Periodic metallic surfaces: boundary conditions improvement assuring guided TEM propagation

R. Pierre, B. Gralak, G. Tayeb, and S. Enoch,
Institut Fresnel-CNRS (UMR 6133), 13397 Marseille cedex 20, France.

Due to convenient properties, phased-array antennas are now required in microwave telecommunications for space, naval or research-oriented usage. Each antenna has to emit a canonical signal: we are interested in generating a quasi-plane wave while exciting a TEM mode in a rectangular waveguide which is forbidden by physics in the case of metallic walls.

Although, the difficulty should be overcome using periodic structures as guiding walls. Among the surfaces matching the desired conditions, the so-called hard surfaces seem to exhibit adequate properties: partially made of metal and under particular incidence and frequency, they tolerate a tangent electric field without phase reversal at reflection.

But, still, the design of rectangular hard horn antennas is difficult since the available bandwidth for emission remains narrow. The challenge is to get pure metallic and thin devices compliant with large bandwidth feeds. It appears that a good understanding of the near field behaviour is crucial in order to make advances in this domain. In fact, most of published works rely on the phase of the reflection coefficients of an impinging plane wave and do not pay attention to the contribution of evanescent waves. Therefore, a new approach involving modal and fictitious sources methods will show how evanescent modes are needed to realize the required boundary conditions.