THE DESIGN OF ATTENUATION FILMS IN KA-BAND

Xu Nien-Zeng

Vice-chairman of the Committee of Society of Microwaves, CIE. Chief Engineer of SRIMT. P.O. Box 5321 Shanghai, China

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Abstract
The inherent deviation between measured and theoretical values of attenuation $A(\text{db})$ and rotary angles are caused by using the substrate with attenuation films, depending on the theory of attenuation and transmission property of fundamental mode $TE_0^1$ in cylindrical waveguides. This paper also discussed the phase problem. According strictly to the wave equation and Poynting's vector, the relation between $A(\text{db})$ and the surface resistance has been deduced. These three main parameters have exact formulas. Some assumptions whose exactitude really exist are based on precise constants and it is thus unnecessary to consider the polarization.

We have designed and fabricated Ka-band attenuation films with the method mentioned in this paper. The measurement results are very good.

The author has not yet found other papers reporting the design of attenuation films.

I. Introduction
The design of the attenuation film is critical in the millimeter wave band, for it finds a wide application in the feed system of signal transmission. As a major component in the attenuator, the attenuation material with correct resistance is also used in precision polarized phase shifters,
wide band detector, precision matched loads, standard dismatched loads, cross mode coupler, as well as other instruments that require an attenuation of the electro-magnetic strength.

The max. attenuation, attenuation accuracy, frequency response, power capacity and insertion V SWR of the attenuator largely depend on the optimal design of the resistive film. The formulae derived in the paper have been used in the design of a precision phase shifter's attenuation wafer, the load of a wide-band detector and ridge wafer of a totally-matched adjustable load. It proved to be high successful.

In the design of a Ka-band precision attenuator, the mathematical models for max. attenuation, transmission error and additional phase shift was derived from transmission coefficient of field vector through polarized degenerate. The ratio between the loss of the resistive film, and the Poynting's vector area integration of the base mode along the axis derived from the field equation of the working mode may be used for working out the calculation formula of resistance R(ohm) per film area, and frequency response expression. From the concept of impedance match and spherical phase front match, we can also obtain the curve equation of transit waveguide tapering cross-section and according by the mathematical equations for the transmission coefficient of possibly excited high order modes and conversion from base mode to higher modes, its attenuations are derived.

The matching error, installation error may result in residual polarization component in polarized degenerate mode in cross attenuation. It is known as "zero drift". A mathematical expression of minimum eccentricity and smoothness of the circular waveguide is put forth to eliminate such zero drift. The other factors effecting the accuracy are accuracy of reading mechanism and the accuracy of transfer chains.

It is recommended to have a detailed analysis of all these factors in the design process if possible with the aide of a computer. The subject in this paper is just one of them -- the design of widely used resistive film.