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PROPERTIES OF ELECTROMAGNETIC PULSE SCATTERING FROM A GROUNDED DIELECTRIC SLAB AT POLARIZING INCIDENCE

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The inverse problem of scattering of an idealized electromagnetic square pulse from a lossy dielectric slab mounted on a perfectly conducting planar surface is investigated.[1] A convenient method for the identification of uniformly coated scattering bodies may employ the application of pulse scattering, since more information can be obtained by such a transient analysis than from the steady state treatment.[2] The distortion of a pulse returned from a scattering obstacle, in fact, does yield some additional information pertaining to the properties of the scatterer. For example, the behaviour of the leading wavefront of a scattered pulse usually displays characteristics of the composition of the body, whereas the behaviour of the trailing return of a scattered pulse is related to the shape of the body and its radii of curvature.[2] The solution to the problem is best facilitated by a Laplace transform approach, since it is defined for a wider class of functions, satisfies the causality conditions, and lends itself to the treatment of more general source dependence. The wavefront technique[3] is incorporated, where the amplitudes of the individual wavefronts are given by the corresponding terms of the expanded c.w. scattering coefficients. The field behaviour in the vicinity of the individual wavefronts can be obtained by considering the asymptotic behaviour of the transform of the field vector for large values of the complex frequencies.

Since the general problem of pulse scattering from a lossy dielectric layer is considered, the field scattered can be obtained by summing the contributions due to the various optical rays associated with the obstacle. The total reflection coefficient is determined separately for the TE and the TM cases employing either the equivalent transmission line concept or the summation procedure of phase-delayed partial reflection coefficients. Particular emphasis is given to define these partial reflection coefficients, which are characterized by a delay factor. These delay factors depend on the geometry and the characteristics of the composition of the scatterer. Also, these delay factors take care of the proper time delay and the dispersive effects of the medium. The result obtained is verified theoretically and experimentally and it is shown that the causal partial wavefront expansion of geometrical optics is satisfied.[4]

The closed form solution of the inverse Laplace transform of the continuous wave partial reflection expansion is presented for the general lossless case of oblique incidence. Whereas, for the slightly lossy and the pronounced lossy cases the closed form solution is given only for normal and polarizing incidence. The results obtained are a definite improvement over those of Brown.[3] The theoretical results indicate that the merits of such a non-steady state inverse scattering approach are, however, restricted to the slightly lossy case. Namely, it is evident from the results obtained that only for the slightly lossy case can the depth and constitutive parameters be obtained from the sampling oscillograms of the pulse returns.[1]

The particular novelty of this treatment is the striking result obtained for polarizing incidence. It is shown that for the lossless case, there is only one single pulse return for polarizing incidence, which is the first internally reflected pulse. For the slightly lossy case almost similar results are obtained, though the first externally and second internally reflected pulse returns will distort the sampling oscillogram. These phenomena are verified by preliminary experimental verification.

Although the presented investigation may be of limited use to the general inverse problem of scattering, it does, however, add another real parameter of analysing properties of dielectrically coated conducting bodies. Such methods are warranted for the determination of the finer structure of the material decomposition of scatterers.[2]

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References

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