AMPERE NEWSLETTER

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EDITORIAL

This issue welcomes Eamon McErleanm Chief Technology Officer at Emblation Ltd, in Scotland, who outlines some innovative ideas for the use of microwave energy in ISM (Industrial, Scientific and Medical) sectors. Specifically he highlights a 100 W solid state generator operating at 2.45 GHz that can be used for low power applications in the fields of thermal ablation, communication, chemistry, plasma as well as material heating and curing.

Also in this issue Professor Nguyen Tran presents a brief outline of high power microwave research activity in Australia.

I would like to extend my best wishes to all AMPERE members for the coming festive season.

AC Metaxas
EUG St John's College
Cambridge UK

NEXT GENERATION MEDICAL MICROWAVE GENERATORS - A STEP FORWARD FOR PATIENT SAFETY

Eamon McErlean
Chief Technology Officer
Emblation Limited
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As regular readers of the Ampere newsletter will know, it is the flexibility of microwave technology that drives innovation in this growing, global market place, and no more so than in the development of state-of-the-art medical treatments.

Applications harnessing microwave power extend from soft tissue ablation (typically the desiccation of tumours) to effective pain management solutions, but while significant attention is paid to the design of the microwave applicator, organisations often overlook the microwave power source itself - and as a consequence leave patients open to a number of risks: from ineffective and inefficient treatment, to serious patient injury.

As products and technology continually evolve, biomedical engineers and medical research teams are learning more about how microwave energy can offer new treatment options and change the way operations are carried out – but there are significant safety issues which must be considered in the design stage of any microwave based medical treatment.

Medical microwave systems

In medical microwave systems the measurement of forward and reflected power is often used as a safety mechanism. This safety function can be used to monitor treatments, detect and react to device failures, connection issues and potential misuse. The advantage of these measurements is that blind treatments can be monitored in real time without requiring the user to inspect the treatment site.

Any inaccuracy in these measurements has the potential to result in either insufficient power being delivered - resulting in poor treatments and a perception of unreliability, or excessive power being administered - inadvertently causing serious patient injury.

The challenge of medical applications

To ensure an efficient transfer of power into

the body, a microwave applicator must be carefully designed to present a good impedance match to the generator when in contact with tissue. However in the case of medical applications, the applicator match is often poorer than the typical industry standard component simply due to the complexity of design.

Any degree of mismatch creates a standing wave – energy that is reflected from the target load and back down the guide. Medical treatments are made even more difficult to measure by the changing properties of human tissue. As a treatment progresses and more energy is absorbed by the tissue its unique properties change and subsequently the impedance match changes. As a result, the microwave applicator suffers from changing efficiency and a Voltage Standing Wave Ratio (VSWR) is created. When this mismatch is considerate i.e. 12dB or worse, standard power measurement techniques are no longer accurate.

The challenge in medical microwave generators is to accommodate the measurement of varying impedance and phase using standard components that are generally calibrated for typical industrial applications, where the impedance match is fixed. Generator systems are frequently constructed around existing industrial amplifiers or standard magnetron based power sources. As a result a number of problems can occur when these devices are employed in medical applications.

A false sense of security

Typically power is measured using standard coupler arrangements where a fixed proportion sample (coupling factor) of the forward and reflected power from a load under optimal conditions are measured and used to monitor performance and progress.

In the situation of medical microwave procedures, where as the procedure advances the match of the applicator is at best 12dB, this change in coupling factor makes the actual power value measurement an unknown quantity.

These effects are further exacerbated by phase changes. In a typical medical microwave system where the chosen method is to have the energy output fixed at a single continuous wave (CW) frequency, a small change in phase caused by tissue changes or physical manufacturing tolerances in interconnecting cables and thermal expansion of components can rapidly shift the point of measurement between the standing wave maximum or minimum, resulting in a compromised and inaccurate reflection measurement. This is even more noticeable at higher frequencies where the wavelength is shorter.

Phase variation has therefore the potential to provide a false sense of security in reflected power measurements. From a safety perspective, for example where an initially high level of reflected power is associated with placement in healthy tissue, VSWR and phase variation could lower the reflection measurement allowing the procedure to inadvertently continue resulting in a serious injury to the individual receiving the treatment. Conversely, measuring an excessively high reflected power could result in an otherwise valid treatment being unnecessarily abandoned.

