# Acoustic Metamaterials Made of Plastic to Improve Building Acoustics

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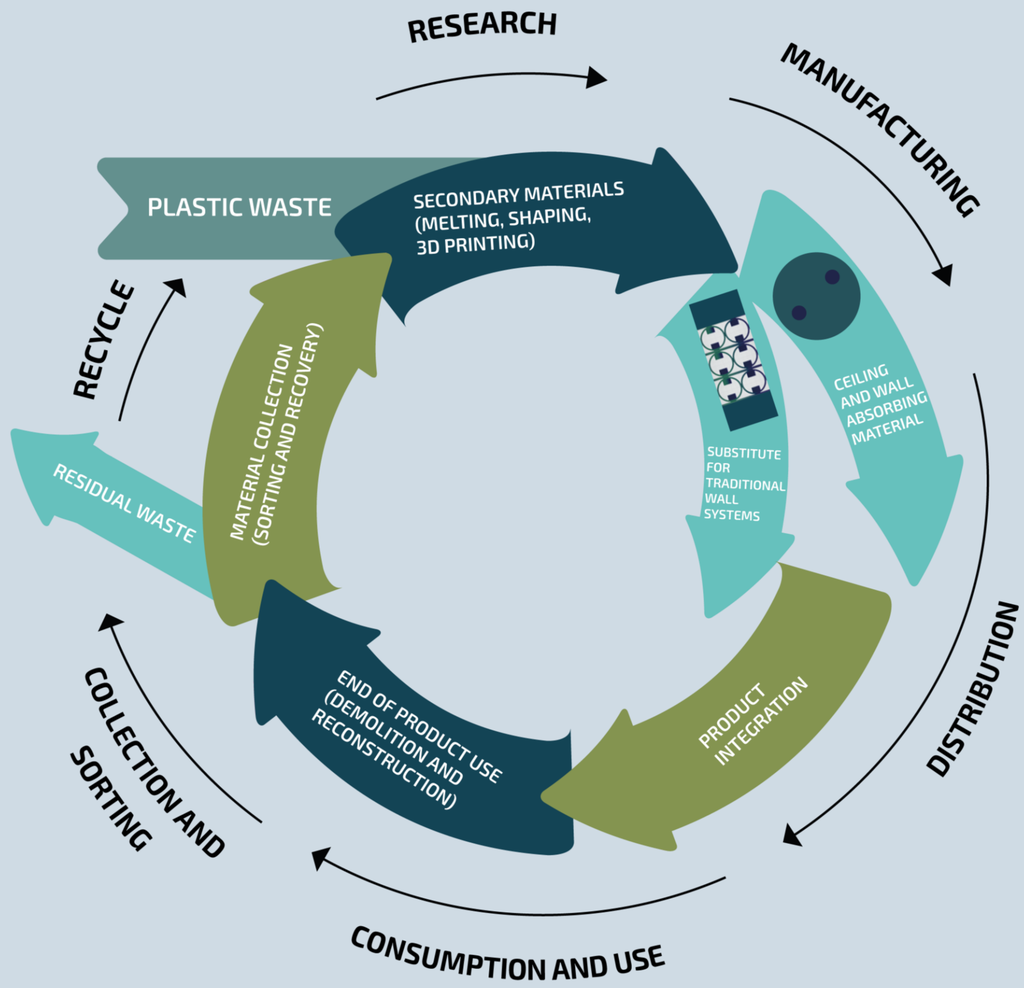
**There is potential for these acoustic metamaterial resonating constructions to be used and to change traditional materials such as gypsum board walls with construction wool.**

Depending on resonator neck hole diameter and neck length, different frequency sound wave can be absorbed effectively. It can be stated, that bigger metamaterial resonator neck hole means higher sound absorption peaks, when longer neck shifts those peaks to the lower frequencies.

Adding acoustic metamaterial between two partitions improves lower frequency transmission loss and removes any sudden declines in transmission loss, which means system is more stable and more predictable in sound insulation.




## Introduction

In recent years, there has been an increase in research on acoustic metamaterials for noise control and sound absorption improvement to reduce reverberation time in buildings.

