ACCURACY AND LIMITATIONS OF MICROWAVE CAVITY PERTURBATION THEORY

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Cavity perturbation theory has been applied extensively in determining the complex permittivity of lossy dielectric materials at microwave frequencies. In practice, the accuracy of the results obtained is limited by two main factors. One factor relates to approximations made in applying the perturbation formulas. The other factor is associated with uncertainties in experimental measurements of resonant frequency and quality factor of the empty cavity and of the cavity containing the sample. Judgments about conditions under which cavity perturbation theory yields acceptably accurate results have. been based largely on qualitative reasoning and intuition in most earlier wok.

In the present study wc assess the accuracy of cavity perturbation theory quantitatively with the aid of an exact theory in which Maxwell's equations arc solved analytically for' a cylindrical sample extending along the entire axis of a cylindrical cavity. The results are discussed within the context of optimal application and inherent limitations of cavity perturbation theory. A new analytic approach that yields simple pertubation formulas with improve.d accuracy and greater range of applicability is proposed. Such for mulas are needed for example in treating larger samples and certain low loss materials. [Work supported by NASA].