Triple-Notched Band CPW fed UWB Antenna with Metallic Reflector for High Gain Performance

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Abstract

This paper exhibits the design and performance of a coplanar waveguide (CPW) fed triple notched band ultra-wide band (UWB) antenna. Proposed prototype has two U-shaped slots on the patch and an inverted U slot in feed line with a metal reflector beneath the radiating element. Proposed structure renders wider impedance bandwidth extended between frequencies 2.71GHz to 12.92 GHz for VSWR < 2 with three rejection bands in the frequency ranges 3.456 to 3.988 GHz (WI-MAX IEEE 802.16), 5.27 to 6.032 GHz (WLAN IEEE 802.11 a/h/j/n) and 7.88 to 8.65 GHz (X-band down link satellite system) for VSWR > 2. The utmost simulated gain of proposed antenna with reflector is close to 9.9dBi at 7.4GHz. A sharp reduction observed in the efficiency values of the proposed structure at stop bands. Perhaps, this structure proved as a useful tool for various applications in modern communication systems including UWB.

1. Introduction

The outspread bandwidth of ultra wideband technology is extensively preferred by academia and industry due to its credible usage in high-speed data transfer and microwave imaging [1-2]. In 2002, the Federal Communications Commission (FCC) released an unlicensed band for commercial use in radio communications in the frequency range of 3.1-10.6 GHz. Since permitted power emission level of UWB band is quite low so this band is easily interfered by other adjoining high power communications systems such as WiMAX communication system, WLAN communication system, and ITU X-band communication. The disruptions of these high power communication systems with UWB communication systems can evade by applying the band rejection filter [3]. Many UWB antennas with band-notched characteristics proposed in the literature [4-13]. Zarrabi [4] reported a triple notch band UWB antenna that had a fractal Koch structure with a T-shaped stub. The central frequency of these notch bands is 2 GHz, 3.5 GHz, and 5.8 GHz subsequently. M. Sharma [5] presented an Urn-shaped UWB antenna along with T-shape stub and two C-shaped slots resulted in a triple notch band with central frequencies allocated for WI-MAX IEEE 802.16, WLAN IEEE 802.11 a/h/j/n and X-band down link satellite systems. Syed and Aldhaheri [6] proposed a CPW fed UWB antenna with eliminating IEEE 802.11 and HIPERLAN/2 frequency bands. Hu [7] reported a novel rectangle tree fractal structure which constituted with superposition of a number of rectangular patches. Ultra wide band performance obtained by embedding defects on the ground plane and band rejection characteristics achieved through inserting three U-slots on the fractal tree shaped patch structure. A novel triple notch UWB antenna reported by Tang and Yang [8] which have a circular patch structure with a partially truncated ground plane. To incur band rejection characteristics, a square ring short stub loaded resonator embedded. Amiri [9] investigated an inverted triangle-shaped patch with the trapezoid shaped ground plane for extreme wide band operation. The dual rejection characteristic for C and WLAN bands obtained through embedding a pair of L-shaped slots in radiating structure. A novel modified octahedron shaped structure with dual rejection band characteristics reported by Mishra and Shau [10]. Ding and Wong [11] communicated an elliptical UWB antenna with single band rejection. The overall size of this antenna reduced through cutting a half elliptical opening from the main radiator. Das [12] reported a low-cost and simple rectangular monopole antenna in which single, double as well as triple notched bands achieved by fluctuating spiral slot length with a median frequency of 3.57 GHz, 5.12 GHz, and 8.21 GHz respectively. S. Yadav [13] communicated a rectangular shaped radiator with a modified ground plane. The bandwidth of this structure extended from 5.0 GHz to 25.5 GHz. Single WLAN band rejection obtained by etching an L-shaped slot in the radiating patch structure.

In this communication, a design and performance of a planar CPW feed edge truncated circular patch having triple band-notched characteristics have discussed. Two U-shaped slots in the radiating patch and an inverted U-shaped slot in the feed line has introduced one by one to obtain the triple band-notched characteristics. The WI-MAX, WLAN, and ITU 8.0 GHz bands cater electromagnetic interference with the UWB communication system; hence the rejection of

Ring Slotted Circularly Polarized U-Shaped Printed Monopole Antenna for Various Wireless Applications

