CHAPTER: 6

TYPES OF METAMATERIAL

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Depending upon the sign of permittivity and permeability, metamaterials are broadly classified into artificial dielectric, artificial magnetics and left handed materials. Chiral metamaterials are also the type of metamaterial which lacks mirror symmetry in its structure. All these types of metamaterial are discussed in detail below

1. Resonant Metamaterial

These metamaterial are made of resonant elements e.g. split ring resonator. Permittivity and permeability of these metamaterial have large dynamic range close to the resonant frequency. Small change in frequency causes the large change in permittivity and permeability of these metamaterial. Using resonant element large dynamic range material parameters can be designed, which is main advantage of these metamaterial. But these materials have high loss and narrow bandwidth near resonant frequency.

2. Non-Resonant Metamaterial

Theses metamaterial are constituted by non-resonating particles or elements e.g. I shaped elements. Permittivity and permeability of these metamaterials vary slowly with respect to frequency. These metamaterials have small loss and broad bandwidth. These are main advantages of these metamaterials, but using them material parameters can be designed in small dynamic range.

Basic types of metamaterial are given below:

1. Artificial dielectric

The metamaterial with negative permittivity in microwave and other regions can be generated artificially by arranging thin rods or cylinders resonator in cubic structure such that lattice constant of the structure and diameter of rods are small as compared to operating wavelength permittivity.

Figure 6.1: Electric coupled field

2. Artificial magnetics

These materials have negative permeability and positive permittivity and these are also called mu negative material (MNG). These materials show negative value of permeability below the plasma frequency. A stack of edge-coupled split rings (EC-SRR) displays negative permeability.

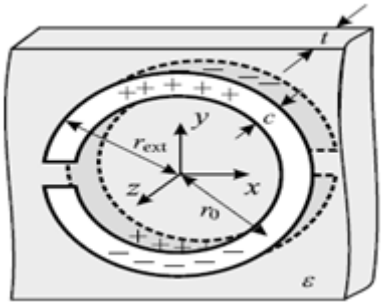

Figure 6.2: Broadside coupled split ring resonator

3. Negative index material

Refractive index is purely imaginary when either permeability or permittivity is negative and it results in evanescent waves. When permittivity and permeability are both positive then refractive index will be positive and it results in propagation of forward wave. When permittivity and permeability are both negative, the refractive index is negative and it results in propagation of backward wave. The materials with simultaneous value of negative permeability and permittivity are called Negative-index materials. These materials are also called left handed materials.

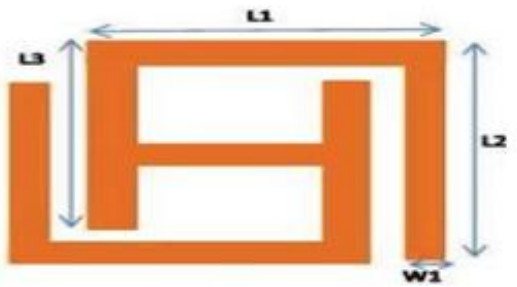

Figure 6.3: Negative index metamaterial

4. chiral material

These materials consist of particles which cannot be superimposed on its mirror images as shown in Fig. 6.4 These materials are different from metamaterials in which permittivity and permeability are both required to be negative for attaining negative value of refractive index. But in chiral materials negative refractive index can be achieved due to strong chirality without having the negative value of either permittivity or permeability or both .Refractive index n for chiral metamaterial.

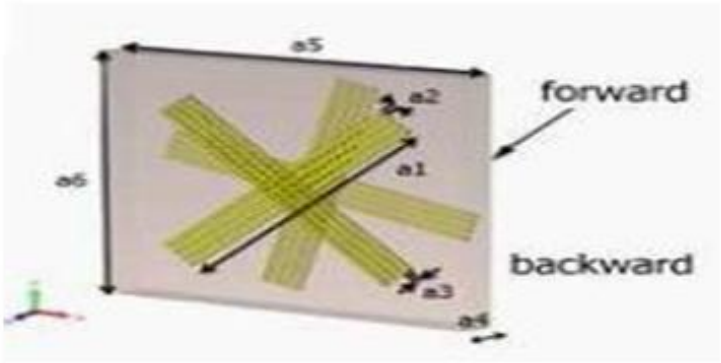

Figure 6.4: Chiral metamaterial

CONCLUSION

In previous years, this metamaterial technology mainly used four types of MTM like double negative MTM, single negative MTM which defines different characteristics to the design .now days different types of material tested for the antenna design to prove its negative characteristics.