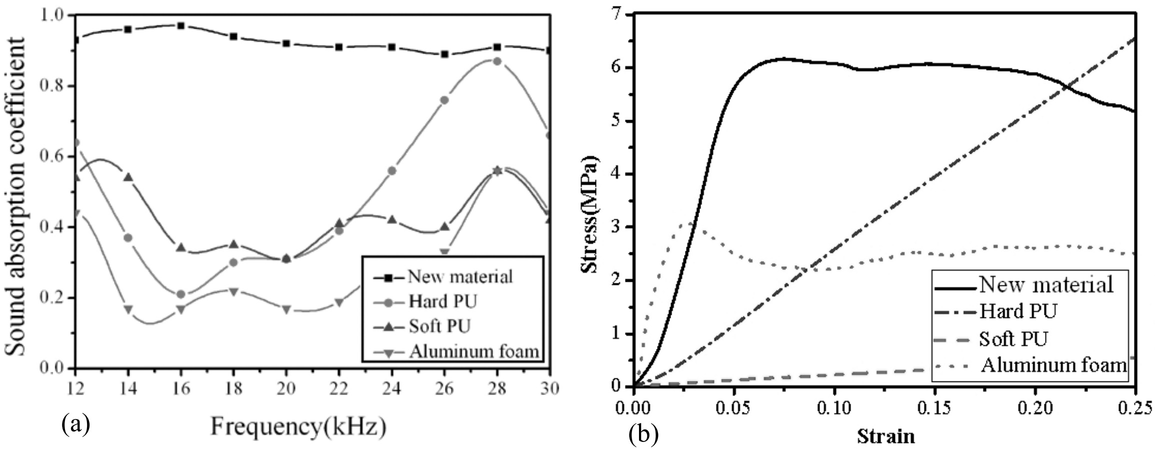

Fig. 1 - (a) Underwater absorption coefficients for different materials; (b) Compressive stress-strain curves of the new material and its component materials.

Fig.1 (b) exhibits the comparison of compression resistance experimental result between the new material and its separate components. The new material shows compressive strength over 6MPa, while that could not be achieved by PU and aluminum foam. It means that the new material can keep a good mechanical behavior even in 500 meters water depth. Compression resistance capacity of this composite material is originated from whole effects achieved by structural design. The interpenetrating network structure unified strong wide band sound absorption capability and high mechanical strength in the new material, while it appears to be conflicting in normal circumstances.

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