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Abstract

In this communication, the design and performance of micro strip line feed U-shaped printed monopole antenna for Bluetooth/WI-MAX/WLAN communications systems is reported. The proposed monopole antenna has an eight shaped slot on the patch and an eight shaped ring structure in the ground with a metallic reflector beneath the ground plane. The CST Microwave Studio 2014 used for the simulation analysis of antennas while measurements performed by applying Vector Network Analyzer (R&S-ZVA 40). This radiating structure provides triple broad impedance bandwidths, i.e. 265MHz (in 2.280 GHz to 2.545 GHz frequency range), 116 MHz (in 2.660 GHz to 2.776 GHz frequency range) & 2.12 GHz (in 3.83 GHz to 5.956 GHz frequency range), wider 3dB axial ratio bandwidth 1.33 GHz (in 4.69GHz to 6.02GHz range), nearly flat gain (with maximum gain close to 5.56 (dBi) and good radiation patterns in the desired frequency range. This antenna may be a useful structure for 2.45GHz Bluetooth communication band as well as in WLAN & WI-MAX communications bands.

1. Introduction

The rapid advancements in the wireless communication systems, especially in the field of high data transfer, have awakened more interest of the scientific community towards the performance enrichment of the wireless antennas. These antennas must perform well for application in communication systems, including WLAN applications specifically 802.11b and 802.11g for 2.4 GHz communication systems, 802.11a standard for the 5 GHz communication system, high-speed 802.11n for operation in both 2.4 GHz and 5.0 GHz bands as well as in WI-MAX applications [1-2]. Circularly polarized planar monopole patch antennas are found suitable for these bands due to their flexibility in orientation, easy feeding, low profile structure and low fabrication cost of mass production [3]. Looking these advantages, extensive efforts have been made by researchers to improve the inherent limitations of planar antennas [4-17]. These include design of fork like monopole with a wide slot ground [4], wideband E-shaped micro strip patch antenna for 5-6 GHz wireless communications systems [5], miniaturized U-slot patch antenna with enhanced bandwidth [6], Wideband omni directional monopole antenna [7], flared monopole antenna with a V-shaped sleeve [8], L-shaped printed monopole antenna with wide impedance bandwidth [9] etc. A trapezoid conductor backed plane applied to get a dual band antenna incubating WLAN and WI-MAX in [10]. A triple-band monopole patch covering the WLAN & WI-MAX communication systems obtained by using electric-LC (ELC) and EBG structures [11]. A new design of coaxial probe feed dual layer circular patch antenna presented in [12]. With the substantial bonding between two patches, a wide bandwidth approx. 25% obtained. Most of these references have larger patch size, but the compactness of structure is the main requirement in modern wireless communication systems. A very compact asymmetric coplanar strip fed monopole structure for dual frequency bands presented in [13]. Another compact design presented in [14] which has L-shaped radiating element, a modified inverted-F-shaped stub and a C-shaped parasitic radiating element for WLAN and WI-MAX application. Triple bands obtained by applying a pair of inverted-L slots etched on the ground plane and a split-ring resonator (SRR) in [15]. A tapered printed structure attached to U-slot reported in [16] to achieve WLAN dual frequency bands. In [17], a directional dual band performance obtained by tuning the lengths of the inner symmetrical trapezoidal slots and the outer trapezoidal arms.

The main objectives of this communication to obtain a single structure which has compactness, high gain, multiple operation bands and circular polarization. Rectangular and circular configurations are the most common configuration. In this communication, a new U-shaped design has offered which has a compact size compared to other configurations and provides circular polarization that desires in several wireless communications. Broadband performance and circular polarization have achieved through U-shaped monopole structure with an eight shape ring slot in the patch geometry and an eight shape ring in the ground plane. The gain of the antenna has improved through application of a metallic reflector placed beneath the radiating structure. The CST Microwave Studio 2014 has used for the simulation analysis of antennas while measurement has performed by

Pramana – J. Phys. (2017) 89:11
DOI 10.1007/s12043-017-1399-7

Density functional study of $AgScO_2$: Electronic and optical properties

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Abstract. This paper focusses on the electronic and optical properties of scandium-based silver delafossite ($AgScO_2$) semiconductor. The density functional theory (DFT) in the framework of full potential linearized augmented plane wave (FP-LAPW) scheme has been used for the present calculations with local density approximation (LDA) and generalized gradient approximation (GGA). Electronic properties deal with energy bands and density of states (DOSs), while optical properties describe refractive index and absorption coefficient. The energy bands are interpreted in terms of DOSs. The computed value of band gap is in agreement with that reported in the literature. Our results predict $AgScO_2$ as indirect band-gap semiconductor. Our calculated value of the refractive index in zero frequency limits is 2.42. The absorption coefficient predicts the applicability of $AgScO_2$ in solar cells and flat panel liquid crystal display as a transparent top window layer.