The use of resonators and their integration into metamaterial structures is a relatively new and unexplored field, despite the fact that resonators as standalone systems and their working principles are well-known and frequently used in acoustic engineering.

Plastic recycling is highlighted as an important step in the transition to a circular economy to avoid the use of fossil resources and close the plastic recycling cycle.

## Samples and measurement methodology

Our acoustic metamaterial made of plastic are based on the Helmholtz resonator working principle, composed of two filled with air chamber cells with different neck diameters and lengths.

Sound absorption coefficient measurement method with impedance tube is based on the fact that the complex sound reflection coefficient *R* can be determined by measuring the transfer function $H_{12}$ between two positions at distances $x_1$ and $x_2$ of the test sample.

$$\alpha = 1 - |R|^2$$

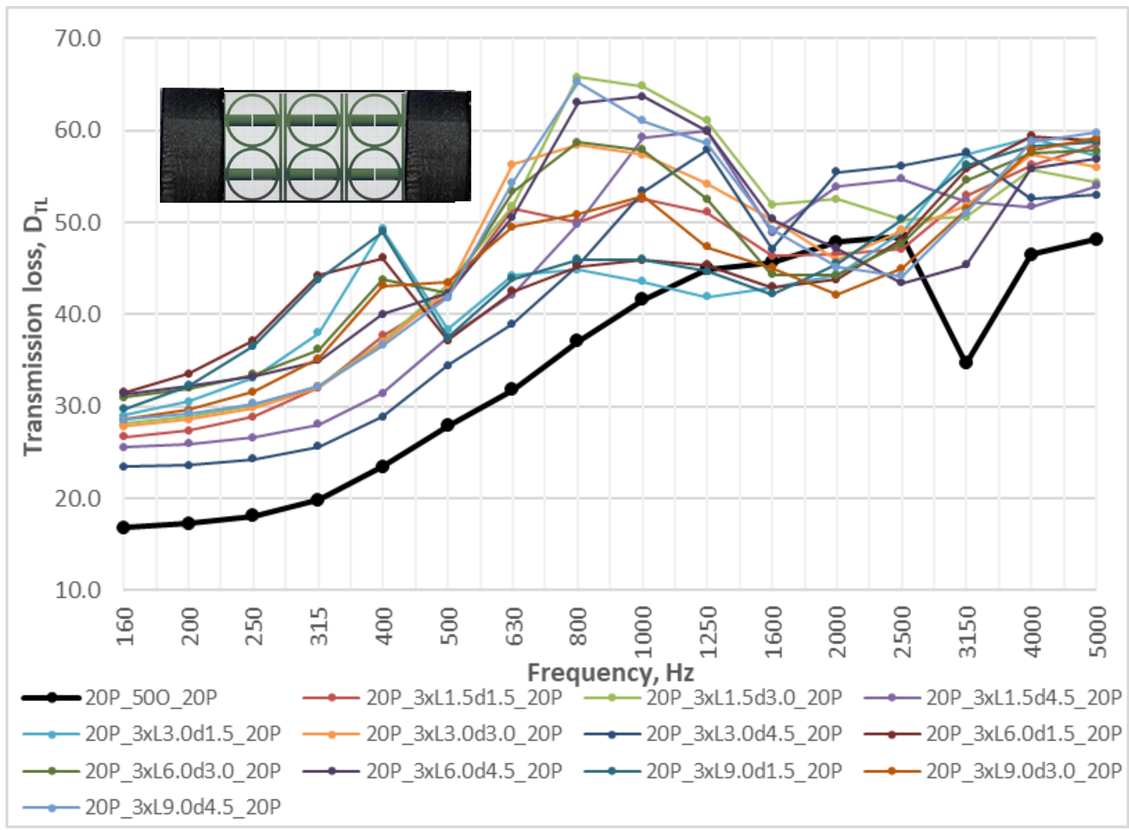
A system of four microphones and one load in impedance tube was used for the study of sound transmission loss.

$$TL = 20\log(\frac{1}{\tau})$$

## α and $D_{TL}$ measurement results




PET-G 3D printed acoustic metamaterials sound absorption coefficient (α)




Sound transmission loss ($D_{TL}$) of PET-G acoustic metamaterial systems with 20 mm ABS plastic plates (20P)