

3D Printed mmWave Dielectric Resonator Reflectarray Antenna

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In this paper, we will present our recent progress in the design of additively manufactured (AM) millimeter-wave (mm-wave) reflectarray antennas (RAA). The reflection coefficient of distinct unit cell geometries will be characterized. By correlating the dimensions of the unit cell with their reflection phase response, the performance of the unit cells is used to realize an antenna array capable of producing an arbitrary radiation pattern. The resulting system has potential for use in applications such as 5G/6G communication, SatCom communication, and remote sensing.

RAA systems are relatively cheap to fabricate as they do not require the complex feeding network inherent to phased array systems. Furthermore, the RAA can be designed in planar or conformal geometries, while emulating the functionality of a parabolic reflector, or other complex electromagnetic structures. Therefore, cube satellite technologies are uniquely positioned to benefit from the design freedom offered by 3D printed RAAs operating in the mm-wave frequency regime. By integrating a high gain conformal antenna array into existing cube satellite systems, these antennas can meet the unique requirements of satellite communication while lowering cost, enhancing design freedom, and reducing the volume of the payload. Notably, the majority of reported RAAs are designed to operate in the microwave frequency band. Therefore, it is important to develop systems that are suitable for operation in the mm-wave frequency regime. In this paper, distinct reflectarray structures and their constituent unit cells are analyzed using fullwave electromagnetic solvers (e.g. CST).

Figure 1 shows a one-dimensional far field cut of a dielectric resonator reflectarray (DRRA) designed for operation at 100GHz. The phase compensation surface of the DRRA is fed by a 10dBi standard gain horn offset by 25 degrees from the optical axis of the unit cell array. This configuration reduces aperture blockage while incurring minimal degradation to the aperture efficiency. The focal to diameter (F/D) ratio is 0.94. The DRRA unit cells have a fixed diameter of 1.5mm and achieve a phase compensation range of 2π by varying the height of the unit cell as a function of its position relative to the phase center of the feed horn. During the simulation, the focal length of the horn is iteratively optimized to a value which correlates with the maximum gain of the secondary radiation pattern. Through this process the CAD design of a DRRA is produced which can then be fabricated by utilizing commercially available 3D printing systems.

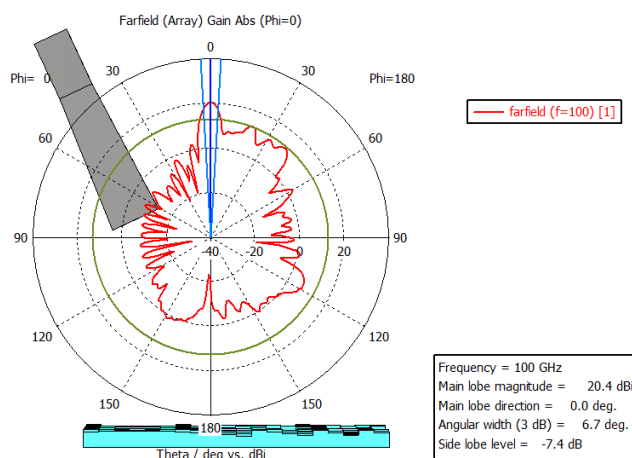


Figure 1. Simulated radiation pattern of the designed dielectric resonator reflectarray.