Design of additive manufactured Luneburg Lens working at W-band

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Luneburg lens is an attractive gradient index device for wide angle radiation scanning because of its broadband behavior, high gain and ability to form multiple beams. Every point on the surface of an ideal Luneburg Lens is the focal point of a plane wave incident from the opposite side. The refractive index distribution of a spherical Luneburg Lens is given by Equation (1):

$$n = \sqrt{2 - (\frac{r}{R})^2} \qquad (1)$$

where n is the refractive index, R is the radius of the lens and r is the distance from the location to the center of the sphere.

In this work, a 3-D printed Luneburg lens structure operates at W-band is designed. The required continuously varying relative permittivity profile is realized by controlling the filling ratio of a polymer / air based unit cell. A 2-cm diameter lens is designed to work at W-band. The effective permittivity of the unit cell is calculated by effective medium theory and simulated by full-wave finite-element simulation software ANSYS HFSS. Efficient and accurate fabrication of the designed 3-D lens is enabled by a polymer-jetting rapid prototyping technique. Since the refractive index of the lens is independent with frequency as long as the long wavelength condition holds (to guarantee the effective medium approximation), it could operate across a wide frequency range (i.e., 20 to 100 GHz). Compare to our previous 3D printed gradient index lens at X-band, a different unit cell structure is applied to avoid the small structure which is hard to print at high frequency. Figure 1 is a printed sample showing the center layer of the lens. This 3D printed W-band Luneburg lens antenna will be characterized and the results will be presented in the conference.

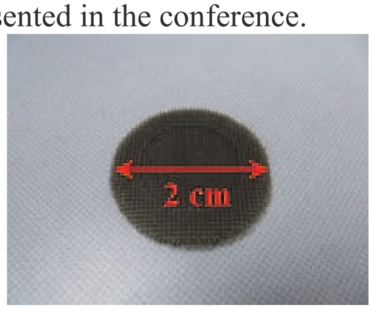

Figure 1. A printed sample shows the center layer of the W-band Luneburg lens fabricated using rapid prototyping technique.

This kind of 3-D lens antenna can be utilized in various applications including direction finding and low-cost electronic beam scanning. Compared to traditional Luneburg lens fabrication techniques, this additive manufacturing technique has advantages of lower cost and faster speed.