AMPERE NEWSLETTER

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EDITORIAL

I am delighted to report on the election of Bob Schiffmann as President of IMPI for the following year. I recollect meeting Bob for the first time at the IMPI Europe Congress at Loughborough University in the UK in 1973 where he was elected President. At this meeting I also came across such luminaries as Geoffrey Voss, Wayne Tinga, Maria and Stan Stuchly and many others. We also reproduce a letter from Bob to IMPI members relating some news regarding the affairs of IMPI.

This issue welcomes Professor T.A.O Junwu who describes some recent research activities at ENSEEIHT, Toulouse. In fact Professor T.A.O Junwu is the Chairman of the13th International AMPERE Conference on Microwave and High Frequency Heating, to be held in Toulouse during September 2011.

Ricky Metaxas. Editor
EUG St John's College
Cambridge UK

BOB SCHIFFMANN ELECTED NEXT PRESIDENT OF IMPI

The Board of Governors at the last IMPI Symposium in Denver Colorado, elected Bob Schiffmann as the next President of IMPI for 2010-11. Bob has a long association with IMPI having been its President from 1973 until 1982 and a Board member for over 20 years. Bob on his election comments, "I take this as not just an honor, but a serious obligation to lead and improve the status of this major scientific society".

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MICROWAVE RESEARCH AT ENSEEIHT TOULOUSE

by Prof. TAO Junwu
ENSEEIHT-LAPLACE, INP Toulouse
University of Toulouse, France

A. Introduction

The research in microwave techniques and electromagnetic at ENSEEIHT Toulouse have a history of several decades. These activities were held successively in the Microwave Laboratory and the Electronics Laboratory, and finally in 2009 these were integrated in the research activities of the Laboratory Plasmas and Energy Conversion (LAPLACE) in Toulouse.

From the beginning the emphasis was on practical applications for optimizing the transfer of microwave energy to specific loads. For this a number of skills have been developed such as in the theory of microwave circuits, in microwave measurements and characterization, in the generation and amplification of microwave power, and in analytical and numerical modeling of electromagnetic fields. For years the development of these skills has followed and

supported the evolution of scientific and industrial problems, while benefiting from the latest technological advances in electronics and computer sectors.

The essence of microwave research at ENSEEIHT is characterized by the constant concern to work in concert with local and national industry in the microwave. As regards these collaborations two fields have emerged: firstly, participation in research projects in the field of telecommunications, especially satellite telecommunications in collaboration with the French National Space Studies Centre (CNES) and Alcatel Space (now Thales Alenia-Space) has allowed the development of skills in design and prototyping of microwave waveguide passive devices and radiating elements, and a set of electromagnetic modeling tool well before the emergence of commercial CAD tools; and secondly, research activities in collaboration with national industrial leaders in the energy sector in the use of microwave power were problems related to microwave-materials interactions, generation and amplification of microwave power, design of specific applicators and automation of facilities (control of the duration and integration of equipments) had to be tackled at both laboratory and industrial level. The first experiment at ENSEEIHT started in the 70s with Electricité de France (EDF), who had established clubs to develop university-industry applications of electricity in the nuclear program and in this context Professor Serge LEFEUVRE chaired the 1979 IMPI conference in Monaco. This meeting gave the idea of a European independence on microwave power research and the need for a framework that has become AMPERE. A large number of PhD projects were involved in areas such as dryers and in the drying of wood, plaster, paper, bread, etc. There have been several books published by EDF.

B. Examples of research in industrial microwave applications

Here we present some examples to illustrate part of recent research at ENSEEIHT, Toulouse.

1. Continuous characterization of electrical properties of materials during RF drying

The processing by microwave and RF energy of a material requires the safe and optimal transfer of RF and microwave from the source to the load. Knowledge of the electrical properties of the material and their changes during processing is essential for the design of an RF applicator and the adjustment of the tuning element. An integrated system of RF heating, real-time reflection coefficient and sample weight measurement was designed and installed, all controlled by a computer. Figure 1 shows an example of measuring the weight of the sample during RF heating.

