Metamaterials and their Applications

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Without doubt, 'wave' can be considered as one of the fundamental elements of nature, where its discovery and understanding, is considered one of the most astonishing achievements of mankind This is due to the fact that the wave is considered as the means of "recognition" and "communication" between elements of our nature. Living creatures communicate with each other through different forms of sound or pictorial waves. Although scientists have somewhat attempted to shed light on these waves by classifying them in different frequency bands, a concise understanding of the behaviour of these waves would only be possible upon interface with various media and if the structural properties of these media as well as the mutual interaction effects are examined.

In scientific terms, relationship between wavelength and structural unit-cell-size determines the behaviour of both wave and the media. Based on the available scientific facts and findings about waves, it is time to investigate the reciprocal effects of waves and media from a structural point of view. In other words, we envision conditions under which waves can be controlled appropriately by considering an intelligent design of a structure they traverse. The research shows that this has indeed become feasible by the "Metamaterials" technology. Metamaterials are artificial media or structures, thanks to their potential in providing controllable parameters, that can offer extraordinary properties not readily available in nature. In this paper we attempt to introduce metamaterial technology, and provide a general picture of its unique features and extraordinary applications (such as invisibility, miniaturisation, performance enhancement, etc.); and perhaps most importantly, shed light on the possibilities that metamaterial has opened to scholars in various fields.

Keywords: Metamaterials, Electromagnetics, Radio and Microwave Frequencies, Nanoplasmonics, Composite and Optical Metamaterials, Invisibility.

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