Dynamic mass density limits of acoustic metamaterials made of clamped elastic plates

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Organizing thin clamped elastic plates in a periodic structure appears to lead in some interesting acoustic metamaterial phenomenon such as negative or zero dynamic mass density. The aim of this study is to experimentally and theoretically characterize the propagation of sound waves in a one dimensional structured periodic array made of thin elastic plates. First we present an inverse method to retrieve the mechanical properties of the elastic plates by using the acoustic measurements of the reflection and transmission coefficients. Properties such as the Young modulus, the density, the loss factor and Poisson's coefficient are obtained. To do this characterization, a 4 microphones transmission tube is used, leading to the determination of the reflection and transmission curves versus frequency. An optimization process is then used between numerical results from the model and the experimental data. Once the elastic plates are characterized, we analyze the properties of a finite periodic array of such kind of plates, paying special attention to the different behavior of the system depending on the properties of the elementary building blocks. Due to the strong dispersion produced by the system, different regimes of values of the effective dynamic mass density can be obtained, from negative mass density to zero mass density. We analyze the consequences of such regimes in the propagation of sound waves through this periodic array.