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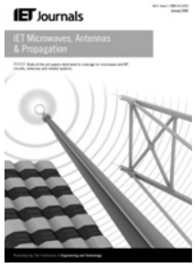
In Special Issue on Microwave Metamaterials: Application to Devices, Circuits and Antennas



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Editorial

Microwave Metamaterials: Application to Devices, Circuits and Antennas

Since the 'big-bang' of Metamaterials in 2000, there has been an intensive expansion of related research activities. Initially in this first decade of the 21st century, these efforts were focused primarily on the novel and often exotic physics properties of Metamaterials, which are generally associated with combinations of negative, near-zero, and positive medium properties. As researchers confirmed many of those fundamental and unique properties of Metamaterials, research efforts moved towards their application to, for example, the fields of microwave engineering and telecommunications. While there have been direct applications of metamaterials, many others have arisen simply based on ideas cultivated by their properties and performance characteristics. We have seen significant progress concerning microwave circuit, device and antenna designs in terms of miniaturisation, performance improvement, multi-functionality, efficiency, etc., that have been stimulated by metamaterials and their unusual properties. As a consequence, Metamaterial Technology is progressively achieving a level of maturity in Microwave Engineering that 'real-life' applications and 'penetration' into the market may be envisaged on a more regular basis.

The aim of this Special Issue is to showcase the results of several groups/labs in the international Metamaterials research community whose activities have a special emphasis on their applications in microwave engineering and related areas. Our advertised topics included, but were not limited to the: Theory and physical understanding of metamaterials, Three-dimensional and isotropic metamaterials, Metamaterial transmission lines, components and systems, Metamaterial-based or inspired antennas and electrically small antennas, Tunable and active metamaterials and applications, Metamaterial-based filters, Metasurfaces, Imaging devices, Metamaterials at millimetre wave frequencies and beyond, Fabrication techniques, Numerical techniques, and Novel phenomena and devices. From over 30 submissions, we have selected 20 papers to share with you through this Special Issue. They include five papers on transmission line metamaterials and their applications, six papers on the applications of metamaterials and related metamaterial-inspired constructs to antennas, two on their applications to waveguides, three on their multi-functional applications, two on their tunable or controllable properties for applications, and two on lens and imaging applications.

We would first like to thank all of the authors, including not only those whose papers you will find in this Special Issue, but also those whose work you will find reported elsewhere, for sharing your exciting efforts with us. We also would like to express our special thanks to all of the reviewers whose time and efforts made this Special Issue a reality. We especially would like to thank Paul Rowley, Editorial Assistant, Research Journals, The IET, for his tireless help and support, from the initial proposal stages to this final product.

Finally, we sincerely hope that you, the reader, will enjoy the papers we have selected for this Special Issue. We hope they stimulate new ideas that will lead to even more interesting physics and microwave engineering applications.

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Ferran Martín was born in Barakaldo (Vizcaya), Spain, in 1965. He received the B.S. degree in physics and the Ph.D. degree from the Universitat Autònoma de Barcelona (UAB), Barcelona, Spain, in 1988 and 1992, respectively. From 1994 to 2006, he was an Associate Professor in Electronics in the Departament d'Enginyeria Electrònica (Universitat Autònoma de Barcelona), and since 2007 he has been a Full Professor of Electronics. In recent years, he has been involved in different research activities including modelling and simulation of electron devices for high-frequency applications, millimeter-wave and THz generation systems, and the application of electromagnetic bandgaps to microwave and millimeter-wave circuits. He is now very active in the field of metamaterials and their application to the miniaturisation and optimisation of microwave circuits and antennas. He is the head of the Microwave and Millimeter Wave Engineering Group (GEMMA Group) at UAB, and director of CIMITEC, a research Centre on Metamaterials supported by TECNIO (Generalitat de Catalunya). He has acted as Guest Editor for three Special Issues on metamaterials in three international journals. He has authored and coauthored over 300 technical conference, letter, and journal papers and he is coauthor of the monograph on metamaterials entitled Metamaterials with Negative Parameters: Theory, Design, and Microwave Applications (Wiley, 2008). He has filed several patents on metamaterials and has headed several development contracts.

