

Meta-material behavior of the new Coherently Radiating Periodic Structures (CORPS)

D. Betancourt, A. Ibáñez, R. García and C. del Río
Grupo de Antenas. Universidad Pública de Navarra. Dpto. IEE
Campus Arrosadía s/n, 31006 Pamplona, España
Phone: +34 948169326, E_mail: carlos@unavarra.es

Since Professor Veselago in the Sixties glimpsed the characteristics of Meta-materials (also called: Left Handed materials- LH, Double Negative Materials- DNG, Composite Right/Left-Handed Structures - CRLH, among others) few structures with left handed properties exist, that is to say, with negative ϵ and μ . These structures, e.g., Split Rings and Mushrooms widely have been studied in the last decade.

In this paper, the study of the new Coherently Radiating Periodic Structures (CORPS) like a Meta-material sets out. The shape of the structure under study is composed by two different layers, one layer is an array of square metallic patches and the other layer is an array of cross shaped slots. All the elements of each layer are placed in a rectangular lattice grid of λ_g , ensuring coherent coupling between elements of the same layer being this the main feature of the Coherently Radiating Periodic Structures (CORPS). To built up the whole structure, a total number of three layers (patches-slots-patches) are stacked and separated by dielectric slabs of either 10.2 or 1.0006 (air) of permittivity. The simulations were done using MoM and Finite Elements Method (i.e. Ansoft Designer and HFSS respectively).

The study of the structure begins analyzing the characteristics of each layer separately, obtaining the transmission parameters for the cross-shape Slots Array and two layer of Array of Patches. Also, in each one to identify the real part of ϵ and μ using the approach of Nicolson–Ross–Weir (NRW) [1] to find out the effective parameters of the structure for normal incidence. The same procedure is applied to the stacked structure made up of Patches Array with the cross-shape Slot Array in middle to form the complete Patch-Slot-Patch structure. As result is verified the existence of negative ϵ and μ parameters, as well as the existence of negative refractive index for a range of frequencies where additionally was found high transmission. Similarly, it is verify that the structure is electrically small (i.e. $K_{real} * d \leq 1$, where K refers to the parameters extracted by NRW method for a normal incidence and d is the size of the same one).

On the other hand, the structure is analyzed like a FSS with the same performance characteristics of a Coherently Radiating Periodic Structure – CORPS, in which the elements are separated approximately by λ_g and the periodicity in the horizontal plane assures that coupling (coherent in this case) between all elements in each layer of the structure, contributes positively to radiation in normal direction.

The applications of this novel CORPS structure go from satellite/terrestrial imaging systems, thanks to the possibility to define highly directive beams quite close each other; to Arrays when doing use of their qualities of periodicity, filtrate and coherently coupling.

References

- [1] R.W. Ziolkowski, "Design, Fabrication and Testing of Double Negative Metamaterials," IEEE Trans. Antennas Propagat., Vol.51,pp.1516-1529, July 2003.