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Fano-Resonance-Based Wideband Acoustic Metamaterials with Highly Efficient Ventilation

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Abstract : Ventilated acoustic metamaterials have attracted considerable research attention due to their low-frequency absorptions and efficient fluid ventilations. In this research, a wideband acoustic metamaterial with auditory filtering ability and efficient ventilation capacity were proposed. In contrast to a conventional Fano-like resonator, a Fano-like resonator composed of a resonant unit and two nonresonant units with a large opening area of 68% for fluid passages was developed. In addition, the coupling mechanism to improve the narrow bandwidths of conventional Fano-resonance-based meta-materials was included. With a suitable design, the output sound waves of the resonant and nonresonant states were out of phase to achieve sound absorptions in the far fields. Therefore, three-element and five-element coupled Fano-like metamaterials were designed and simulated with the help of the finite element software to obtain the filtering fractional bandwidths of 42.5% and 61.8%, respectively. The proposed approach can be extended to multiple coupled resonators for obtaining ultra-wide bandwidths and can be implemented with 3D printing for practical applications. The research results are expected to be beneficial for sound filtering or noise reductions in duct applications and limited-volume spaces.

Keywords : fano resonance, noise reduction, resonant coupling, sound filtering, ventilated acoustic metamaterial
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