The Emblation Safe SweepTM solution

As the standing wave changes with phase, the solution is to vary the operating frequency of the signal over a predetermined frequency band, which as a result shifts the position of the standing wave. This can be accomplished using new transistor technologies such as GAllium Nitride (GAN) which possess the necessary bandwidth capability. By sweeping across an appropriate frequency range the full VSWR peak to dip or “ripple” can be measured, and real time data processing can completely eliminate this measurement uncertainty.

This problem has been addressed for medical and industrial applications in the MSYS245 (fig.1) and ISYS245 microwave generators designed and manufactured by Emblation Microwave. These systems feature the Safe Sweep™ technology which provides users with a more accurate and reliable measurement of reflected power allowing for treatment progress to be easily and safely monitored and controlled. The use of Safe Sweep™ demonstrates a significant improvement over the standard CW measurement by offering a measurement system that is independent of phase and mismatch impedance.

Fig.1 MSYS245 microwave generator and amplifier

About Emblation

Emblation Limited is a world leader in the field of microwave technology, specialising in the development and manufacture of compact, state-of-the-art microwave solutions for use in medical, industrial & scientific applications.

The requirement for low cost, light weight, compact and portable microwave generators is becoming more commonplace in industry. Emblation's systems are fully functional and certified to meet medical and industrial standards, ideal for those in the fields of thermal ablation, communication, chemistry, plasma and material heating and curing.

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HIGH POWER MICROWAVE RESEARCH ACTIVITIES IN AUSTRALIA

Professor **Nguyen Tran**
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Microwave Power Components
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The research activities in Australia have had a much less public exposure than before, which may be due to the fact that high power microwave research results do not represent novel activities in the eyes of newspaper reporters. But the activities remain surprisingly high as shown below. Most research activities cover a wide range of topics such as rock crushing, wood modification, food heating for cooking or sterilization, chemical extraction, plasma sterilization, nano-particle generation, weed treatment, termite disinfestation, timber drying and modification etc…. While the "senior' researchers such as Grigori Torgovnikov and Nguyen Tran are still around, it is exciting to see the emergence of young researchers, who are venturing into the field with better equipment and software simulation. It is anticipated that new research data will become available in the near future at AMPERE and other high power microwave conferences.

Grigori Torgovnikov still blows up wood then infuses it with a glue and metallic compounds to create a new type of wood having better strength and quality. He has inherited microwave generators from Melbourne

University and is using them for collaborative work with industries. He still has one or two postgraduate students under his wings. In his words:

'The new technology of microwave wood modification is based on the supply of high intensity MW power, up to 135,000 kW/m³ at frequencies 0.922 and 2.45 GHz. Such power induces significant changes to the microstructure of wood and a dramatic increase in wood permeability. A number of potential commercial applications have been developed based on the fundamental changes in wood structure. These include: the treatment of refractory wood species with preservatives, rapid drying of hardwoods, relief of growth and drying stresses in timber, the manufacture of the new wood materials

'Intensive MW power applied to green wood generates steam pressure within the wood cells. Under high internal pressure the pit membranes in cell walls, tyloses in vessels and weak ray cells are ruptured to form pathways for easy transportation of liquids and vapors. An increase in the intensity causes the formation of narrow voids in the radial-longitudinal planes resulting in a thousand-fold increase in wood permeability to liquids and gases.

'MW wood modification technology provides significant material and energy savings and improves both economic and environment performance of a very traditional industry.

Nguyen Tran is very passionate about using as much simulation as possible for his industrial microwave applicator designs. There seems to be a big demand from industry because of a much lower cost for applicator design.

One postgraduate student has investigated microwave plasma for continuous surface sterilization of food. She uses co-thermal simulation to gain a better understanding of a microwave plasma process and software to design microwave applicators that work without much mechanical alteration. Another former postgraduate student is finishing off a thesis on the effects of microwave energy on the softening timber samples.

Nguyen Tran has been active in doing consulting work for industry in particular on chemical processing and oil extraction, food sterilization, rubber vulcanization and low energy rock crushing.