Keywords. Density functional theory; band structure; optical properties.

PACS Nos 71.15.Mb; 71.20.−b; 78.20.−e

1. Introduction

The wide band-gap delafossites have emerged as a new family of transition metal oxide materials with a number of remarkable electronic and optical properties [1–4]. Among them, copper and silver-based delafossites are of particular interest because they have sufficiently wide band gap and can be used as window layer in a variety of optical devices. The unique feature of this semiconductor family is that they can be combined with N-type semiconductor to form PN junction [1] which can be used as an inner layer of solar cells for electricity generation. This peculiar characteristic has established a benchmark in invisible electronics and opened a new era in solar cell technology [5–9].

Dietrich and Jansen [10] synthesized and reported the 3R phase of $AgScO_2$. Shannon *et al* [11] reported the syntheses of various delafossite families including $AgScO_2$ and provided lattice parameters for the 3R phase. These lattice parameters are converted into 2H-type structure and then optimized by Kandpal and Seshadri using the CASTEP code [12]. They reported the influence of d10–d10 interactions and predicted the candidature of these structures for transparent conducting oxide (TCO) applications. Nagarajan *et al* [13] synthesized a series of compounds like $CuMO_2$ (Sc, Y, Cr, $Fe_{0.5}V_{0.5}$) and $AgMO_2$ (M = In, Sc, Cr, Ga) and reported the conductivity of these compounds. They predicted that Cu-based compounds show higher conductivity than Ag-based compounds. Sheets *et al* [14] synthesized $AgScO_2$ and observed the mixed phase of this compound. They predicted the optical band gap for $AgScO_2$ to be 3.8 eV. They also reported theoretical band gap (2.4 eV) using LMTO method at gamma point of Brillouin zone (BZ) which is in far agreement with the said optical value. Using minima hopping method combined with high-throughput calculations Cerqueira *et al* [15] explored the periodic table in search of novel oxide phases and predicted structure as well as band gap for vaious oxide structures. Cerqueira *et al* [15] reported the band gap for $AgScO_2$ as 2.1 eV which was appreciablly smaller than the band gap calculated by Sheets *et al* [14]. The debate over band gap and limited number of reports encouraged the present investigation on optical and electronic properties of $AgScO_2$.

Published online: 20 June 2017

Journal of Nanofluids
Vol. 6, pp. 1031–1045, 2017
(www.aspbs.com/jon)

Mixed Convective MHD Flow and Heat Transfer of Uniformly Conducting Nanofluid Past an Inclined Cylinder in Presence of Thermal Radiation

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The objective of the present study is to analyze the mixed convective steady magnetohydrodynamic (MHD) boundary layer flow and heat transfer of uniformly conducting nanofluid past an inclined cylinder in presence of thermal radiation. By using appropriate transformation the governing partial differential equations of momentum, energy and concentration in cylindrical polar coordinates are reduced into set of nonlinear ordinary differential equation and solved analytically by Differential Transform Method (DTM) with Padé approximation. The effects of various physical parameters namely magnetic parameter M, curvature parameter γ, Prandtl number Pr, Thermophoresis parameter N_t, Brownian motion parameter N_b, radiation parameter R_d, Lewis number Le, and mixed convection parameter λ on the velocity, temperature and nano-particles concentration profiles are depicted graphically and analyzed comprehensively in detail. The obtained results are also compared with known results and are found to be in excellent agreement.

KEYWORDS: MHD, Nanofluid, Inclined Cylinder, DTM-Padé, Radiation, Numerical Solution.