An electromagnetic analysis of the applicator assembly and the sample was performed using a software based on finite elements (FEM). An inverse modeling was carried out through an optimization programme using as error function the comparison between measurements and electromagnetic analysis of the whole set-up. Figure 2 shows the variation of the electrical properties of the load in the form of a complex relative permittivity during sample material drying.

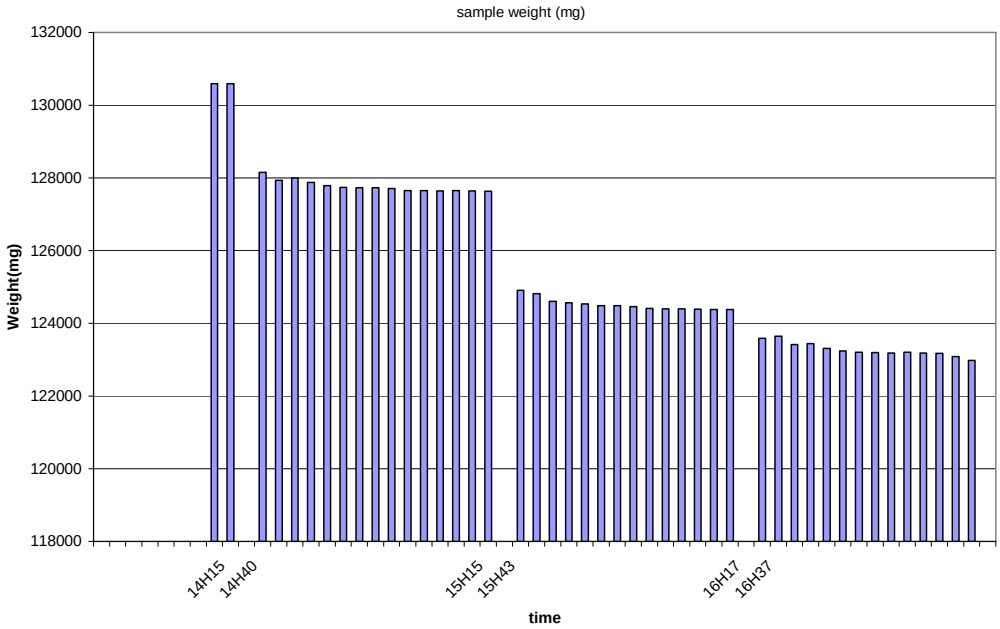

Fig.1 Variation of the weight of the material sample during a 13.56MHz drying

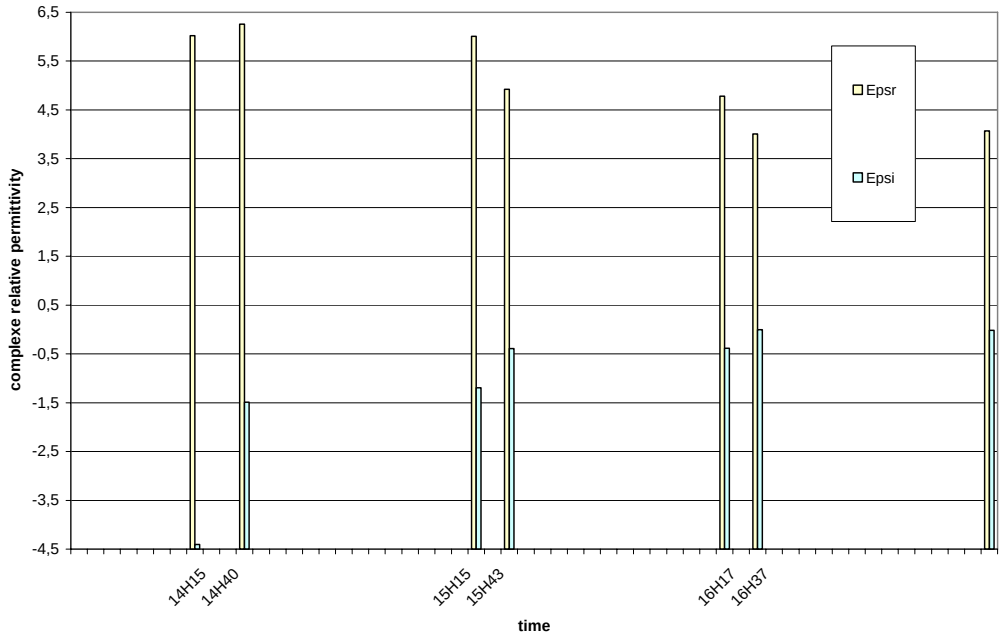

Fig.2 Variation of the real and imaginary parts of the complex permittivity of a sample of a material during drying with RF. Values are deduced from inverse modeling.

2. Sintering of micro- and nano-sized alumina powder

In order to get a very dense material, it is convenient to mix micro- and nano- particles so that the smallest grains fill the space between grains of larger size. Microwave heating is well-suited for sintering a compact of this type because the threshold process which appears in the nano particles induces homogeneous heating, further relayed by electrical conductivity in the entire compact.

Microwave sintering of micro- and nano-alumina powders mixed together was studied recently under a collaborative programme between the Universities of Krasnoyarsk and ENSEEIHT Toulouse. ENSEEIHT worked with Pechiney powders and Krasnoyarsk with homemade powders by explosion in a bomb. The aim was to obtain pills as dense as possible.

A special microwave oven was designed to introduce homemade lossy ceramics to produce infrared heating of the sample surface necessary to get a homogeneous temperature profile. The heating process included different steps: a heating slope of 100°/min up to 1300°C, a dwell for 30 minutes (to transform ??? alumina into ? phase), the last slope of 100°/rnn up to 1600°C and a last dwell time of 30 minutes. The temperature slowly decreases in the oven over the course of 2.5 hours. The temperature in the microwave furnace was controlled by a pyrometer directly focussed on the surface of the sample.

