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Bandwidth enhancement of a multilayered polymeric comb array antenna for millimeter-wave applications

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Abstract This paper introduces a new multilayered polymeric comb array antenna fabricated on a polydimethylsiloxane (PDMS) dielectric substrate. PDMS is selected due to its excellent electrical and mechanical properties such as low permittivity, water resistance and robustness. The polymeric comb array antenna consists of a zigzag array aligned at −90° with respect to the radiating patch with full ground plane. The radiating patch is embedded inside the PDMS substrate while the coaxial connector is located at the bottom of the transmission line. The proposed antenna functions from 22.649 to 27.792 GHz. Simulated and measured reflection coefficients and radiation patterns agreed well. A maximum gain of 9.856 dB is recorded at 25 GHz, indicating suitability for implementation in millimeter-wave applications.

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1 Introduction

In recent years, significant attention has been given to millimeter-wave communications due to its capability as a new technology to fulfill the demands for high speed communication and improved capacity [1, 2]. Microstrip structure is one potential solution for millimeter-wave antenna due to its low profile and simple structure [3]. Comb array antenna is formed by a comb-line feeding technique, which significantly improves the reflection coefficient. Reflections from all elements are synthesized in phase to provide good matching at the feeding point [4] when its element spacing is one guided wavelength, λ_g.

Millimeter-wave antennas require a low dielectric substrate in order to increase its dimension and efficiency. Polydimethylsiloxane (PDMS) material which has the permittivity of 2.7 is chosen as a dielectric substrate of the proposed comb array antenna. This polymer substrate is flexible and compatible with many silicon micromachining techniques, e.g., liquid crystal polymer [5] or benzocyclobutene (BCB) [6]. PDMS features several attractive characteristics such as low cost, low permittivity, low loss and light weight [7–11]. Besides that, PDMS substrate can be molded into any shapes, thicknesses and any sizes based on optimized simulation requirements. Moreover, it is colorless, water resistant and is able to contain metallic elements of the antenna [7].

Ref. [8] demonstrates PDMS as a substrate of millimeter-wave antenna. Another PDMS patch array antenna operating at 60 GHz was proposed in [9]. To the best of author's knowledge, a millimeter-wave comb array antenna on PDMS substrate is presented here for the first time, operating from 22 to 27.8 GHz. The antenna design is first described in Sect. 2.1, and its fabrication process explained in Sect. 2.2, with detailed explanations of the method