

# THE WAVE



*The newsletter publication of the International Microwave Power Institute*

**September/October 2016**



## **PRESIDENT'S MESSAGE**

Other than self-aggrandizement and the need to "publish or perish", why does one publish research in scientific journals? An obvious answer is to let the world know of one's accomplishment, but that's not enough. A requirement for publishing a research paper is that the methodology be clearly identified and described in a manner to allow the conclusions to be independently verified. Imagine that for over a century numerous experiments have been performed to verify the predictions of Einstein's Theory of Special Relativity, first proposed in 1905! I bring this up because of the situation that arises when a researcher provides information for publication gathered from tests run in a microwave oven. I review submissions relating to microwave heating and microwave ovens for several scientific journals. I reviewed such a paper recently and immediately rejected it when I saw that the researcher, experimenting with various heat modes to determine their effects upon particular materials, described the microwave equipment as a "1,000 watt (manufacturer's name) microwave oven" and gave the cavity size. This is a totally inadequate description of the equipment and in rejecting the paper I wrote many paragraphs for why it was inadequate. We know that microwave ovens vary from one another, i.e. no two, even of the same model and from the same production run, are exactly alike. Also, a statement such as 1000 W is meaningless since that's the manufacturer's advertised microwave output power, which likely is far higher than the microwave power measured by an IEC method. (Note that there is no mandatory method of measuring and describing microwave output power – it can be whatever a manufacturer decides it should be.)

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## **Fall Offerings: Industrial Microwave Heating, Roadmap to Microwavable Food Success & Solid State Applications**

IMPI's 2-Part Fall Webinar Series will kick off on October 6th with a Industrial Microwave Heating Webinar. Here, Bob Schiffmann will explore how most industrial food processing systems use microwave energy combined with other heat transfer means. These include hot air, steam, frying and more. A number of commercial systems will be described and analyzed. Webinars are FREE for all IMPI Members.

October also brings our Fall 2016 Short Course, "[Roadmap to Microwavable Food Success](#)." This 2-day event will be held at the Penn 's View Hotel in downtown Philadelphia, PA from October 25-27, 2016. This years Short Course is sponsored by Campbell Soup. As of print, registrations are in from ConAgra Foods, Tyson Foods, *Continued on Page 2*

## PRESIDENT'S MESSAGE CONTINUED

So, with only that information, how is it possible for anyone to test and verify the conclusions put forth by the author? Obviously it's not, hence my rejection. (Consider also the consumer's dilemma in trying to determine a product's microwave-heating time.)

In July, at the Third Global Microwave Conference (3GCMEA), several of us discussed this dilemma and a serious proposal was made, but not pursued, to write to the editors of various scientific journals enumerating the requirements necessary to describe the equipment for submissions involving microwave ovens. This situation presents a serious dilemma because so much work is done initially in microwave ovens and I believe that many product and process ideas are first tested in domestic microwave ovens. Unless one knows what one is doing, it's very easy to reach false conclusions: many potential applications have been falsely accepted or rejected because of the researcher did not understand the ramifications of microwave heating and the peculiarities of microwave ovens. Testing in microwave ovens is hard, and the results reached in one microwave oven might not be duplicated in another; or they might occur in several microwave ovens but not in others. The reasons for this are numerous and involve such things as the size and location of the load; the oven's "cold and hot spots"; the differing power output of various ovens; the presence of a turntable; the location of the launch of the microwaves into the cavity; and much more. So what is a researcher to do? After all, if I perform tests in a particular microwave oven in my laboratory and describe it as best I can in terms of power output microwave field distribution, cavity size, launch location, etc., that doesn't mean someone else would be able to duplicate my results even in the same model microwave oven, because it's likely to be different from mine in some aspects. Obviously, the research needs to continue on more sophisticated and better-controlled and understood microwave equipment.

(Please note that these comments do not relate to product testing that needs to be done in numerous microwave ovens. This is a topic we'll examine at the IMPI Fall Short Course in Philadelphia, October 25 – 27, 2016.)

I believe IMPI has a role to play through our various professional activities. To date, we have not made good use of the IMPI blog or social media, and this is something that Molly and I are discussing and we are working on a program to improve this situation. It is important that we disseminate information, not just to ourselves, but also more broadly to persons who are likely to be using or anticipate using microwave ovens and microwave heating. We need to assist those individuals so that what they do is meaningful, and that they then, depending upon the results, understand how to evaluate their results and what the next steps need to be. As is usually the case, we would appreciate your input and assistance.

