JOURNAL OF SOUTHERN COMMUNICATION ENGINEERING
ISLAMIC AZAD UNIVERSITY BUSHEHR BRANCH
E-ISSN: 2980-9231
https://jce.bushehr.iau.ir
https://doi.org/...

Vol. 14/ No. 55/Spring 2025

Research Article

Comparison of the Performance of Two Terahertz Antennas Based on Photonic Structures for Cancer Tissue Detection

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Received: 18 March 2024
Revised: 6 May 2024
Accepted: 7 May 2024

Abstract

This article proposes the design and performance comparison between two wideband Vivaldi antennas (more than 120% bandwidth) operating at 0.5-2 THz and a dual-band log-periodic antenna at 1.2 and 1.5 THz for cancer detection with novel arrangements of photonic crystals, metasurfaces, and grating reflectors. In the Vivaldi structure, the photonic crystal walls are implemented on both sides of the antenna to provide an electrical shield to focus energy for gain enhancement and antenna directivity as well as sidelobe reduction. The front-to-back ratio (F/B) is another issue for this antenna where toothed elements are used as reflectors to reduce the antenna's backlobe. This antenna covers the frequency range of 0.5-2 THz with a maximum gain of 8.8 dBi. The proposed antenna is used for breast and skin cancer detection modeled by a Debye 2nd order model. In the second structure, a log-periodic toothed antenna is used as the radiator along with photonic crystals and metasurfaces to improve antenna directivity and reduce the F/B ratio. In this structure, the metasurface is designed as a fractal disk to also exhibit dual-band characteristics. The maximum antenna gain is increased to 11.5 dBi with near 90% efficiency. Reflection and transmission values, pulse response, and phase change of healthy and cancerous tissues are used for cancer detection.

Keywords: Antenna, Photonic crystals, Grating reflector, Terahertz, Cancer spectroscopy, Metasurfaces terms.

Highlights

- Utilizing photonic crystals and combining them with a metasurface structure to transform a log-periodic antenna into a strong resonator and employing the structure as a probe.
- Introducing a novel configuration of Vivaldi antennas using photonic crystals and a toothed reflector, aiming to provide shielding, reduce sidelobes, and enhance directivity.
- Presenting a pattern recognition algorithm to distinguish cancerous tissue from healthy tissue, using the output of antennas to design a data processing system.
- Employing directive antennas, metasurfaces, and shielding to generate a directional antenna pattern and detect cancerous tissue.

Citation: [in Persian].