Subwavelength Resolution of Conical Fresnel Zone Lens

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Compared to the bulky and heavy ordinary lens the Fresnel zone (FZ) plate has the advantage of being thin, light and easy to manufacture. The ordinary lens, however, has a broadband and effective focusing. For a better FZ lens efficiency the next techniques are employed: subzone phase-correcting, curved (3D) zone surface or both put together. Here the second technique is illustrated in a Conical Fresnel Zone (CFZ) lens of Metal rings (Soret-type CFZM.ν.α lens), and both techniques are applied in a CFZ lens of Dielectric rings (Wood-type CFZD.ν.α lens) rings, where ν is the number of rings and α is the cone half-opening angle.

Both FZ lenses are designed at the low-THz frequency of 229GHz (wavelength λ=1.31mm) for a focal length F=30mm and roughly the same lens diameter $D=2R_v$~25mm. The lens half-wave flat rings are located on a truncated-cone surface and illuminated by a plane wave as shown in Fig. 1. For a specified ν, λ, F and α, the zone radius R_v and axial coordinate Z_v are easy calculated. With the change of α from 90^0 to 25^0 the length of CFZM.ν.α lens and the size of its focusing spot vary significantly. The focusing gain G, transverse and axial resolutions ΔX,Y/λ and ΔZ/λ of several CFZ lenses and a plano-hyperbolic (PH) lens with the same F and D are listed in Table 1. The lens focusing field is studied by use of precise computer simulation software.

Table 1 Main focusing parameters

Lenses	G (dB)	ΔX/λ	ΔY/λ	ΔZ/λ
PH	20.9	1.45	1.45	11.07
CFZM.2.90	13.7	1.30	1.33	9.10
CFZM.3.45	15.8	**0.97**	**0.96**	3.63
CFZD.3.45	21.0	**0.88**	**0.94**	4.14
CFZM.5.30	16.5	**0.59**	**0.72**	1.68
CFZM.8.25	17.3	**0.45**	**0.72**	**0.92**

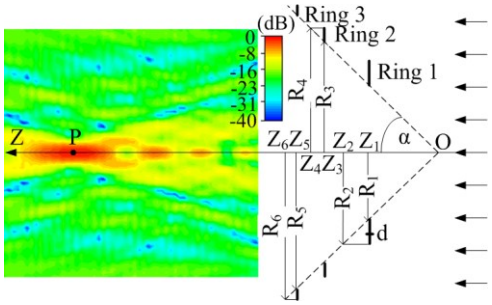

Figure 1 Focusing of CFZm.3.45 lens

Conclusions: (1) Decrease of α from 90^0 to 25^0 leads to CFZM lens gain growth from 13.7 to 17.3 dB; (2) CFZD.3.45 lens matches in gain the ordinary PH lens, and surpasses the CFZM.3.45 lens by 5.2 dB and CFZM.2.90 planar lens by 7.3 dB; (3) Decline in α produces important imaging effect: small transverse (ΔX/λ and ΔY/λ) and axial (ΔZ/λ) ratios are obtained, which correspond to a big space resolution (Table 1: values in **bold**). CFZM.8.25 lens has a unique **3D subwavelength** resolution.

Applications: The studied CFZ lenses can be applied in microwave and THz focusing and imaging systems, and for a construction of light and effective FZ lens antennas.

(This work was helped by the Chilean CONICYT ACT-53 and Fondecyt 1120714 projects)