A Metal Mesh Flat Prism For MM-wave Applications

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***Abstract*— By using the previously unwanted dispersive properties of metal mesh artificial dielectrics, we propose a novel design for a flat prism. This is a device that steers an incident plane wave by a given angle based on its frequency. This is achieved by using existing graded index theory and further understanding of the dispersion effects in metal mesh grids. Such a device would act as an alternative to diffraction gratings and operate over the frequency range of 100-200 GHz.**

I. INTRODUCTION

It has recently been show that a metal mesh grids can be used to create various graded index flat lenses [1][2]. The geometry of the grid can be varied to give a range of different refractive indices, as well changing the symmetry of the structure to induce birefringence. These devices have been designed and shown to have good broadband performance. This is due to the fact that in their operating frequency range the refractive index does not change with frequency. However, there is a region where these structures become highly dispersive, that is there is a variation in the refractive index with frequency. In this abstract we propose a novel flat prism design that exploits this behavior in the structure.

Such a device could be used as an alternative for a diffraction grating in applications where maximum detected power needs to be conserved since it will only steer the beam and not diffract it.

II. DESIGN

To be able to design such a device, the exact dispersive behavior must be found for each structure. Designing a metal mesh artificial dielectric is well understood [3], but this does not consider the dispersion that occurs at higher frequencies. This can be accounted for by considering the structure as a 1d photonic crystal [4]. By using an equivalent circuit approximation to give the ideal admittance of a given grid, an analytic expression can be given which describes how the refractive index changes with frequency. Figure 1 shows this behavior for a single structure. As it can be seen at lower frequencies, there refractive index is constant, while at higher frequencies it changes more rapidly before the cutoff of the structure occurs. This is the region such a prism will be designed to operate.

The ideal prism design is based on a linearly graded index slab. It has been shown [5] that depending on the gradient of the slab, an incident plane wave will be refracted by a given angle. If this were designed using similar geometry as before, it would be possible to have a broadband beam deflector.

For it to operate as a prism, the deflection angle and the thus the index gradient has to change as function of frequency. This can be achieved by adjusting the geometry so that the frequency region of interest is now in this dispersive region.

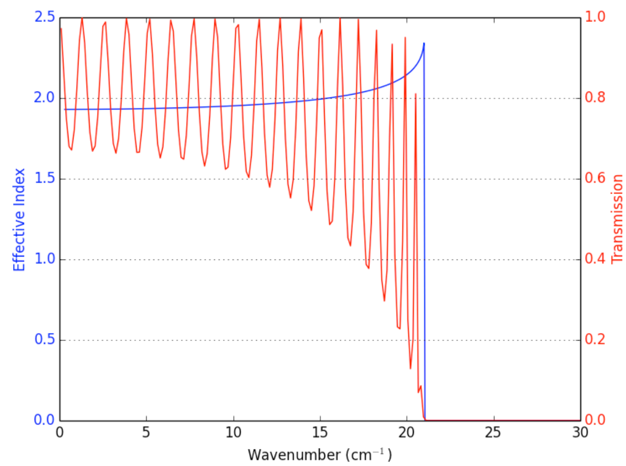

Figure 1 Comparison of transmission profile and equivalent effective index for a given structure.

This means that for a given frequency, an incident wave will each see a different gradient and thus be deflected by a given angle.

A parameter space can be performed to find the optimal geometry configuration that will give the required deflection.

III. CONCLUSION

We have outlined a process in which the previously unwanted dispersive effects of metal mesh artificial dielectric can be exploited to produce novel mm-wave prism. A design is currently being finalised and a prototype will be fabricated shortly.

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