ARTICLE

1. INTRODUCTION

The base fluid (water, oil, ethylene glycol, etc.) containing nanometer-sized particles/fibers is said to be nanofluid.[1] Materials generally used for nanoparticles are Al_2O_3, Cu, TiO_2, Ag, etc. These fluid syntheses realized to have great properties that make them conceivably fruitful in many scientific and engineering executions in heat transfer, including nuclear reactors, fuel cells, microelectronics, power generation and transportation, space technology, defense and ships, thin film solar energy collectors. The addition of very small quantity of moderately higher thermal conductivity solid nanoparticles to the common base fluids dramatically increases the thermal conductivity. Eastman et al.[2] showed that an increase of 40% in thermal conductivity of ethylene-glycol with 0.3% increment in Cu nanoparticles. In another study Das et al.[3] proved that a 10–25% rise in thermal conductivity of water with 1–4% Al_2O_3 nanoparticles. It is also observed that the thermal conductivity of nanofluids positively increases with temperature compared to pure liquids. Due to higher thermal conductivity of these particles compared to the conventional fluids commonly used in heat transfer, it is expected that the nanofluid have a better thermal efficiency than the base fluid. In such areas where the nanofluids can be used as conventional fluid as engine cooling, improving diesel generator efficiency, cooling of heat exchanger devices, biomedical science, domestic refrigerator, solar water heating, nuclear reactor, defense, aerodynamics rocket, missiles, power plants for inter planetary, flights and space crafts which operate at high temperature. Yang et al.[4] and Jahani et al.[5] have done the first theoretical and experimental review letter on nanofluid with applications. Kuzetson and Nield[6] used Buogiorno model[7] to investigate a natural convection flow of a nanofluid over a vertical plate which consists of different slip mechanism: a buoyancy ratio, a thermophoresis parameter, a Brownian motion parameter, inertia, diffusionphoresis, gravity Magnus effect and fluid drainage. A modified Buogiorno's two component modal was also employed for nanofluids with the effect of the nanoparticle volume fraction distribution by many authors. Malvandi et al.[8] have studied slip effects on unsteady stagnation point flow of nanofluid over a stretching sheet. Malvandi and Ganji[9] investigated slip flow of Al_2O_3-water nanofluid inside a circular micro channel considering Brownian motion and thermophoresis effect in presence of magnetic field. Moshizi et al.[10]

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Email: guptasumit.edu@gmail.com
Received: 1 April 2017
Accepted: 25 May 2017

Engineering Computations

Numerical simulation for magnetohydrodynamic three dimensional flow of Casson nanofluid with convective boundary conditions and thermal radiation

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Numerical simulation for magnetohydrodynamic three dimensional flow of Casson nanofluid with convective boundary conditions and thermal radiation

Keywords: non-Newtonian nanofluid, Thermophoresis, Brownian motion, stretching sheet, OHAM, numerical solution.

1. Introduction

The study of boundary layer flow and heat transfer of nanofluids has attracted the attention of many researchers due to its enhanced thermal conductivity. The term 'nanofluid' was first proposed by Choi [1] with a mixture of nanoparticles and base fluid, including oil, water and ethylene glycol mixture. It refers to a liquid containing a dispersion of submicronic solid particles (nanoparticles) length on the order of 1-100nm. These nanoparticles are suspended much longer than mille and micrometer sized particle with low gravitational properties and increase the heat transfer rate at any physical aspects. Due to its significant thermal conductivity enhancement, nanofluid have already been used in several industrial and engineering application including biomedical sciences, solar water heating, nuclear reactor, defense, aerodynamics rocket, improving diesel generator efficiency [2] etc. Wang and Majumdar [3], Yang et al. [4] and Jahani et al. [5] established the first theoretical and experimental review letter on nanofluid. Masuda et al. [6] investigated the potential of nanofluid in advanced nuclear systems. After Masuda [6], Pak and Cho [7] discussed the heat transfer due to addition of submicron metallic oxides particles in the base fluid. Buongiorno [8] provide the mathematical model for understanding convective transport in nanofluids. Nield and Kuznetsov [9] showed the effects of thermal convection on the horizontal length of porous medium filled by a nanofluid. Sheikholeslami et al. [10] presented the effect of magnetic field on natural convection in an inclined half annulus enclosure filled the Cu-water nanofluid. Makinde and Aziz [11], Makinde et al [12] and Ibrahimi and Makinde [13] give some research on the nanofluids considering the Brownian diffusion and thermophoresis. Makinde [14, 15] and Motsumi and Makinde [16] study the boundary layer flow of nanofluid over a flat plate. Malvandi and Ganji [17] investigated the thermo physical properties of Al_2O_3-water nanofluid inside a circular channel with the magnetic field effects. Moshizi et al. [18] presented a theoretical description of Al_2O_3-water nanofluid inside a concentric pipe with internal heat generation/absorption. Malvandi and Ganji [19] also discussed a forced convective effect of alumina water nanofluid in a cooled plated channel. Fully developed mixed convective flow of nanofluid in a pipe was first developed by Malvandi et al. [20]. Hedayati and Ganji [21] established the effects of nanoparticle migration and heating on convective TiO_2-H_2O type nanofluid inside a vertical microchannel. Bachok et al. [22] presented a stagnation point flow of three dimensional nanofluid flow and heat transfer over a stretching surface. Sheikholeslami et al. [23] applied control volume based finite element method (CVFEM) to discussed magnetic field effects in a half annulus region with a constant heat flux. Rashidi et al. [24] provides a comparative study between two phase and single phase of heat