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Design of Aesthetic Acoustic Metamaterials Window Panel Based on Sierpiński Fractal Triangle for Sound-Silencing with Free Airflow

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Abstract : Design of high-efficiency low, frequency (<1000Hz) soundproof window or wall absorber which is transparent to airflow is presented. Due to the massive rise in human population and modernization, environmental noise has significantly risen globally. Prolonged noise exposure can cause severe physiological and psychological symptoms like nausea, headaches, fatigue, and insomnia. There has been continuous growth in building construction and infrastructure like offices, bus stops, and airports due to the urban population. Generally, a ventilated window is used for getting fresh air into the room, but at the same time, unwanted noise comes along. Researchers used traditional approaches like noise barrier mats in front of the window or designed the entire window using sound-absorbing materials. However, this solution is not aesthetically pleasing, and at the same time, it's heavy and not adequate for low-frequency noise shielding. To address this challenge, we design a transparent hexagonal panel based on the Sierpiński fractal triangle, which is aesthetically pleasing and demonstrates a normal incident sound absorption coefficient of more than 0.96 around 700 Hz and transmission loss of around 23 dB while maintaining e air circulation through the triangular cutout. Next, we present a concept of fabrication of large acoustic panels for large-scale applications, which leads to suppressing urban noise pollution.

Keywords : acoustic metamaterials, ventilation, urban noise pollution, noise control
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