Design and fabrication of a light weight Luneburg Lens operating at X-band

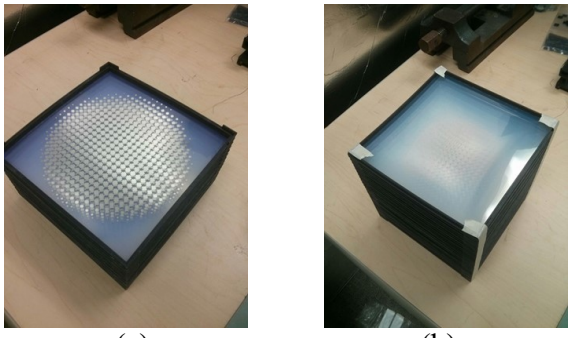
Min Liang and Hao Xin*
Department of Electrical and Computer Engineering, University of Arizona,
Tucson, AZ 85721 USA

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

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

where ε_r is the permittivity, R is the radius of the lens and r is the distance from the location to the center of the lens. Previously, a 3D printed Luneburg lens structure was realized by control the filling ratio between polymer and air [1]. Majority of the lens is made of polymer, therefore, its weight increases significantly when the size of lens becomes larger.

In this work, a light weigh Luneburg lens structure operates at X-band is designed and fabricated. Printed conductive ink with designed patterns on thin film dielectric substrate was used to realize the continuously varying relative permittivity profile. The effective permittivity of the unit cell is simulated by full-wave finite-element simulation software ANSYS HFSS. An ink jet printer was used to print the designed patterns on the dielectric substrate. A number of 3D printed supporting frames made of polymer were used to assemble the lens mechanically. Compared to our previous 3D printed Luneburg at X-band with the same size which has a weight of 500 g, the weight of all the thin film substrates is less than 20 g. Majority of the lens weight is from the supporting frames which is about 180 g. By replacing the frames with other lighter materials such as foam, the weight of lens can be further decreased. Fig.1 (a) shows a photograph of the cross-section cut through the center of the lens and Fig. 1(b) is the entire lens structure. We have characterized the performance of this light weight Luneburg structure and the measured results agree well with simulation. The measured results will be presented in the conference.



(a) (b)

Figure 1. Photos of the fabricated X-band light weight Luneburg lens. (a) The cross-section cut through the center of the lens; (b) The entire lens.