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Meta Material's Application and Advantage in Current Industries

Mr. Nandakumar Swami[1], Mr. Nilesh pawar[2]
HOD Mechanical Dept., Y. B. Patil Polytechnic, Akurdi[1]
Asst. Prof. D. Y. Patil College of Engineering Akurdi[2]

ABSTRACT

His paper discusses elementary properties of meta materials and its application. It additionally discuss the recent analysis activities on meta materials in numerous areas like antenna style, style of high frequency parts & devices, microwave engineering etc. The meta materials are designed media whose magnetic force responses are totally different from those of their constituent parts. Here general blessings of meta materials are known. The most analysis directions associated with meta materials are mentioned. During the past 10 years, an excellent interest within the research of meta materials has been discovered. Meta materials are artificially fancied materials that show the properties that are not detected in present materials. Meta materials exhibits negative permittivity and/ or negative porousness.

Keywords: meta materials, LHM, Antenna, Biosensor.

I. INTRODUCTION

The word „Meta" is taken from Greek whose that means is "beyond". "Meta materials" has the exotic properties on the far side the natural occurring materials. These are the materials that extract their properties from their structure instead of the material of that they're composed of. The primary and one among the most necessary contributions to the current topic was created in 1968 by V. G. Veselago who said that materials with each negative permittivity and negative porousness are theoretically doable [1]. In 1999, John Pendry known a practical thanks to build left-handed meta materials (LHM) which didn't follow the standard right hand rule [2]. He proposed his style of sporadically organized Thin-Wire (TW) structure that depicts the negative worth of effective permittivity [3]. It absolutely was shown that the structure has a low plasma frequency than the wave within the microwave regime. Because of its low Plasma frequency, this structure will produce a good negative permittivity at microwave frequencies. It was additionally incontestable that negative magnetic permeability can be achieved exploitation an array of split-ring resonators [4]. Later then, Smith incontestable a brand new LHM that shows at the same time negative permittivity and permeability and dole out microwave experiments to check its uncommon properties in 2000 [5]. Shelby et al showed negative refraction by experimentation for the primary time using a Meta materials with recurrent unit cells of split ring resonators (SRR) and copper strips [6-7]. wu et al projected 3 structures together with symmetrical ring, omega and S structure for SRRs [7]. Several researchers have worked on meta materials to extract their potential in numerous fields. This paper summarizes history of meta materials, its classification, advantages and applications.

II. Meta Materials Types

Electromagnetic Meta materials

Electromagnetic meta materials (EM) are the materials which have a brand new sub section inside electromagnetism and physics. EM is employed for optical and microwave applications like, band-pass filters, lenses, microwave couplers, beam steerers, and antenna radomes.

Double Negative Meta materials:

Double negative meta materials (DNG) are the meta materials that have each permittivity and porosity is negative with negative index of refraction. These

also are referred to as negative index meta materials (NIM)

Bi-isotropic and Bi-anisotropic Meta materials:

Primarily based on the freelance electrical and magnetic responses represented by the parameters permittivity and magnetic porosity, the meta materials area unit classified into single or double negative. However in several samples of magnetism meta materials, the electric field causes magnetic polarization, and the magnetic field induces AN electrical polarization, i.e., magneto electric coupling. Such media denoted as bi-isotropic media because it exhibits magneto-electric coupling that's anisotropic, and additionally known as a bi-anisotropic.

Chiral Meta materials:

When a meta material is built from chiral components then it's known as chiral meta material.

Single Negative Meta materials:

In single negative (SNG) meta materials either permittivity or porosity area unit negative, however not each. These area unit ENG meta materials and MNG meta materials mentioned below. Interesting experiments are conducted by combining two SNG layers into one meta material. These effectively create another type of DNG meta material. A block of ENG material and block of MNG material are joined to conduct wave reflection experiments. This resulted within the exhibition of properties like resonances, anomalous tunneling, transparency, and 0 reflection. Like DNG meta materials, SNGs are innately dispersive, so their permittivity å, porosity µ, and refraction index n, will alter with changes in frequency

III. Applications of Meta Material

Patch Antenna

There are numerous problems whereas we design a patch antenna like - compactness in size, gain improvement, radial asymmetry improvement, increased bandwidth, suppressed side lobes or back lobes. Meta materials are being employed for up the performance of typical patch antennas. Directivity and gain are often increased by mistreatment meta material as antenna substrate. If a supply is embedded in an exceedingly substrate with zero index of refraction, then per Snell's law, the exiting ray from substrate are terribly shut traditional to the surface. Then, all the refracted rays are in virtually constant direction round the traditional. Therefore, the nearer the operational frequency is to the plasma frequency, the higher directivity are often achieved. Enoch et al., had used meta material as substrate [6]. The layers of copper grids separated by foam were used as meta material. This meta material possessed the plasma frequency at concerning 14.5 GHz. Monopole antenna fed by a coaxial cable was used as a source of excitation and also the emitting a part of the monopole was around centered at the center of the meta material substrate. A ground plane was value-added to substrate. It had the best directivity at 14.65 GHz. Since the meta material features a plasma frequency at concerning 14.5 GHz, the index of refraction is getting ready to zero at this frequency. Per Snell's law, the refracted ray from the meta material are terribly getting ready to the traditional of it. Therefore he obtained the simplest directivity at 14.65 GHz.

