

## **Review of Various Types of Metamaterials with Unusual Properties**

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### **Abstract**

Metamaterials are rationally designed artificial materials composed of tailored functional building blocks densely packed into an effective (crystalline) material. While metamaterials historically are primarily thought to be associated with negative refractive indices and invisibility cloaking in electromagnetism or optics, it turns out that the simple metamaterial concept also applies to many other areas of physics namely the thermodynamics, classical mechanics (including elastostatics, acoustics, fluid dynamics and elastodynamics) and in principle also to the quantum mechanics. This lecture will review the basic concepts and analogies behind the thermodynamic, acoustic, hydrodynamic, elastodynamic/elastostatic, and electromagnetic metamaterials and differences among them. It will provide an overview of the theory, the current state of the art and example applications of various types of metamaterials. The review will also discuss the homogeneous as well as inhomogeneous metamaterial architectures designed by coordinate-transformation-based approaches analogous to transformation optics.