

Feasibility Study of Enhancing Temperature Change Detection through Metamaterial Technology for Hyperthermia Monitoring

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The demand for innovative and personalized therapies for treating cancer is a challenge involving numerous research fields. However, despite society's best intellectual efforts, cancer is still a not easily curable disease. Lately, hyperthermia (or thermotherapy) has been reconsidered as a successful treatment method, able to lead to positive outcomes when used together with conventional cancer treatments, such as surgery, chemotherapy, immunotherapy and radiotherapy [1]. During thermotherapy, the body is exposed to high temperatures which damage and kill cancer cells, usually without injuring normal tissues. When this treatment is applied, a continuous temperature monitoring of the treated area is needed to verify therapy's effectiveness and provide patient's safety. Ultra-wideband (UWB) radar has the potential to monitor temperature changes during hyperthermia treatment by measuring the signals backscattered by the heated area of the body. This technique is cost effective and computationally easy to implement [2].

This work demonstrates how metasurfaces (MTS) could be used to improve the detection of the dielectric contrast induced in the treated area by the heating process. In particular, our study focuses on investigating the feasibility of enhancing the "weak" signal scattered from a heated tumor-mimicking target by incorporating an antireflection-coating MTS in a hyperthermia monitoring system. To this end, we have modelled several setups using CST Microwave Studio®, for which the MTS's interaction with the EM waves emitted by the system's antennas has been studied. Our results suggest that the proposed MTS film can have an enhancing effect when placed between the radiating elements and on a neck phantom designed to evaluate temperature monitoring in hyperthermia treatment. The study, therefore, suggests that MTS technology can be an advantageous component in the development of functional UWB hyperthermia monitoring devices.



Figure 1. Jerusalem Cross-shaped MTS unit cell and hyperthermia monitoring setup.

References

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