STUDY OF INHOMOGENEOUS DIELECTRIC RESONATORS FOR LINEARLY/CIRCULARLY POLARIZED MICROWAVE ANTENNA APPLICATIONS

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TABLE OF CONTENTS

APPENDICES

LIST OF PUBLICATIONS

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ABBREVIATIONS

AR	Axial Ratio
ATM	Antena Tampalan Mikrostrip
APD	Antena Penyalun Dielektrik
BW	Bandwidth
CTO	$CoTiO_3$
CP	Circularly Polarization
CSSR	Conventional Solid State Reaction
CST	Computer Simulation Technology
DBS	Direct-Broadcast Satellite
DEM	Differential Equation Method
DR	Dielectric Resonator
DRA	Dielectric Resonator Antenna
DUT	Device Under Test
DWM	Dielectric Waveguide model
FDTD	Finite Difference Time Domain
FD	Frequency Domain
FIT	Finite Integration Technique

FET	Finite Element Method
FESEM	Field Emission Scanning Electron Microscopy
HPP	High Performance Probe
IEM	Integral Equation Method
LAN	Local Area Network
LP	Linearly Polarization
LHCP	Left Hand Circular Polarization
MPA	Microstrip Patch Antenna
ME	Maxwell Equations
MTO	$MgTiO_3$
NS	Nested Square
NSDR	Nested Square Dielectric Resonator
NSDRA	Nested Square Dielectric Resonator Antenna
PCB	Printed Circuit Board
RHCP	Right Hand Circular Polarization
SS	Solid Square
TD	Time Domain
TE	Transverse Electric

TEM	Transverse Electromagnetic
TKS	Teknology Komputer Simulasi
TLF	Tremendously Low Frequency
TM	Transverse Magnetic
UHF	Ultra High Frequency
XRD	X-ray Diffraction

KAJIAN PENYALUN DIELEKTRIK TAK HOMOGEN UNTUK APLIKASI ANTENA GELOMBANG MIKRO POLARISASI LINEAR/BULAT

ABSTRAK

Dalam tempoh tiga dekad yang lalu terdapat banyak penyelidikan telah didedikasikan untuk penyalun dielektrik (PD) homogen (ketelusan tunggal) dengan bentuk silinder, persegi/segi empat tepat dan bentuk hemisfera menjadi pusat tumpuan. PD ini telah disiasat secara teori, secara ilmiah dan uji kaji oleh itu, semua prestasi utama parameter pengawal untuk PD homogen adalah diketahui. Telah amat diketahui bahawa PD homogen boleh melakukan hanya satu tujuan pada satu masa iaitu gandingan kuat kepada punca dan oleh itu lebar jalur galangan adalah sempit dan sebaliknya. Untuk mengatasi kelemahan PD homogen, dalam kerja ini PD tak homogen direka bentuk dalam apa-apa cara bahawa geometri asas penyalun dikekalkan supaya alat penganalisis teori, berangka dan eksperimen yang ada boleh digunakan secara berkesan untuk PD tak homogen yang dicadangkan. Penyalun tak homogen ini diperkenalkan secara sistematik ke arah azimuth (φ) supaya taburan medan elektromagnet dalam penyalun tetap sama dengan pelbagai kurungan yang berlainan tenaga. Untuk mengesahkan idea-idea ini tiga penyalun yang berbeza berdasarkan penyalun dielektrik silinder (PDS) dan penyalun bentuk persegi/segi empat tepat disiasat. Untuk PDS dua sektor 90^{O} berbentuk pai tak homogen dengan ketelusan yang tinggi diperkenalkan pada arah-φ dengan cara sektor yang mempunyai ketelusan sama diletakkan dalam kuadran yang bertentangan. Begitu juga, satu lagi PD tak homogen (bentuk bujur-berpecah) direka bentuk dengan memasukkan jalur segi empat tepat ketelusan tinggi di tengah-tengah dua PD separuh silinder arah φ. Akhir sekali, reka bentuk ketiga kajian ini adalah berdasarkan kepada

PD berbentuk persegi di mana ketelusan diturunkan dengan memperkenalkan jurang udara dalam penyalun yang kelihatan seperti PD persegi bersarang. PD tak homogen yang dicadangkan diuji untuk aplikasi antena jalur lebar polarisasi linear (PL) dengan teknik pengujaan biasa iaitu garis mikrostrip. Manakala, untuk reka bentuk polarisasi bulat (PB), adalah penting untuk mengujakan dua mod ortogon dengan amplitud yang sama dengan itu teknik penyuapan yang berbeza digunakan. Analisis teori, berangka dan eksperimen antena penyalun dielektrik (APD) tak homogen menunjukkan bahawa dengan mereka bentuk dengan betul penyalun tak homogen, sambutan lebarjalur galangan, nisbah paksi (NP) lebarjalur, gandaan dan kecekapan APD boleh ditambahbaik. Bagi ketiga-tiga APD tak homogen PL ini lebihkurang 56% lebarjalur galangan telah dicapai yang menunjukkan peningkatan 80.5% daripada lebar jalur PD homogen dengan ciri-ciri sinaran stabil sepanjang jalur operasi. Sambutan NP lebarjalur PB tak homogen APD telah direkodkan menjadi 200% lebih daripada homogen. Untuk APD tak homogen yang pertama dan kedua gandaan telah meningkat sehingga 6.5 dBi manakala bagi PD persegi bersarang gandaan kekal hampir sama dengan PD persegi homogen. Dengan merujuk kepada penemuan ini didapati bahawa prestasi APD secara jelas bertambah baik dengan pengenalan sistematik ketakhomogenan dalam PD.

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ABSTRACT

In the last three decades a huge amount research has been dedicated to homogeneous (single permittivity) dielectric resonators (DRs) with cylindrical, rectangular/square and hemispherical shapes being the center of attention. These DRs have been investigated theoretically, numerically, and experimentally therefore, all the major performance controlling parameters are known for the homogeneous DRs. It well known that a homogenous DR can serve only one purpose at a time i.e. strong coupling to the source and hence narrow impedance bandwidth and vice versa. To overcome these drawbacks of homogenous DRs, in this work inhomogeneous DRs are designed in such a way that the basic geometry of the resonator is maintained so that the available theoretical, numerical and experimental analysis tools can be effectively applied to the proposed inhomogeneous DRs. The inhomogeneities in the resonators are introduced systematically in the azimuth (ϕ) direction so that the electromagnetic field distribution in the resonators remains the same with different range of energy confinement. To validate these ideas three different resonators based on cylindrical dielectric resonator (CDR) and rectangular/square shape resonators are investigated. For inhomogeneous CDR two 90^{o} pie shape sectors of relatively high permittivity were introduced in the ϕ-direction in a way that sectors with same permittivity are placed in the opposite quadrant. Similarly, another inhomogeneous DR (split-oval shape) was designed by inserting high permittivity rectangular strip in the middle of two half cylindrical DR in the ϕ direction. Lastly, the third design of