Potential Risks to Human Health Originating from Future Sub-MM Communication Systems

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In the near future, applications will come on line that require data transmission in ultra-high rates of 100 Gbit per second and beyond. In fact, the planning for new industry regulations for the exploitation of the sub – THz band are well advanced under the auspices of IEEE 802.15 Terahertz Interest Group. One aspect of this endeavor is to gauge the possible impact on human health by the expected explosion in commercial use of this band. It is, therefore, imperative to estimate the respective Specific Absorption Rates (SARs) of human tissues.

In the interaction of microwave radiation and human beings, the skin is traditionally considered as just an absorbing sponge stratum filled with water. This approach is justified when the impinging wavelength is greater than the dimensions of the skin layer. However, in the sub-THz band this condition is violated. In 2008, we demonstrated that the coiled portion of the sweat duct in upper skin layer could be regarded as a helical antenna in the sub-THz band. The full ramifications of what these findings represent in the human condition are still very unclear, but it is obvious that the absorption of electromagnetic energy is governed by the topology for the skin and its organelles, especially the sweat duct.

An additional factor comes in to play when it is realized that the Sympathetic Nerve Response controls sweat gland activity and this activity affects the reflectance, *R*. Our findings suggest the possibility of a direct reading of the human mental state with all that this implies. These considerations, coupled with the view that the interaction of the sweat duct with an EM wave is based on their helical morphology, lead one to question the health implications of sub-THz communications and their possible consequent side effects on the public.

We are approaching a situation whereby the wavelength of new communication systems will be on par with the typical layer dimensions of human skin and other tissues. This could lead to preferential layer absorption in these same tissues of wireless signals under the 5G designation.

Has industry properly considered possible health consequences as a result of the introduction of the 5G standard?

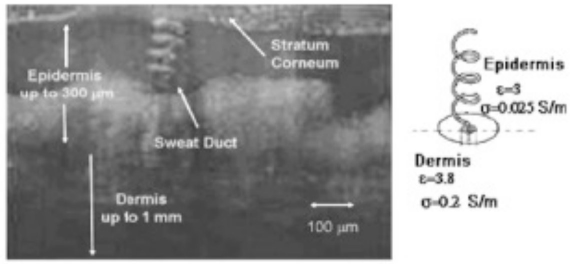

Figure 13D optical coherence tomography image (reproduced with permission from ISIS GmbH) of a single human eccrine sweat gland embedded in the human skin and a schematic presentation of the duct as a helical antenna embedded in the skin, where the dermis-epidermis interface acts as a dielectric reflector. The respective permittivity of the skin layers are marked. They were estimated for the specific frequency range based on the water content of the layers [1,2].

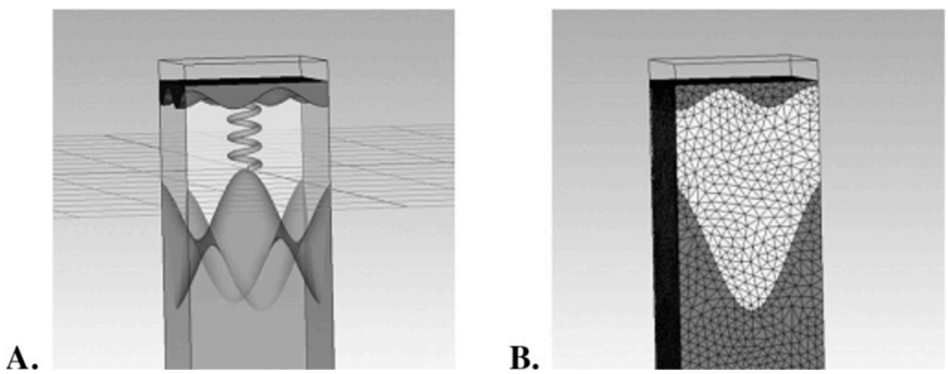

Figure 2 The 3-layer skin model. The simulation is conducted over the (a) unit cell using (b) tetrahedral mesh. Periodic boundary conditions extend the model into the surrounding space [3,4].

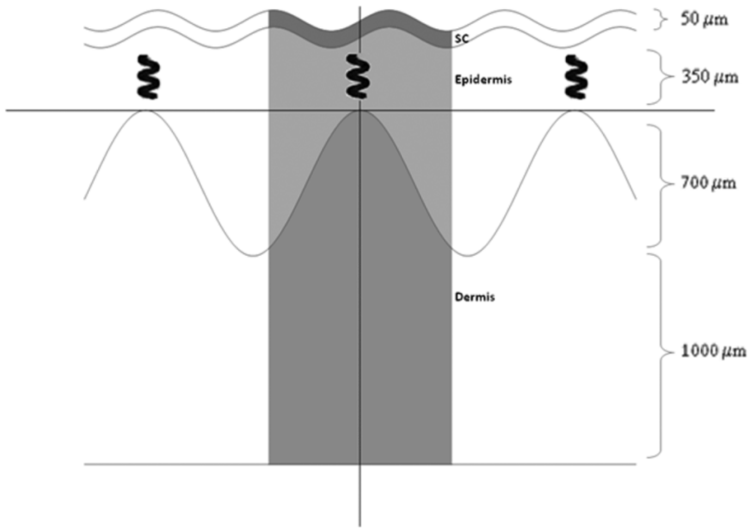

Figure 3The model side cross-section. The skin is divided into three layers: stratum corneum (SC), epidermis and dermis. The helical sweat ducts are located in the epidermis. Sinusoidal functions with different spatial frequencies and amplitudes are used in order to model the non-flat boundaries between the dermis, epidermis and SC [3,4].

References

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