David McClean has been active in applying his microwave skills to provide important service for different industries. Some examples of current major projects are listed below:

1) Pipe line cleaning (Malaysia 2011, 100kW) – design and development of a potable system for cleaning blocked oil pipelines.
2) Coffee Roaster (Australia 2011, 60kW) – design and development of a coffee roasting plant.
3) Animal Stunning (Australia 2011 - , 100kW) – development of a process for the humane stunning of sheep and cattle.
4) Nano Particle Chemical processor (Singapore 2011, 100kW) – design and fabrication of a system for producing nano-particles.
5) Olive leaf processing(Tunisia 2011, 100kW) – design and fabrication of a system for pre-drying drying olive leaves extraction of valuable by-product.(current)

Graham Brodie has landed a few big research grants to enable him to grow his research activities and fulfill his research ambitions. They will keep him occupied and stimulated for many years to come. The five projects he is involved with are:

1) Microwave control of weeds in cropping systems – this is a conglomeration of 4 different projects looking at different aspects of the problem. It is supported by the grains industry even though it is know that the energy costs are going to be higher than chemical control. He had funding support from three other funding organizations.
2) Microwave treatment to reduce the energy associated with crushing sugar cane – supported by the SRDC.
3) Microwave treatment of lucerne hay to

increase its digestibility by ruminant animals

4) High performance drying of plantation grown eucalyptus timber – an ARC supported project to continue the CRC Wood Innovations work on microwave preconditioning of wood prior to solar drying.
5) Detection and treatment of termites and decay in wood-in-service – an ARC supported project

There are a few important projects on using microwaves to create a new fuel, composite dielectric manufacturing and oil and chemical extraction. There is also some work on using high power at a very high frequency at such as 24GHz, 38GHz and 60GHz. But unfortunately these projects are out of bound and can't be reported.

WORLDWIDE NEWS

GEN: GENETIC ENGINEERING AND BIOTECHNOLOGY NEWS

Feature Article: Jun 1, 2010 (Vol. 30, No. 11)

About Microwave Chemistry Speeds Up Discovery

An interview with Dr Oliver Kappe can be viewed at

http://www.genengnews.com/gen-articles/microwave-chemistry-speeds-up-discovery/3311

MICROWAVE STERILISATION INITIATIVE FROM WARMICK FOODS INC

Warmick Foods a leading US based convenience food manufacturer is using an Microwave Assisted Thermal Sterilisation (MATS) process to improve the quality of foodstuffs. MATS is an FDA approved process. More information from

http://wornick.com/news

MICROWAVE HEATING IN ZEOLITES

Scott Auerbach at the University of Massachusetts Amherst has developed a new molecular-level probe to track how various components in a mixture absorb microwave energy to different extents. Results of their experiments conducted at the Institute Laue-Langevin, Grenoble, France, are reported in a recent issue of Physics Review Letters. In brief, the authors claim, I quote, "the first unambiguous, microscopic evidence for athermal effects in microwave-driven zeolite-guest materials." Could any AMPERE member familiar with this work comment?

More information from

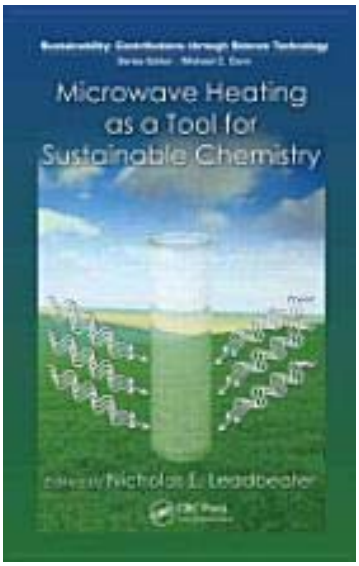
http://www.physorg.com/news/2011-04-scientists-microwave.html

CAMBRIDGE INSTITUTE FOR MANUFACTURING (IFM): REPORT

The Institute has recently issued (Sept 2011) an international review outlining various approaches to global manufacturing research. Copies from:

http://www.epsrc.ac.uk/newsevents/pubs/mags/connect/2011/83/Pages/manufacturingresearchaninternationalreview.aspx