The final densities of the compacts were measured by the Archimedes method.

The sintered samples reached densities of 98% with uniform microstructures without significant grain growth. The microstructures of the microwave-sintered samples were observed by scanning electron microscopy (SEM) (Fig. 3).

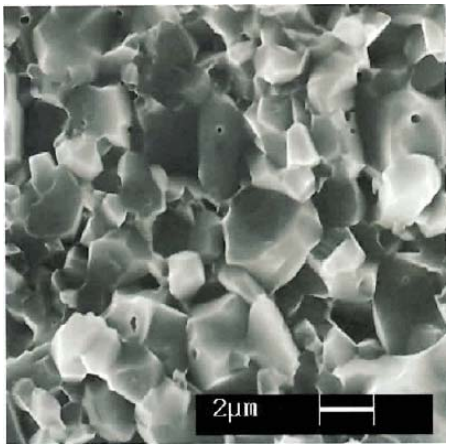

Fig. 3 SEM micrographs of the ceramic $Al_2O_3{}^{c}$(P172SB) – $Al_2O_3{}^{f}$ obtained.

To aid in understanding the process of microwave sintering, a 3D FE model has been designed using COMSOL Multiphysics software to describe the heating process. The model's geometry consists of a truncated pyramid (Fig. 4) comprised by 7 regular tetrahedrons (4 are kept compact to simulate a big particle) and three layers of free space inside the others, which are marked in Fig. 4 in blue colour. The seven tetrahedrons represent bigger grains of alumina micro powder ($d_{0,5}$=0.52 µm), and the free space is filled by the alumina nano powder grains of smaller size ($d_{0,5}$= 0.077 µm). The volumes of the bigger and the smaller grains are in ratio 9: 1, as in the experiment.

Appropriate boundary conditions are chosen to describe the process of sintering. The

thermal source was microwave power Q_{av} and the electrical conductivity is proportional to the temperature**.**

Figure 5 shows the threshold process around the smallest grains (the nanopowder). We assume that a thin layer of air surrounds these grains; the difference of permittivity produces a high electric field, shown by the blue lines, which starts the electric conduction simulated by $\sigma \approx \sigma_0(|E|>E_0)$, where E_0 is the threshold field. This conduction dissipates electric energy which increases the temperature shown by the two red points; after some time the conductivity/dielectric losses also appear in the micro grains. Hybrid microwave and infrared heating simulation lasted for 13 minutes, and showed that temperatures up to 1300°C were reached, as shown in Figure 6.

