Review of: "Corrections of Common Errors in Current Theories of Microwave Absorption Caused by Confusing Film and Material"

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The authors present an inventory of misinterpretations and sometimes incorrect applications of the theory of power absorption of microwaves by a film. This is an important subject in the context of electromagnetic interference shielding, among other fields.

The subject is treated in textbooks [a,b], and excellent reviews are available [c]. In spite of the abundant literature devoted to the optical properties of films, the interpretation of, for instance, impedance matching conditions may remain somewhat tricky. In addition, as pointed out by the authors, counter-intuitive wave phenomena (see e.g., ref. [d]) may complicate the interpretation of results.

Liu and Drew's paper aims at drawing the attention of the readers to some misuse of terms and possible hidden difficulties. Most common errors underlined by the authors come from the confusion between material parameters and the actual electromagnetic properties of the film in its environment.

The theoretical background the authors have used exploits the analogy between the optical properties of planar multilayers and the electrical properties of a two-port network. It is recommended that the authors illustrate some points of their development by referring to formulas that are more familiar to members of the photonics community than the electrical properties of transmission lines can be. In normal incidence, the surface impedance of a film of thickness d on a thick substrate with index of refraction n_L is [b]

$$Z_{in} = Z_M \frac{Z_L + jZ_M \tan\phi}{Z_M + jZ_L \tan\phi}$$

where $Z_M = Z_0/\sqrt{\epsilon_r}$ (for simplicity, we have set μ_r=1 everywhere), $Z_L = Z_0/n_L$ is the impedance of the thick substrate (load impedance) and $\phi = k_0 d\sqrt{\epsilon_r}$, $k_0 = 2\pi/\lambda$.. The above formula includes all the cases discussed by the authors. Choosing the load impedance such that $Z_{in} = Z_L$ demands $Z_L = Z_M$, which corresponds to the substrate being the same material as the film. Therefore, Z_M is the impedance of the interface between vacuum and the material the film is made of. In the case of a perfect conducting substrate ($Z_L \to 0$), $Z_{in} = jZ_M \tan\phi$ is the reflection loss RL introduced by the authors, which indeed depends on the film thickness through the argument of the tangent function. This trigonometric function contains all the interference effects between the beams within the film of the Fig. 1 from the authors.

The few expressions introduced here above are valid in normal incidence. As the authors are aware of, but do not mention explicitly in their paper, things become more cumbersome in oblique incidence, see Ref. [c].

The paper of Liu and Drew is interesting though its content and by the survey of recent publications it relies on. The message the authors address to the readers is important, especially in view of the increasing effort to design perfect and broad-band absorbing metamaterials in the microwave domain. The paper is therefore worth being published.

References

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