Polarization dependent coupling and screening effects of a set of on-body scatterers

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The evolution of Wireless Power Transfer (WPT) systems has revolutionized the world of wearable and implantable technologies. These devices, of increasing impact in our daily lives, necessitate a robust and efficient power source to ensure optimal operational performance. One of the fundamental aspects for improving the performance of such devices is the optimization of electromagnetic transmission. Amplifying the electromagnetic field intensity can be advantageous in various contexts. At the same time, it may be of interest to consider protection against excessive penetration of electromagnetic power inside the human tissues. Shielding the electromagnetic field within tissues, particularly in a WPT system, can offer several benefits, primarily in terms of safety, efficiency, and reliability. It can addresses concerns related to electromagnetic interference, potential health risks, and environmental impact, contributing to the overall reliability and effectiveness of the technology.

In [1] the electromagnetic transmission in a WPT system has been modelled using an analytical approach based on the scattering of a plane-wave by an array of dielectric cylinders over a multilayer. The source of the scattering problem is a plane-wave and the dielectric cylinders simulate simple, ad-hoc designed, objects that can be easily located on textile fabrics worn by a person or a patient, in order to increase the power transfer to a wearable/implantable device. In this contribution, we propose our method extended also to the case of conducting scatterers providing several solutions to improve electromagnetic transmission to an implantable/wearable device or to obtain shielding effects. The geometry of the scattering problem is sketched in Fig. 1. The frequency considered in this contribution is $f = 2.45$ GHz. The relative permittivity and the loss tangent of the biological tissues are: skin $\varepsilon_r = 38$ and tg$\delta = 0.28$, fat $\varepsilon_r = 5.28$ and tg$\delta = 0.14$, muscle has $\varepsilon_r = 52.79$ and tg$\delta = 0.24$ [2]. Our analytical method allows determination of the field scattered by the cylinders in each medium through expansions into cylindrical waves, expressed through plane-wave spectra (CWA, Cylindrical Wave Approach). Numerical results, showing how intensification or shielding effects depend on the polarization of the source, will be shown at the conference.

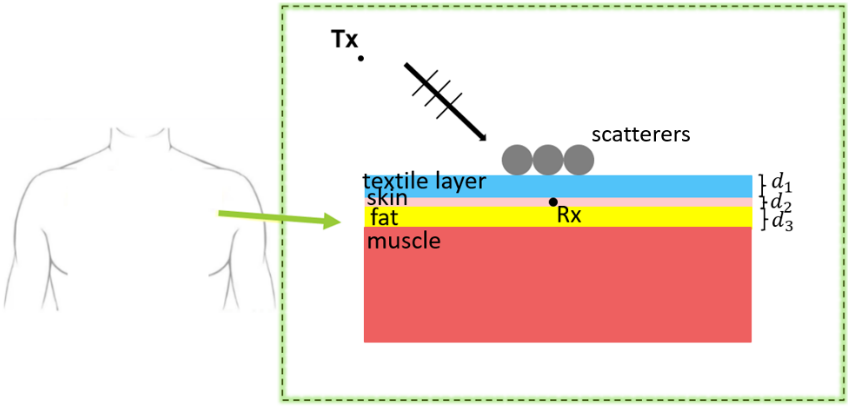

Figure 1. Geometry of the problem

References

[1] L. Tognolatti et al., "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*, vol. 6, pp. 280-286, 2022.

[2] S. Gabriel, R. W. Lau, and C. Gabriel, "The dielectric properties of biological tissues: II. Measurements in the frequency range 10 Hz to 20 GHz," *Phys. Med. Biol.*, vol. 41, no. 11, 1996, Art. no. 2251.