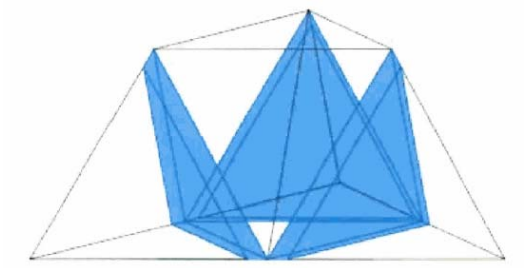

Fig.4 Model of alumina grains

The choice of microwave energy was a good one as it was initially thought and subsequently shown by modelling. In fact, heating of the nanopowder acts like seeds disseminated throughout the volume. It produces a homogeneous heat pattern when the micro grains become heated by themselves. To obtain material of very high density it is necessary to use different granulometries, and this blend fits well with compound microwave heating to produce uniform sintering.

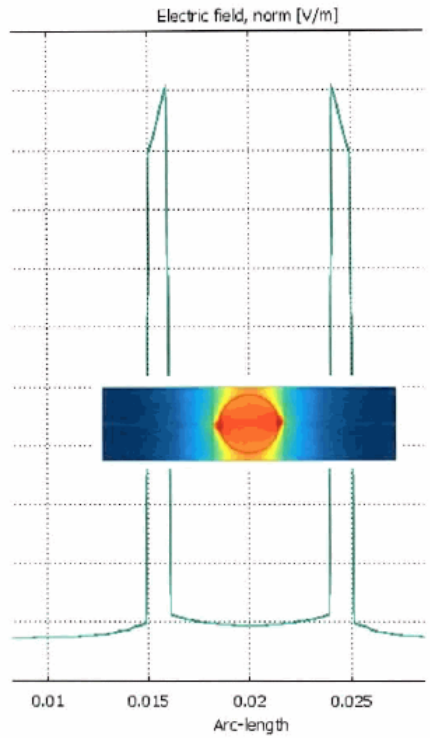

Fig. 5 Threshold process

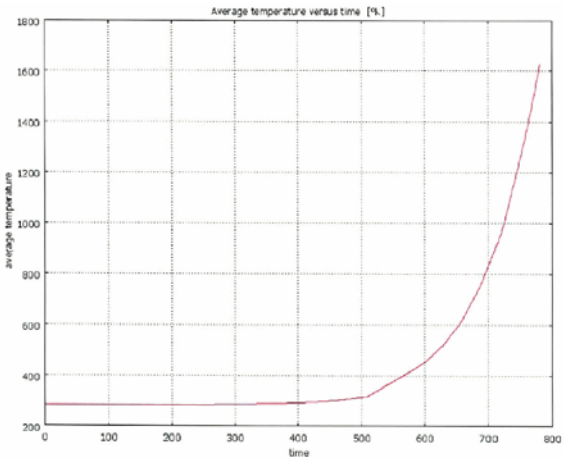

Fig. 6 Average temperature during the heating

3. RF and microwave power flow control devices

Flow control devices for RF and microwave power are essential in complex systems such as industrial drying installations or other microwave and RF applicators. Microwave switches and circulators are the most used flow control devices.

Plasma switch. A microwave switch has been designed and fabricated using plasma as a switching component. The use of a plasma aims to control electronically the switching function. The first test circuit was realized on an alumina substrate (Figure. 7a), on which a gold conductive microstrip was burned. In this circuit a plasma was created (Figure 7b) by applying 300 V DC voltage, allowing the transmission of microwave power.

Theoretically no transmission will be observed when the DC voltage is removed and the plasma considered as perfect insulator. Experimentally a difference of 9dB has been observed on the transmission coefficient with and without the controlling DC voltage.