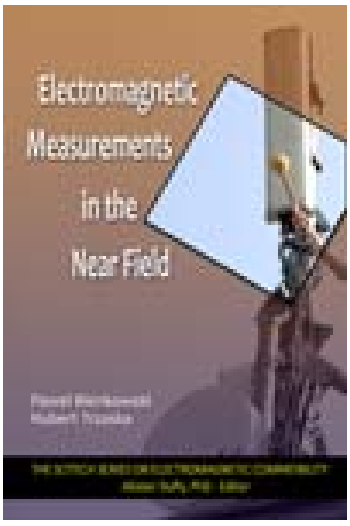
BOOK



Microwave Heating as a Tool for *Sustainable Chemistry*
Edited by Nicholas E. Leadbeater - Taylor and Francis (2010) - Hardback - 278 pages - ISBN 1439812691

If a member is aware of this book could they please write a short review for publication in a future issue of the AMPERE Newsletter

2ND EDITION BOOK



Electromagnetic Measurements in the Near Field, 2nd Edition
Pawel Bienkowski, Hubert Trzaska
Binding: Hardcover
Pages: 220
ISBN: 9781891121067
Publisher: SciTech Publishing © 2011
List Price: $89.00 | Website Price: $71.20

This book is devoted to the specific problems of electromagnetic field (EMF) measurements in the near field and to the analysis of the main factors which impede accuracy in these measurements. It focuses on careful and accurate design of systems to measure in the near field based on a thorough understanding of the fundamental engineering principles and on an analysis of the likely system errors.

INTERNATIONAL JOURNAL OF RF AND MICROWAVE COMPUTER AIDED ENGINEERING (2011 WILEY PERIODICALS INC.)

Presently running in its 3rd year and published online every two months. It contains articles which use relevant computer techniques as are used in RF and MW heating and drying systems but the topics covered are widely different and concerns mainly the area of communications

More information from:
http://onlinelibrary.wiley.com/journal
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EVENTS

14th Seminar "Computer Modeling in Microwave Engineering and Applications
Bayreuth, Germany, 5-6 March, 2012.
Multiphysics Modeling in Microwave Power Engineering
Organized by IMMG of the WPI, USA and Chair of material Processing University of Bayreuth, Germany
Deadline for submission of abstracts 9 January 2012
For more information visit
http://www.wpi.edu/+CIMS/IMMG/Seminars/

PIERS 2012
Kuala Lumpur, Malaysia, 27-30 March, 2012
The conference information can be found at
http://piers.org/piers2012KualaLumpur/
Upcoming & Recent PIERS visit:
http://piers.org/

Time-domain FEM and Applications
International Workshop on Finite Elements for Microwave
Engineering
Estes Park Colorado, USA, 4-6 June, 2012
More information can be found in
http://www.engr.colostate.edu/FEM2012

IMPI Congress 2012
Bally's, Las Vegas USA, 20-22 June 2012
For more information contact
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GCMEA 2012 MAJIC 2st
Global Congress on Microwave Energy Applications
Long Beach California USA, 23-27 July 2012
Organised by the Microwave Working Group
International Committee Chairperson B Krieger
Cober Electronics USA
http://wwwjemea.org./majic2012/

SCEE 2012
Scientific Computing in Electrical Engineering
ETH, Zürich Switzerland, 11-14 September 2012

Topics
1. Computational Electromagnetics
2. Circuit and Device Modelling & Simulation
3. Coupled Problems
4. Mathematical and Computational Methods

Last SCEE 2010 to browse through
http://sites.onera.fr/SCEE2010/node/1

14th International AMPERE Conference 2013
The Management Committee of AMPERE is pleased to announce that the14th International AMPERE conference on Microwave and High Frequency Heating will be staged in the UK during September 2013. Details will be published online in due course www.ampereeurope.org

The information contained in this Newsletter is given for the benefit of AMPERE members

All contributions are believed to be correct at the time of printing and AMPERE accepts no responsibility for any damage or liability that may result from information contained in this publication

Readers are therefore advised to consult experts before acting on any information contained in this Newsletter

Association of Microwave Power in Europe for Research and Education (AMPERE Europe)