CHAPTER: 4

CLASSIFICATION OF METAMATERIAL

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CLASSIFICATION OF METAMATERIAL

Fundamentally, the classification of natural and metamaterial (MTM) is based on the propagation phase constant (β) of the current flowing through the antenna element. The material is classified as natural if the value of β is greater than zero (β>0) other than The material is classified as MTM if the value of β is less than zero (β < 0) for a specific wave frequency band or zero at the non-zero frequency (β=0).[36] The right-handed (RH) material having ε > 0 and μ > 0 demonstrates the phase constant of wave propagation (β) to be a positive value (β > 0) and is termed as double-positive (DPS) material.

The single negative material such as like epsilon negative (ENG) having ε < 0 and μ > 0, and mu negative (MNG) having ε > 0 and μ < 0) exhibits phase constant of wave propagation is zero (β = 0, evanescent). The left-handed (LH) material having ε < 0 and μ < 0 demonstrates the phase constant of wave propagation to be a negative value (β < 0) and is termed as double negative (DNG) material. An RH material is well found in nature, whereas ENG, MNG, DNG materials are artificial and named to as MTM.

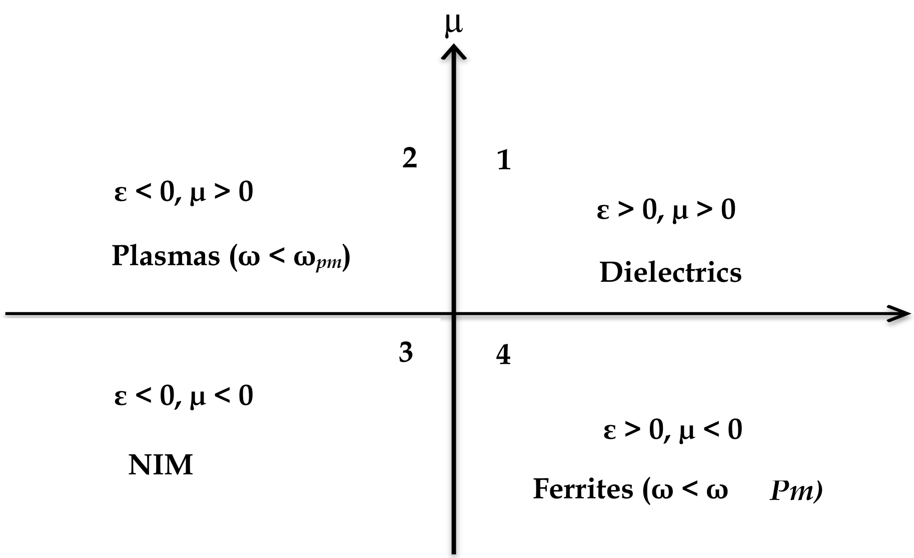

Figure 4.1: Classification of metamaterial

Table 4.2 - variation in parameter and performance due to different metamaterial technology over the years

MTM technique	f, GHz	max gain, dBi	Max Efficiency, %	S11 Band width, %	Size reduction, %	Dimension, $\lambda 0$	Year
SRR and CRLH-TL	3.30	5.4	74	14.1	-	0.277× 0.277× 0.033	2020
High refractive index	2.5	-1.4	-	-	45.7	0.41×0 .41×0. 13	2020
Elliptical shaped SRR	2.78, 6.02	-	83.33, 99.38	3.59, 25.41	-	0.259× 0.203× 0.014	2019
FSS	1.59, 1.96	-	-	-	-	0.042× 0.042× 0.0007	2019
RIS and partially reflective surface	5.85	12.5	-	24.3	-	1.55×1 .55×0. 11	2018
Compliment ary capacitively loaded loop	3	4	>95	8.1	79.5	0.15×0 .09×0. 007	2018
ENG-TL Complement ary concentric closed ring	1.16, 2.32, 3.58	1.59, 2.1, 4.97	73, 82, 95	8.54, 10.25, 35.75	-	0.11×0 .11×0.	2018

resonator						006	
CSRR and MTM slab	2.34	-0.6	84.2	5.3	56.7	0.23×0.23×0.009	2018
CSRR	1.8	7	-	-	48	0.97×0.73×0.009	2018
CRLH, SRR	1.62, 2.78	1.05, 2.59	98.5, 97.2	2.46, 1.07	51.9	0.162×0.108×0.008	2017
CSRR	7.5	4.7	82	120	-	0.23×0.29×0.015	2017
Meandered PIFA magneto dielectric nano composite surface	0.946	1.26	74.19	7.24	-	0.075×0.075×0.003	2016
ZOR	3.7	1.59	91.5	25.4	57.9	0.095×0.042×0.013	2015
ENG-TL	2.66	3.42	86.2	21.5	-	0.213×0.237×0.012	2015

CONCLUSION

The metamaterials structure design is within the sort of a unit or multiple unit cells assembled together into an array. Thus, the first step in designing the antenna MTM is to style and analyze the most factors affecting the resonance frequency, permittivity, and permeability of its building block. to boost the radiation properties of the antenna by using metamaterials, antennas are often placed above the reflector so as to radiate in one direction only, while reducing the rear radiation. during this case, the metamaterial isn't used as a medium but used as a tool, which is active substrate for the formation of plasma environment in MTM. The gap between the antenna and also the metal surface should be chosen for a minimum of $\lambda/4$, where the metamaterial acts as a reflective plane to spice up the radiation.