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REFLECTION POLARIZERS

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Corrugations in a conducting surface can totally polarize the reflected wave for arbitrarily polarized incidence. It is well known that the right-angled echelette grating will do this for TE polarization only, when the period $d/\lambda = 1/(2\sin\theta_i)$, where θ_i is the angle of incidence from the normal and λ is the wavelength. Then the TM polarized component of the incident wave is wholly backscattered when the groove depth is $h/\lambda = 1/(2\cos\theta_i)$. The same effect can also be achieved with rectangular groove corrugations [1], [2] but now either TE or TM or both polarizations may be eliminated from the reflected wave. The former arrangement may be used to provide a polarization pure antenna beam, the latter in the design of radar targets which totally backscatter the incident wave or in the reduction of multipath interference.

The easiest way to achieve total reflectivity of TE polarization from rectangular grooves is to make the groove widths less than $\lambda/2$. Total backscatter of TM polarization will occur with the period satisfying the above Bragg condition and with an appropriate groove depth. For very thin slots this depth is approximately $\lambda/4$, as shown in Fig. 1. Wider slots require shallower grooves, particularly for incidence near grazing, have less critical tolerances and are consequently effective over a broader range of incident angles and frequencies.

Fig. 2 shows the predicted and measured reduction in TM polarized specular reflection from a surface with groove width to period ratio $a/d = 0.25$ and $h/\lambda=0.21$ designed for complete TM backscatter at $\theta_i=64.25°$. The predicted curve is for plane wave incidence on an infinite surface. Measured values are for a $31\lambda \times 13\lambda$ brass surface with 56 corrugations and 9° beamwidth transmitting and receiving horns at 1.4 m. from the surface at $\lambda=8.6$ mm. Here corrugations reduce TM polarized specular reflection by about 30dB at the design angle, while TE polarization is essentially perfectly reflected.

Effects similar to those of Fig. 2 have been observed with fewer corrugations [3]. Numerical results recently obtained by Facq [4] for TM-polarized scatter from finite near-optimum rectangular groove surfaces show a reduction in diffraction efficiency from 99% for an infinite surface to 96% for one with only 5 grooves. Thus relatively few corrugations are needed for effective polarizers.

Pure TM polarized specular reflection requires a surface with grooves sufficiently wide to admit the TE_1 mode ($a>\lambda/2$). A design for $\theta_i=45°$ ($d=0.707\lambda$), for example, has $a/d=0.754$. When $h/\lambda=0.96$ TE polarization is totally backscattered and TM polarization totally reflected. The rather deep groove will tend to restrict the bandwidth and effective angular range. Experiments at 35GHz are being made with this surface profile.

Reflection-type circular polarizers having periods much less than $\lambda/2$ are also being investigated with the incident wave linearly polarized at 45° to thin metal vanes on a conducting sheet the TE component is reflected from the tips of the vanes and, in principle, the TM component delayed by 90° if the height of the vanes is $\lambda/8$, resulting in circular polarization. However a rigorous numerical solution shows a phase delay in the TM component of less than 90°. The correct depth for both thin vanes and rectangular corrugations is being determined.

References:

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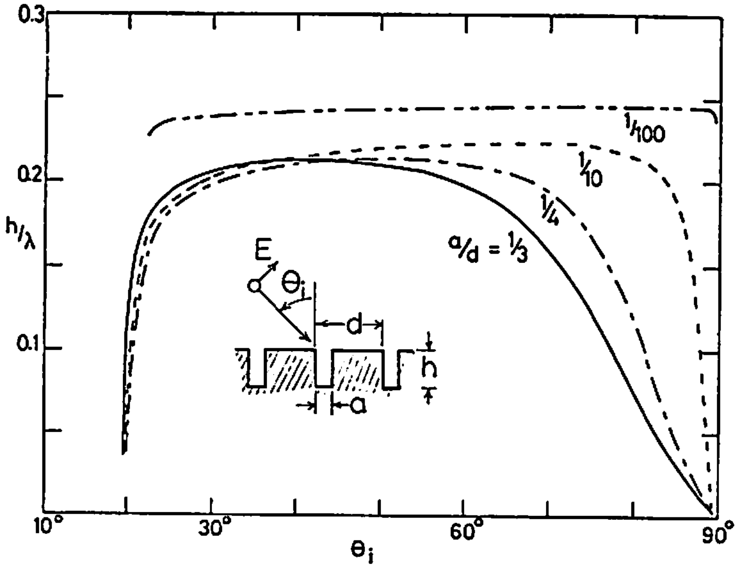

Fig. 1 Corrugation depth h vs. angle of incidence θ_i for total TM polarized backscatter from rectangular groove surfaces with $d/\lambda=1/(2\sin\theta_i)$

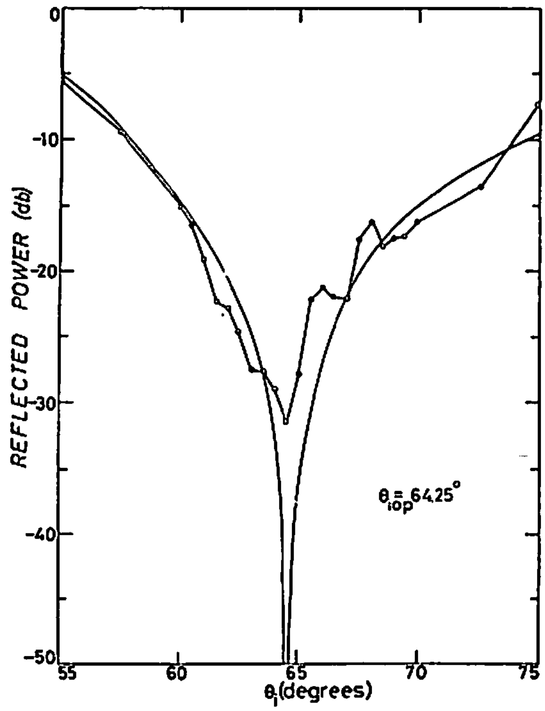

Fig. 2 Reduction of TM polarized specular reflection by rectangular grooves in a conducting surface with λ=8.57 mm. with d=4.75 mm., a=1.20mm. h=1.78mm. ——— predicted o–o–o measured (31λ x 13λ surface with 56 grooves)