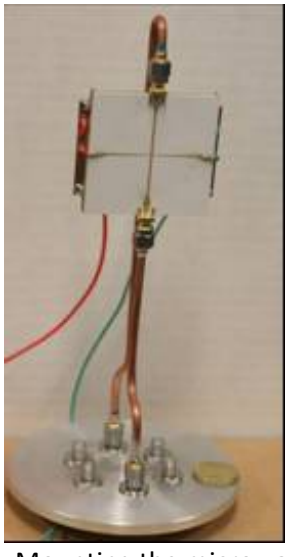

Figure 7a. Mounting the microwave circuit test sockets on crossings sealed to the vacuum chamber in the experimental set up

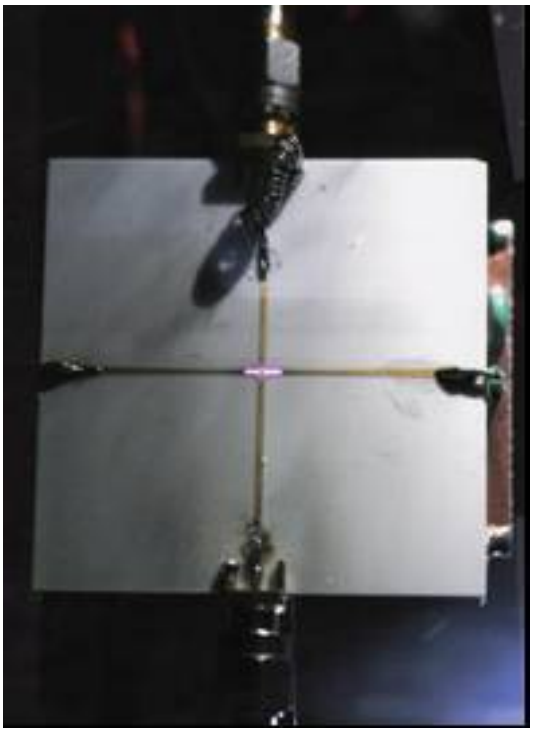

Figure 7b. Electric discharge in the plasma with DC voltage of 300 V.

Cryogenic circulator. The operating mode of microwave and RF circulators is well known and the design of such device poses no difficulty. For industrial applications at very low temperature (around 75K), the problem is quite different, and particularly because of the strong temperature dependence of the magnetic properties of ferrites for which a very small change can make the devices unusable. We have developed an original design procedure for solving this problem. A series of prototypes were produced and tested. The following Figures show respectively a circulator designed by us, the used cryogenic test equipment with liquid nitrogen, then the comparison between measurement results and simulation carried out using a program developed in our laboratory using the finite boundary element method and a commercial finite element method (FEM) based software.