With best wishes for the beginning of autumn,

Best wishes,

Bob



### FALL OFFERINGS CONTINUED...

General Mills, PepsiCo, Campbell's and several other mills companies. See our full program here and register by September 24th to save \$100 on your registration fee.

We will round out our Fall programming with Part 2 of our Fall Webinar Series: **Solid-State Generation of RF and Microwave Energy and its Applications**. Dr. Klaus Werner of the R.F. Energy Alliance will report on the fundamentals of solid state RF generation, the technologies involved, typically used system architectures, control schemes, as well as existing and future markets, the associated applications and the role of the RF Energy Alliance.

Registration for these Fall Events can be [found here](#).

Education remains a focal point for IMPI. If you have any topics you would like us to explore in our 2017 Webinar series, please send your recommendations to [molly.poisant@impi.org](mailto:molly.poisant@impi.org) by October 15<sup>th</sup>

## Dechlorination in Metallurgy Using Microwave Processing Technology

By Dr. Ric Gonzalez

IMPI Executive Vice President and Research Fellow, ConAgra Foods, Inc.

Last fall, I had the honor and privilege to be invited to the 17<sup>th</sup> Chinese National Microwave Energy Application Conference in Nanjing, China. I gave two talks there. The first was an introduction to our IMPI organization and the second was about collaborative microwave modeling research with the University of Nebraska. After the conference, I was cordially invited by Professor Shenghui Guo to give the same talks at Kunming University of Science and Technology (KUST). The highlights of the trip to Kunming were touring the National Engineering Laboratory of Microwave Energy and Equipment Technology, followed by the tour of the first and perhaps only microwave metallurgy processing facility in the world of its kind. The 2000-kilowatt large-scale production equipment that I saw was developed by KUST. It is truly a great technological innovation and a breakthrough in the metallurgical field.

As we members of IMPI recognize, heating and treating with microwave energy is a green and highly efficient technique for various thermal processes. Advantages of microwave heating over conventional processing methods include non-contact heating, energy transfer without heat transfer, rapid heating, material-selective heating, volumetric heating, clean and green synthesis, and a higher level of safety and automation. Some microwave-based metallurgical processing techniques for drying, sintering and other chemical reactions have been demonstrated to have 10-20% improved efficiency over techniques that do not use microwaves.

Professor Jinhui Peng's group at KUST has pioneered important work in the application of microwave technologies toward industrial engineering. For more than two decades, the team has focused on the application of microwave energy in extractive metallurgy. Liu and others from the group published one of the early papers in 1990 in this field, detailing the behavior of different minerals heated under microwave irradiation and results from microwave assisted chlorination of sulfide minerals using ferric chloride. In recent years, the work at KUST has expanded to include various other applications of microwaves, including: (i) carbothermic reduction of metal oxides; (ii) clean drying; (iii) dechlorination of metallurgical valuable by-products; (iv) preparation of activated carbon with high surface area; (v) generation of clean hot air; (vi) heating of highly corrosive pickling acid for cold rolled titanium alloy coils; and (vii) drying of water-based paints.

In the zinc and lead smelter industry, there are many valuable by-products, such as ZnO dust, CuCl residue, etc., which also contains many valuable metals such as Ag, In, Ge, Zn, Pb, Cu and others. Because the chlorine (Cl) element can do severe damage during zinc electrowinning, it has to be removed before being recycled into the zinc metallurgy system.

There are two conventional means for removal of Cl from ZnO dust and CuCl residue:

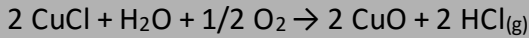
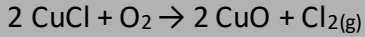
1. Multi-hearth oven/kiln heating at 700°C, resulting in Cl going to waste gas resulting in potential air pollution;
2. Alkali washing of Cl, which transfers the Cl into waste water, resulting in potential water pollution.

Peng's team found that Cl-containing compounds have very good absorptivity of MW energy, which leads to enhancement of the Cl removal reaction. So, they proposed a new process of drying, roasting, and purification, by using MW energy.

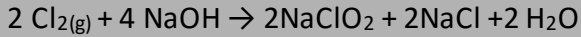
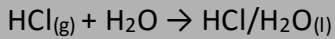
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## **Metallurgy Processing Facility Continued**

The reaction under MW at 400°C is:



Cl becomes a useful resource for producing HCl and NaClO<sub>2</sub>:



Compared with the conventional multi-hearth process, the temperature is reduced by about 250°C and the time is reduced 50% with an energy savings of approximately 30%. Moreover, the MW roasting process is green and clean with no Cl containing waste gas or waste water produced.

