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Scattering by a set of dielectric cylinders on a biological multilayer

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Over the next few years, implantable and wearable devices will be used for remote health monitoring and other applications, but, due to the high absorption of electromagnetic field in human tissues, the development of these devices for 5G systems at millimeter waves is challenging. In [1] we have presented the analytical solution to the scattering problem of a far-field source by perfectly conducting targets above a semi-infinite lossy medium, with the aim of studying the effect of metallic embellishment objects that can be inserted in dresses worn by people or patients, when wearable or implantable devices are used. Different configurations were analyzed to study possible intensification or shielding effects of the electric field, both at frequencies 2.4 GHz and at 24 GHz.

In this contribution, we present a successive study in which we consider a more realistic structure [2]. The geometry of the scattering problem is described in Fig. 1 (a), where *N* dielectric cylinders are placed on top of a multilayer structure representing, for example, a layer of cotton, above a biological medium, modelled as skin, fat and muscle layer (insert of Fig. 1 (b)). The plane-wave source is expressed through expansions into cylindrical waves, solving the scattering problem with the Cylindrical Wave Approach (CWA). We demonstrate that a set of dielectric cylinders worn on a textile fabric can focus and intensify the electromagnetic field in the underlying region, as shown in Fig. 1 (b), where the magnitude of the total electric field at the interface vacuum-cotton, in the middle of the skin and in the middle of the fat layers, are reported. This study is of interest in applications involving wireless power transfer for biomedical applications, e.g., remote health monitoring via small implantable or wearable devices.

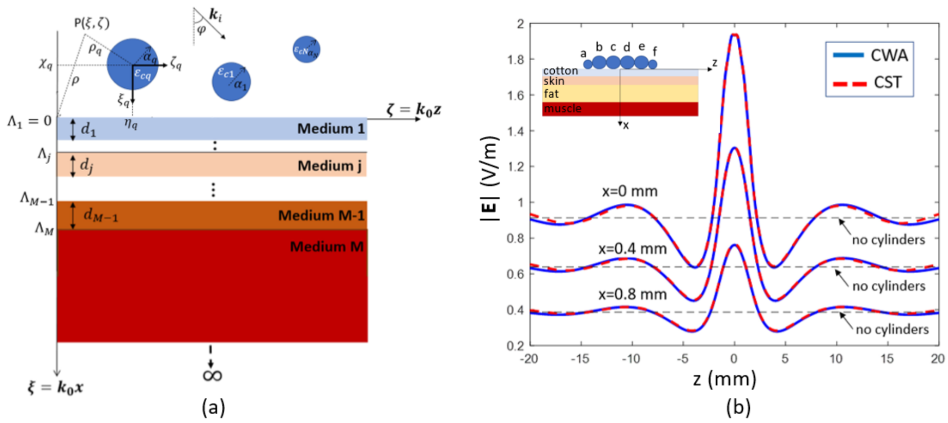

Figure 1. (a) Geometry of the scattering problem; (b) Magnitude of the total electric field along three different levels within the multilayer structure shown in the insert. Comparison between Cylindrical Wave Approach and CST Microwave Studio; $\varphi = 0, f = 24$ GHz.

1. C. Ponti, L. Tognolatti, and G. Schettini, “Electromagnetic Scattering by Metallic Targets Above a Biological Medium With a Spectral-Domain Approach,” *IEEE Open Journal of Antennas and Propagation*, vol. 2, pp. 230-237, 2021, doi: 10.1109/OJAP.2021.3057138
2. L. Tognolatti, C. Ponti, and G. Schettini, “Use of a Set of Wearable Dielectric Scatterers to Improve Electromagnetic Transmission for a Body Power Transfer System,” *IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology*, 2021, in press, doi: 10.1109/JERM.2021.3131286