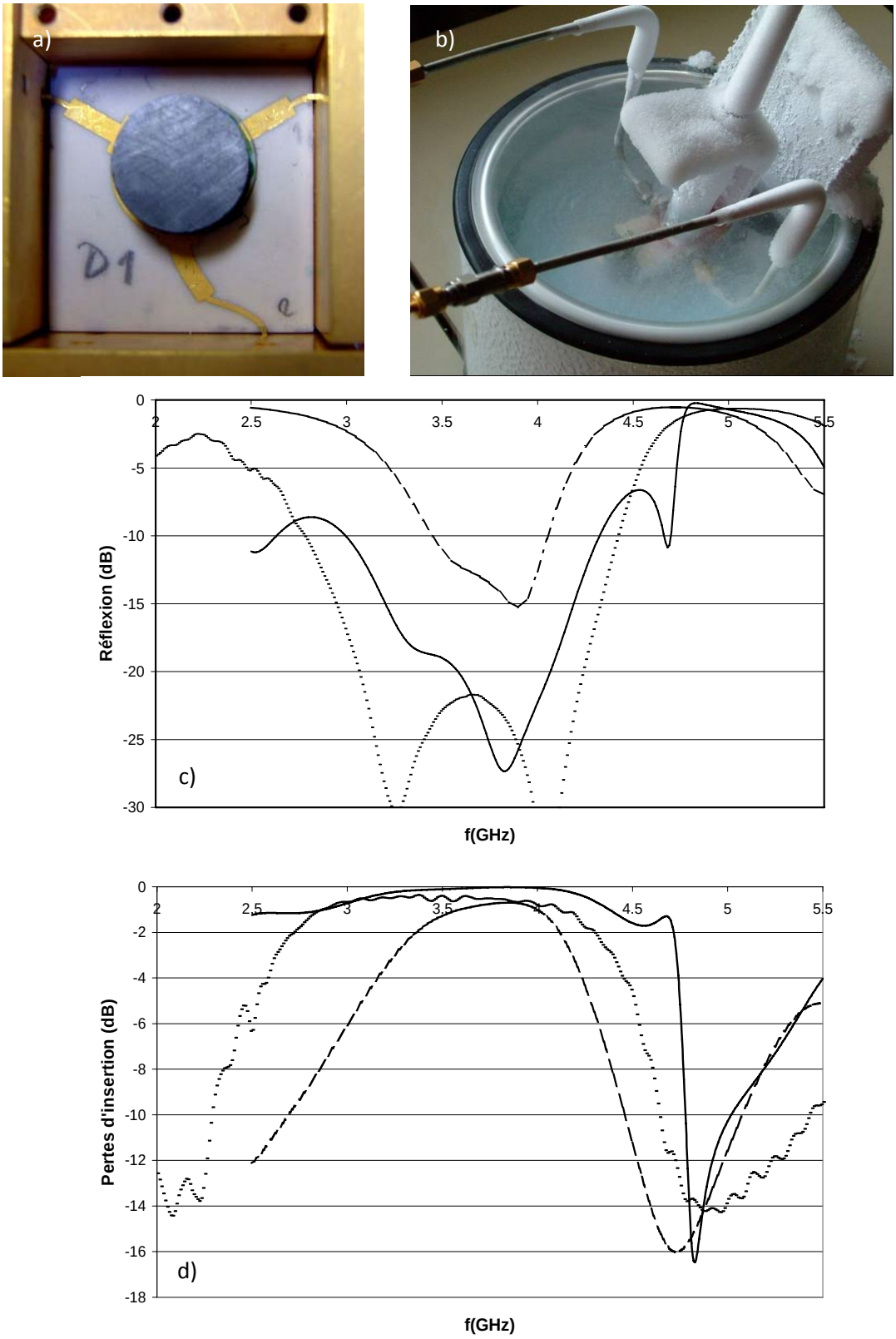

Fig. 8 a) A right hand C band circulator; b) Experimental set-up using liquid nitrogen; c) Comparison of return losses between FEM, boundary element (dotted) modelling and measurement (dashed line); d) Comparison of insertion losses

MESSAGE TO IMPI MEMBERS FROM THE NEW PRESIDENT

Greetings Fellow IMPI Members
July 30, 2010

There is a lot of good news about IMPI that I want to share with you.

Elections: during the Annual Members Meeting there was an election of new Board Members; elected were: Samir Trabelski (USDA), Sohan Birla (University of Nebraska) and yours truly - Bob Schiffmann (R.F. Schiffmann Associates, Inc.).

At the following Board Meeting the following IMPI Officers were elected:

- President: Bob Schiffmann
- Vice President: Ben Wilson (PSC, Inc.)
- Secretary: Dorin Boldor (Louisiana State University)
- Treasurer: Amy Lawson (General Mills)

Several Corresponding Board Members were appointed:

- John Gerling (Gerling Applied Engineering)
- Dave Baron (Consulting Engineer)
- Satoshi Horikoshi (Tokyo University of Science)

Our Past President, Juming Tang (Washington State University) remains as an Ex-Officio Member of the Board.

Management: Beginning August 1, IMPI has a new Interim Director: Molly Poisant, who has replaced Kimberly Thies who ended her position as IMPI's Executive Director on July 31, 2010. Molly has excellent credentials and has grabbed hold of her new position with excellence and enthusiasm. She is a very positive addition to the Institute.

