Advancements in High-Frequency Antenna Design: Integrating Photonic Crystals for Next-Generation Communication Technologies

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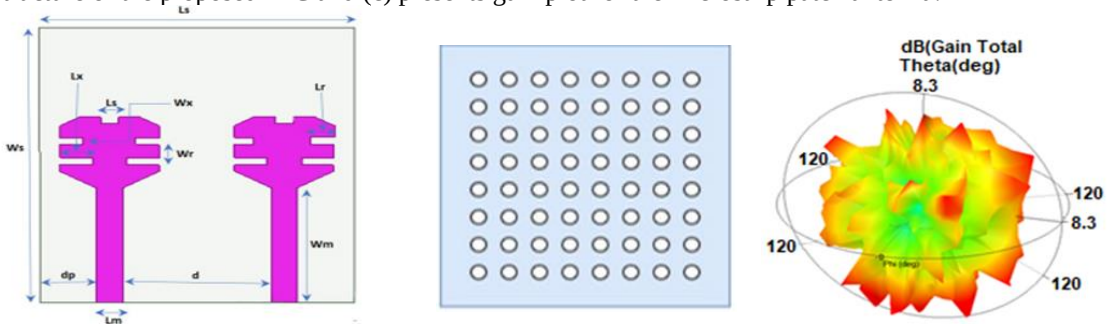
1. Abstract
This study introduces a photonic crystal (PhC)-based microstrip patch antenna array with high gain, designed to meet wireless communication technology demands. The antenna operates between 60.15 GHz and 120 GHz, with a resonant band at 64.80 GHz, delivering a peak gain of 10.50 dBi within this frequency range. In this study uses Rogers RT/Duroid 5880 for its low dielectric constant, improved signal propagation, and mechanical machinability. Air holes in the substrate reduce the dielectric constant, resulting in a more compact antenna design with the potential to enhance broadband bandwidth characteristics.

2.Antenna Design Utilizing Square Lattice Photonic Crystal

PBG structures are periodic dielectric structures that manipulate electromagnetic wave propagation, similar to the electronic band gap in solid-state physics. They have applications in photonics and optical communications, particularly in patch antennas [1]. These structures create a band gap, preventing certain light frequencies from propagating, enhancing their performance, resulting in improved gain, beamwidth, and sidelobe levels. The proposed microstrip patch array antenna configuration is presented in Figure 1(a), while (b) presents the schematic structure of the proposed PhC and (c) presents gain plot for the microstrip patch antenna.



(a) (b) (c)

Figure 1. (a). Proposed microstrip patch array antenna configuration. (b). Schematic structure of proposed PhC. (c). Gain plot for the microstrip patch antenna

The research presents a high gain microstrip patch antenna array using PhC, enhancing gain, bandwidth, and size reduction, and highlighting their potential in 6G technology and RIS design. PhC in antenna design offers compactness, high-frequency operation, and specialized functions for material analysis, imaging, and sensing applications, preparing for 6G technology, and enabling features like FeMBB, xURLLC, and umMTC [2].

References

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