Y. G. Ma et al., diagrammatical that the radial asymmetry of associate EM emission might be a lot of improved by embedding the supply in an anisotropic meta material with either effective permittivity or effective porousness nearly zero [7].

The distinction between this [7] and also the technique of Enoch et al., [6] lies within the problem of impedance couple between the ε-near-zero (ENZ) matrix and surrounding air. The meta material used was anisotropic with effective permittivity close to zero, allowing it to match the encircling media at the correct polarizations. By using the anisotropic slab, the emitted wave received in surrounding air exhibits the characteristics of plane wave same because the straight wave front parallel to the interface shows once it's propagating along ± x axis [7]. It had been shown that the high directivity are often supported by this anisotropic matrix.

R. Khajeh mohammad Lou et al., used 2 styles of meta material superstrates to increase radial asymmetry, gain and bandwidth. Radial asymmetry

improvement was supported zero index refraction development. The radiation energy of patch antenna is targeted close to zero index refraction

IV. OTHER APPLICATION

Meta materials applications are found in varied fields including public safety, sensor detection, high frequency battle field communication, improving supersonic sensors, solar power management, for top gain antennas and remote aerospace applications.

A. WMD Detectors

Army and air Force scientist use meta materials to sight the presence of chemical explosives, biological agents, and contamination. A similar structure and science is employed for cargo and screening rider.

B. Invisible Subs

The meta materials simply manipulate the wavelength of sound that is a lot of larger than lightweight. to form the submarine invisible to enemy sonar, it bends sound around it and this program is funding by naval research. Civilian spinoffs additionally use the meta materials to provide sound proofing rooms with perfect acoustics.

C. Revolutionary electronics

Army engineers use the meta materials as a switch device for building quick and tiny photonic instrumentation as a result of in future circuits makes with the use of light instead of electricity. To entice lightweight will be turned on and off a semiconductor combines with the meta materials within the device. These photonic chips are ten times quicker than this chips.

D. light and sound filtering

To control light or sound signals that improve ultrasound resolution and alter a material's color, nano scale wrinkles of Meta materials are used. These materials will be created with a multi-layer deposition method and high-precision. By employing a fraction of a wavelength every of the layer's thickness will be control. The precise wrinkles spacing scatters the chosen frequencies that created by compression the materials. These are employed in medical diagnostics, sound suppression and nondestructive material testing.

E. Biosensor

Biosensors are vital tools in several areas, like environmental observation, food safety and unwellness diagnostics in the investigation of biological phenomena's. In past the fluorescence-based ways were wont to prove it however recently Meta materials been utilized by researchers in bio sensing technologies as a result of its detection of label-free bio molecules and efficient value [5].

F. Meta materials absorber

A Meta material absorbent expeditiously absorbs magnetism radiation. Meta materials absorbers supply advantages over conventional absorbers like supplementary miniaturization, wider ability, and increased effectiveness [6]. To create a high magnitude relation of electromagnetic wave absorption, it needs effective medium style, permittivity and magnetic permeability

G. Superlens

A superlens uses Meta materials to realize resolution beyond the diffraction limit. The diffraction limit is inherent in conventional optical devices or lenses.

H. Clocking Devices

Meta materials are a basis for making an attempt to create a sensible cloaking device. The cloak deflects microwave beams thus they flow around a "hidden" object within with very little distortion, creating it seem virtually as if nothing were there at all. Such a tool usually involves encompassing the thing to be cloaked with a shell that affects the passage of sunshine near it.

I. Acoustic Meta materials

Acoustic Meta materials are unnaturally made-up materials designed to manage, direct, and manipulate sound within the kind of sonic,

infrasonic, or supersonic waves, as these may occur in gases, liquids, and solids.

J. Seismal Meta materials

Seismic Meta materials are Meta materials that are designed to counteract the adverse effects of seismal waves on manmade structures that exist on or close to the surface of the earth.

V. Meta Materials Advantages

A. directivity enhancement Meta materials has inherent property that controls the direction of no particulate radiation so as to gather the originating energy during a small angular domain around the traditional to the surface. A DNG material enhances the directive properties of associate antenna.

B. bandwidth improvement

Meta materials antenna increase achieved information measure as compared to the standard patch antenna. This is achieved by use of superstreet of meta mateial over conventional antenna or by loading of LHM.

C. Radiated Power improvement

A small antenna will increase the radiated power through the application of DNG Meta materials. little dipole antenna closed with DNG meta materials is use to extend the radiated power way more as compared to the conventional antenna.

D. Beam width and facet lobes

The meta materials antennas decrease the beam width and facet lobe ratio and so enhance the directivity and cut back the return loss of antenna

VI. CONCLUSION

Meta materials is that the new field of analysis, with none doubt it becomes an especially exciting analysis space. The researchers from multiple disciplines are being attracted towards Meta materials attributable to its distinctive magnetism properties. During this paper, a brief review of the history of Meta materials, a number of salient options, numerous varieties, applications and totally different modeling strategies of Meta materials have been mentioned. The Meta materials have resulted in surprising enhancements in electromagnetic response functions which will supply exciting prospects of future style of devices, elements and salient properties of Meta materials.

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