44th Symposium: Our recent Symposium in Denver, July 14-16, was an impressive technical success. There were 79 attendees from 13 countries who attended 38 podium presentations and 21 posters. The Conference opened with a plenary talk by Dr. Paul Hall, President of AIV Microbiology, whose talk "Microbiological Safety Aspects of Microwavable Foods" preceded the Microwave Food Safety Panel, where Dr. Bill Shaw of the USDA/FSIS joined Dr. Hall, and Bob Garfield of the AFFI and chaired by yours truly.

Day Two began with another invited paper "The Interaction of Electromagnetic Fields with Materials From 1 MHz to 1 Terahertz: Overview of Applications Past, Present and Trends for the Future" and presented by Dr. James Baker – Jarvis, NIST Electromagnetics Division.

The balance of the two-day symposium sessions were: Process Development, Simulation, Food Quality and Safety, Bio-Energy, Industrial Applications and Systems Design, Chemistry, and Food Processing.

The Symposium received extremely high ratings for the quality and content of the sessions, and the opportunity to meet and speak with like-minded delegates. If you would like a copy of the proceedings please contact Molly Poisant.

IMPI activities: the IMPI Board established 13 new committees to organize and control many of IMPI's operations:

- Strategy And Finance: Ben Wilson, Dave Baron and Bob Schiffmann
- Education: Amy Lawson
- Newsletter: Sohan Birla
- Symposium Planning: Juming Tang
- Bylaws: Dave Baron
- JMPEE: Juan Aguilar (Editor-in-Chief) and Samir Trabelski

MESSAGE TO IMPI MEMBERS FROM THE NEW PRESIDENT

- Membership: Ben Wilson
- Website: Sohan Birla, Amy Lawson, Mawale Shamaila (Nestle)
- AMPERE and other Societies: Bob Schiffmann
- PR and Marketing: Open

You will soon hear from some of the committee members asking for volunteer assistance to carry out the committee activities. I urge you to take part both to strengthen IMPI and for your own professional development.

While the plans are not yet firm, we are intending to hold a 1/2 to 2 day short course in November focused upon new developments in microwavable foods packaging, ovens and marketing, as well as an entire day devoted to microwavable food safety, particularly in light of the Not-Ready-to-Eat (NRTE) products that have entered the retail food chain. You will hear more about the details of this important seminar in short course in the near future.

For June 2011 we are planning a food-based conference to precede the Institute of Food Technology (IFT) conference in New Orleans. Dr. Juming Tang is leading this effort and will be drawing on your participation.

Final comments: during the last few years, IMPI has gone through a difficult time as a result of the recession and other factors. This has caused a declining membership and lower attendance at our annual meeting. However, I believe strongly that we can counteract this and return IMPI to its former high standards. This will take a great deal of work, and I am pleased that I have the support of the Board, many of the members and our new Director Molly Poisant. I know we can meet the challenges if we all pull together. That is why I am asking you to join us, if you can, in fulfilling some of the much-needed tasks required to strengthen the Institute.

I will be sending you updates from time to time on our activities. We will also use the newsletter in some new ways to promote our various activities, as well as providing information important to all our members.

I wish you all well for the rest of the summer,

Bob Schiffmann
IMPI President

Editor's comment: Apart of the names mentioned above three other members remain Board members for the period 2010-11. These are, Juan Aguilar, Daniela Iordache and Steve Vlock.

PACRIM 9 "THE 9TH INTERNATIONAL MEETING OF PACIFIC RIM CERAMIC SOCIETIES"

Incorporating: AUSTCERAM 2011 "The Biennial Meeting of the Australian Ceramic Society" and AFPG-9 "The 9th International Conference on Advances in the Fusion and Processing of Glass"

10th - 14th July 2011
Cairns Convention Centre
Cairns, North Queensland, Australia

The Australian Ceramic Society in partnership with Materials Australia, Australia's peak materials technology body, to operate PacRim 9, Click here for the conference home page. PacRim 9 offers an opportunity for scientific and process equipment manufacturers, service providers and other commercial organisations, to exhibit their products and services to leading researchers brought together at a single venue. Check website for Exhibition and sponsorship opportunities. You are invited to come to Australia, and attend PacRim9, Austceram 2011 present your work, in Symposium 17 Microwave and RF Processing network with leading world experts, visit the technical exhibition and enjoy the spectacular scenery around Cairns.

