

Acoustic metamaterials: opportunities for translation in medical ultrasound

The concept of metamaterials can be applied to acoustic waves in both fluids and solids. These are structured materials to give acoustic properties beyond those given by naturally occurring materials. In this talk, we will investigate how structured porous metamaterials can be utilized to engineer constitutive relationships, giving rise to a wide range of refractive indices from negative, zero to very large values. We can also use the same approach to tune acoustic impedance. An exciting avenue of the application of these metamaterials is acoustic subwavelength imaging. The fine details of an object, being stored in terms of evanescent waves, cannot propagate in free-space and sets the so-called diffraction limit in conventional imaging systems. By restoring the evanescent waves through structured porous metamaterials, the fine details can be transported to the image plane. In addition, the fine details originally carried by the evanescent waves can also be projected into far-fields for further processing with potential usage in non-destructive testing and medical imaging. Furthermore, we will also discuss how metamaterials can be used to introduce new constitutive terms in acoustic and elastic wave propagation. For example, an analog of electromagnetic bianisotropy, or Willis coupling, being proposed a few decades ago, can now be realized in the notion of acoustic metamaterials.