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Sound Absorption Performance of Micro-Perforated Plate Sandwich Structure Based on Triply Periodic Minimal Surface

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ABSTRACT

The sandwich structure based on Triply periodic minimal surface (TPMS) is a lightweight and high-strength multifunctional composite material that combines the versatility of heat exchange, impact resistance, and energy absorption, and has been widely used in various fields such as aviation and aerospace. However, its sound absorption performance has not meant fully studied. In this study, a micro perforated plate Diamond sandwich structure (MPP-DSS) is proposed based on TPMS implicit function method, which is composed of solid panel, TPMS macro-ordered porous structure and micro-perforated plate. The sound absorption performance in the middle and low frequency bands was studied by impedance tube method. The results show that MPP-DSS has higher sound absorption coefficient and bandwidth than traditional perforated plate structure under the same structural parameters. Increasing the thickness of the micro-perforated plate can improve the sound absorption capacity of MPP-DSS in the low frequency range, but the width of the sound absorption band will be narrowed. Different from the traditional perforated plate structure, the sound absorption mechanism of MPP-DSS is the combined effect of resonance and friction loss. By freeze-drying method, the relative sound absorption band width of MPP-DSS can be widened by filling polyurethane strong sound absorption material in the middle and low frequency band. The peak sound absorption frequency moves to the low frequency direction by 294Hz, and the relative sound absorption band width is widened by 23.86%. The sound absorption performance of the low frequency band is mainly determined by the TPMS micro-perforation resonance sound absorption structure, and the sound absorption performance of the higher frequency band is mainly determined by the polyurethane strong sound absorption material, which has certain reference significance for how to design the lightweight high strength middle and low frequency broadband sound absorption structure. This study broadens the versatility of TPMS structure and can provide reference for the design of the integrated structure of carrying and absorbing sound.

KEYWORDS

Triply periodic minimal surfaces; micro-perforated sandwich structure; sound absorption performance; composite structure

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