The Chair for Symposium 17, Prof. C. Leonelli has arranged the publication of papers contributed to this symposium at the PACRIM 2011 from the Microwave and Radio Frequency Processing of Ceramics in a Special Issue of the IMPI's journal, Journal of Microwave Power and Electromagnetic Energy (JMPEE).

Abstracts and Papers must be submitted through the conference home page, click here to go to the conference home page for deadlines and program detail.

Further information may be obtained by contacting Prof. Cristina Leonelli (Chair and Guest editor) or Michael La Robina (Guest editor) of the Symposium 17 Organising committee.

AMPERE members working in the fields of ceramics and glass are invited to become LIFE members of the Australian Ceramic Society for a once only fee of AU$50.00.

Click here to go to the “Membership” page and download the application form. If one becomes a member then the ACS discount to the PacRim9 fee will apply. Students can join ACS FREE. Clearly, future ACS discounts will apply for any event that ACS is involved in and a discount to its members is offered.

EVENTS

IDS 2010

17th International Drying Symposium,
3-6 October 2010, Magdeburg, Germany.

Deadline for abstract submission: January 18, 2010

For more details contact:
www.ids2010.de or
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MICROWAVE/FLOW CHEMISTRY CONFERENCE 2011

Sharm el Sheikh, Egypt, Feb 25-28, 2011.

C. Oliver Kappe
Chairman
Zing Conference on Microwave and Flow Chemistry 2011
Sharm el Sheikh, Egypt, February 25-28, 2011
www.maos.net http://www.maos.net/

IMS 2011

IEEE MTT-S International Microwave Symposium

Baltimore, MD USA
June 5-11, 2011
http://www.ims2011.org/

MS 2011 invites submission of technical papers describing original state-of-the-art work in a wide range of topics in radio-frequency, microwave and millimeter-wave theory and techniques. The list of technical areas of the IMS 2011 includes:

Topic 33 – High Power Industrial Application: Design of microwave industrial and laboratory applicators, multiphysics modeling/optimization of microwave heating systems, physics of microwave processing of materials, NDE.NDT and dielectric property measurements, systems for microwave chemistry, plasma processing, microwave sintering, microwave-assisted comminution, microwave processing of wood and food.
Paper submission deadline: December 3, 2010.

For details, contact: Dr. Malgorzata Celuch, e-mail: m.celuch@ire.pw.edu.pl , or Dr. Vadim V. Yakovlev, e-mail: vadim@wpi.edu .

ICMAT 2001

Materials Research Society of Singapore will be organizing International Conference on Materials for Advanced Technologies (ICMAT) 2011 from 26 June to 1 July 2011. There will be one of the symposiums on "Microwaves in Science and Engineering Applications" chaired by Profs Dinesh Agrawal and Manoj Gupta. For details please contact Mr Kenneth Tan (icmat@dawnyx.com) or visit http://www.mrs.org.sg/icmat2011/s37.htm

13TH INTERNATIONAL AMPERE CONFERENCE 2011

Microwave and High Frequency Heating, September 2011
Toulouse, ENSEEIHT, France

The Management Committee of AMPERE is pleased to announce that the13th International AMPERE conference on Microwave and High Frequency Heating will be staged in Toulouse during Monday to Thursday September 2011. The conference will be held at the Ecole National Superieure d'Electrotechnique, d'Electronique, d'Informatique, d'Hydraulique, et des Telecommunications

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GCMEA 2012 MAJIC 2st

Global Congress on Microwave Energy Applications

Long Beach California USA
Organised by Microwave Working Group
International Committee Chairperson B Krieger
Cober Electronics USA
http://wwwjemea.org./majic2012/

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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)