Prof. Martin has organised several international events related to metamaterials, including Workshops at the IEEE International Microwave Symposium (years 2005 and 2007) and European Microwave Conference (2009). Among his distinctions, he received the 2006 Duran Farell Prize for Technological Research, he holds the Parc de Recerca UAB—Santander Technology Transfer Chair, and he has been the recipient of an ICREA ACADEMIA Award.

Richard W. Ziolkowski (ScB 1974, Brown University, MS'75 and PhD'80 from the University of Illinois at Urbana-Champaign, all in Physics) is the Litton Industries John M. Leonis Distinguished Professor in the Department of Electrical and Computer Engineering at the University of Arizona. He is also a Professor in the College of Optical Sciences at the University of Arizona. He was the Computational Electronics and Electromagnetics Thrust Area Leader in the Engineering Research Division at the Lawrence Livermore National Laboratory before joining the University of Arizona in 1990. Professor Ziolkowski is a Fellow of both the Institute of Electrical and Electronics Engineers (IEEE) and the Optical Society of America. He was President of the IEEE Antennas and Propagation Society in 2005. He also has been actively involved with the URSI, OSA, and SPIE technical societies. He has served on the International Advisory Boards and Technical Program Committees of several international conferences, including iWAT, ISAP, Metamaterials, and META. He and Prof. Nader Engheta, University of Pennsylvania, are Co-Editors of the best selling 2006 IEEE-Wiley book, Metamaterials: Physics and Engineering Explorations.

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1.1 Classification of Microwave Integrated Circuits. An active microwave circuit can be defined as a circuit in which active and passive microwave devices such as resistors, capacitors, and inductors are interconnected by transmission lines. At low frequencies, the transmission lines are a simple connection; however, at microwave frequencies they are no longer just simple connections and their operation becomes a complicated distributed circuit element. As a result, a microwave integrated circuitâ€™s classification is based on the fabrication method of the transmission lines used for interconnec Microwave frequency metamaterials are usually constructed as arrays of electrically conductive elements (such as loops of wire) that have suitable inductive and capacitive characteristics. Many microwave metamaterials use split-ring resonators.[6][7].Â Metamaterials are under consideration for many applications.[70] Metamaterial antennas are commercially available.Â Metamaterial antennas are a class of antennas that use metamaterials to improve performance.[13][17][72][73] Demonstrations showed that metamaterials could enhance an antenna's radiated power.[13][74] Materials that can attain negative permeability allow for properties such as small antenna size, high directivity and tunable frequency.[13][17]. Request PDF | On Sep 1, 2010, Ferran Martin and others published Microwave Metamaterials: Application to Devices, Circuits and Antennas | Find, read and cite all the research you need on ResearchGate.Â One research line is devoted to exploit metamaterials as loading materials in conventional microwave components (e.g., circuits and antennas) [12][13][14]. By properly loading microwave components with metamaterials, in fact, it is possible to obtain interesting operation and anomalous properties that allow beating most of the main limitations of conventional components, opening the door to new revolutionary ultracompact devices with improved performances. Microwave Metamaterials. Session chairperson(s): Ricardo Marques. Tverskoy hall. A dipole antenna design incorporating both electromagnetic bandgap and zero-refractive index metamaterials Oral.Â The use of different congurations of AMC as lid for packaging of microstrip circuits is proposed for different frequency bands. Experimental results show how they avoid the excitation of cavity modes as well as radiation losses and how compact unit cells can be designed for lower frequencies achieving 2:1 bandwidths.Â Metamaterials - Beyond crystals, noncrystals, and quasicrystals: Microwave applications Keynote. Tie Jun Cui, Radio Department, Southeast University, China. Description. Microwave Devices and Circuits Third Edition. SAMUEL Y. LIAO Professor of Electrical Engineering California State University, Fresno. Iii.Â The central theme of this book concerns the basic principles and applications of microwave devices and circuits. Microwave techniques have been increasingly adopted in such diverse applications as radio astronomy, long-distance communications, space navigation, radar systems, medical equipment, and missile electronic systems.