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Metamaterial Lenses for Microwave Cancer Hyperthermia Treatment

Authors : Akram Boubakri, Fethi Choubani, Tan Hoa Vuong, Jacques David

Abstract : Nowadays, microwave hyperthermia is considered as an effective treatment for the malignant tumors. This microwave treatment which comes to substitute the chemotherapy and the surgical intervention enables an in-depth tumor heating without causing any diseases to the sane tissue. This technique requires a high precision system, in order to effectively concentrate the heating just in the tumor, without heating any surrounding healthy tissue. In the hyperthermia treatment, the temperature in cancerous area is typically raised up to over 42◦C and maintained for one hour in order to destroy the tumor sufficiently, whilst in the surrounding healthy tissues, the temperature is maintained below 42◦C to avoid any damage. Metamaterial lenses are widely used in medical applications like microwave hyperthermia treatment. They enabled a subdiffraction resolution thanks to the amplification of the evanescent waves and they can focus electromagnetic waves from a point source to a point image. Metasurfaces have been used to built metamaterial lenses. The main mechanical advantages of those structures over three dimensional material structures are ease of fabrication and a smaller required volume. Here in this work, we proposed a metasurface based lens operating at the frequency of 6 GHz and designed for microwave hyperthermia. This lens was applied and showed good results in focusing and heating the tumor inside a breast tissue with an increased and maintained temperature above 42°C. The tumor was placed in the focal distance of the lens so that only the tumor tissue will be heated. Finally, in this work, it has been shown that the hyperthermia area within the tissue can be carefully adjusted by moving the antennas or by changing the thickness of the metamaterial lenses based on the tumor position. Even though the simulations performed in this work have taken into account an ideal case, some real characteristics can be considered to improve the obtained results in a realistic model.

Keywords : focusing, hyperthermia, metamaterial lenses, metasurface, microwave treatment
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