Peng's team has been recognized in China as a leader in the engineering application of microwave metallurgical technology. An 84kW production line for treating CuCl residue has also been constructed with 16 million RMB support by the Chinese Ministry of Industry and Information Technology. Profit should be five million RMB every year compared to a two million RMB loss using conventional treatment methods.



*Dr. Ric Gonzalez onsite*



*Figure 1: Microwave Drying Process Equipment*



*Figure 2: Microwave roasting equipment*



*Figure 3: C1-containing gas absorption for producing HCl and NaClO<sub>2</sub> solutions*



*Figure 4: HCl solution purification equipment with microwave energy*



*Figure 6: The whole system view of the MW Cl removal process*

### **Technical Program Chairmen Announced for IMPI 51 Symposium**

IMPI is pleased to announce that Dr. Graham Brodie of The University of Melbourne and Dr. Ric Gonzalez of ConAgra Foods have been named the Co-Chairmen of the 51<sup>st</sup> Annual Microwave Power Symposium. Bob Schiffmann of R.F. Schiffmann Associates Inc. will continue to serve as the Chairman of the Food Science & Technology Program Committee.

IMPI 51 will take place June 20-22, 2017 at the picturesque Sonesta Hotel, Coconut Grove in Miami, Florida. The Call for Papers will be released by the end of September.



*(left to right: Graham Brodie, Ric Gonzalez, Bob Schiffmann)*



For more than 30 years, we have designed and built the world's most advanced industrial microwave systems and high power microwave components.

## Journal of Microwave Power and Electromagnetic Energy

Composition of Issue 3, Volume 50, 2016, will be published on September 30, 2016. Full access to these articles is available to all IMPI Members as part of their annual dues. Contact [molly.poisant@impi.org](mailto:molly.poisant@impi.org) if you need log in details resent to you.

TITLE	AUTHOR(S)
Editor's Message: Microwave Engineering	Juan Antonio Aguilar-Garib
Waveguides for Long-Distance Energy Transport in Microwave Heating	Zhiwei Peng, Xiaolong Lin, Jiann-Yang Hwang, Matthew Andriese, Yuanbo Zhang, Guanghui Li1, Tao Jiang
High-Efficiency and Compact Metamaterial Inspired 900 MHz Rectifier	Sungjin Choi, Ahmed Salim, Heijun Jeong, Sungjoon Lim
Microwave Heat Treatment on Red Sediment Sillimanite-Zircon-Alumina Composites for Fused Zirconia-Mullite Products	Satya Sai Srikant, R Bhima Rao
Effect of Microwave (2.45 GHz) Treatment of Soil on Yield Components of Wheat ( <i>Triticum Aestivum</i> L.)	Muhammad Jamal Khan, Graham Brodie, Dorin Gupta
Prediction of Chronic Kidney Disease using Urinary Dielectric Properties and Support Vector Machine	Peck Shen Mun, Hua Nong Ting, Seyed Mostafa Mirhassani, Teng Aik Ong, Chew Ming Wong, Yip Boon Chong

IMPI members are encouraged to submit papers for consideration in an upcoming issue of JMPEE. Details on the submission criteria, and process, [can be found here](#).

## CALENDAR OF EVENTS

**IMPI Fall Webinar Series: Part 1: Industrial Microwave Heating**, October 6<sup>th</sup> from 11am-12pm. FREE for IMPI Members; \$99 for non-members. Presented by Bob Schiffmann, R.F. Schiffmann Associates Inc. [Register here.](#)

**IMPI's Fall Short Course: A Roadmap to Microwavable Food Success.** October 25-27, 2016. The Penn's View Hotel, Philadelphia, PA, USA. Sponsored by The Campbell Soup Company. [Register here.](#)

**IMPI's Fall Webinar Series: Part II: Solid-State Generation of RF and Microwave Energy and its Applications** November 29<sup>th</sup> from 11am-12pm. Free for Members; \$99 for non-members. Presented by Dr. Klaus Werner of the R.F. Energy Alliance. [Register here.](#)

**The 51<sup>st</sup> Annual Microwave Power Symposium (IMPI 51)**, June 20-22, 2017, The Sonesta Hotel, Coconut Grove, Miami, Florida, USA. More details at <http://www.impi.org/>

## NEWS FROM AROUND THE WEB

[Microwave Drying Equipment Market Size, Growth, Trends, Shares, Forecast and Analysis 2016](#)

[Restaurant Microwave Use: Bad at Cooking, Good at Reheating](#)

[FDA, USDA Offer Tips to Use Your Microwave Safely](#)

[Microwaves Used to Produce "High Quality" Graphene for Electronics](#)



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