3D Microwave Eaton Lens Fabricated by Polymer Jetting Rapid Prototyping

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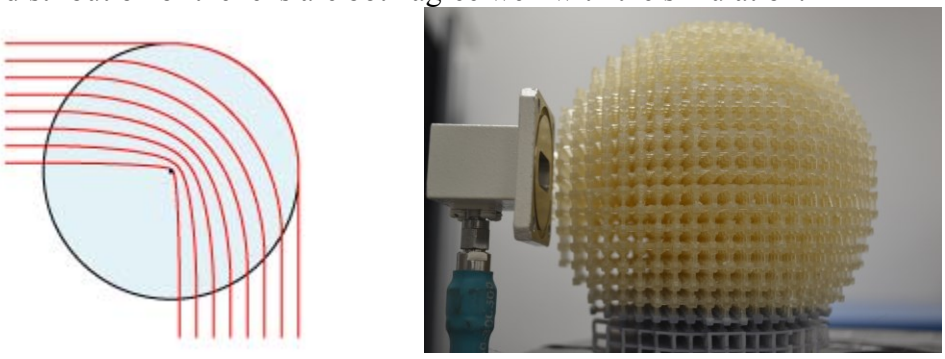
Eaton lens is a kind of gradient index (GRIN) device similar to Luneburg lens and Maxwell fisheye lens that the refractive index gradual varies spatially. It has some unique, enchanting properties that can be utilized in the design of antennas and radar targets. The refractive index distribution of a perfect Eaton lens that bends wave 90 degree satisfies (see Fig. 1(a) [1]):

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

In this work, we designed, fabricated and characterized a microwave Eaton lens structure using a rapid prototyping 3D printer. The required continuously changing of relative permittivity was realized by changing the size of polymer blocks centered on the junctions of a plastic rod space frame. A 120 mm ($4\lambda_0$ at 10 GHz) diameter lens is designed to work at X-band. The effective permittivity of the unit cell is calculated by effective medium theory and simulated with full-wave finite-element simulations. The center part of an ideal Eaton lens diverges to an infinite large refractive index which cannot be realized in practice. Instead, the center region is approximated by 100% filling of the polymer. A polymer jetting rapid prototyping method is implemented to fabricate the whole lens and the picture of the fabricated lens is shown in Figure 1(b). In the measurement, the lens antenna is fed by an X-band waveguide. The measured radiation pattern and near field distribution of the lens are both agree well with the simulation.



(a) (b)

Figure 1. Printed microwave Eaton lens using rapid prototyping technique: (a) Ideal beam of a 90 degree bending Eaton lens (b) The picture of the fabricated microwave Eaton lens.

[1] Martin Šarbort and Tomáš Tyc, "Spherical media and geodesic lenses in geometrical optics" Journal of Optics, Vol. 14, No. 7, 2012.