MICROWAVE WORKING GROUP
"Bridging Science, Technology and Applications"

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Website Links

MW Working Group

AMPERE

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Upcoming Conferences

International Workshop on MW Technology for Materials Processing

Mumbai – INDIA

February 1-3, 2006

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Welcome!

It is exciting for us to greet you with this inaugural edition of The Microwave Working Group (MWG) newsletter. Why are we doing this and how you can benefit from these electronic pages? Until now the MWG's product has been the World Congresses, where Bob most recently served as chairman for the Fourth World Congress (2004). We've had wonderful responses to all of the Congresses, but we've always felt there was a need for more interaction. The Newsletter is our way of communicating with all our friends and supporters and a means to reach out to those interested in microwave or RF technology. We are motivated to do this because our team is made up of scientists, academics, engineers, and users of heating technologies in industry and in research. Our mission is to bridge science, technology and applications and we accomplish this by organizing congresses and producing publications. Our colleagues are international professionals and it is our hope that our efforts will result broadening the understanding of the unique and energy saving capability of microwaves and radio frequencies for heating purposes. We offer ideas and solutions for increased industrial productivity and the creation of new products and processes.

You are sure to be hearing a lot about what we call "The True World Congress" which is being planned for sometime in 2008. It is a first time event that will bring together the principle microwave societies around the world in one meeting. Included will be the groups from China, Japan, U.S., and Europe. It is being organized by The Microwave Working Group and we predict it will be very special.

We hope that this quarterly newsletter will provide a venue for periodic updates on microwave and RF science, technology and applications where contributions are welcomed by all. In addition we hope to keep the readers informed of upcoming conferences and other relevant events. There is also a section where readers may pose a question to our panel of experts and have it answered in an upcoming issue or request a personal response. We'll try to be innovative and provide more than just a calendar of events. We are still seeking a Science Editor, so if you are interested, please let us know.

Bernie Krieger, President, MWG — Bob Schiffmann, Vice President, MWG — Rebecca Schulz, Editor, Spectrum

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SCIENCE

Due to an oversight, two of the papers submitted for publication in the Proceedings from the Fourth World Congress on Microwave and RF Applications were omitted. Below are excerpts from the papers. The entire papers may be downloaded from the Microwave Working

Science Editor:

If you are interested, please let the editor know!

EXPERT ASSISTANCE:

Vendors:

Research:

Group website (link located in the left-column) – once again, my sincere apologies to the authors! Those of you interested in obtaining a copy of the proceedings will find purchasing information on the MW Working Group website.

MICROWAVE-INDUCED MASS TRANSPORT ENHANCEMENT IN NANO-POROUS ALUMINUM OXIDE MEMBRANES

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ABSTRACT

Experiments were conducted to compare the annealing of nano-porous aluminum oxide membranes by 2.45 GHz microwave radiation and by conventional (resistive element) furnace heating. The starting material was Al_2O_3 membranes that were 60 μm thick, 13 mm in diameter, and containing pores approximately 200 nm diameter. Changes in the porosity and morphology were recorded from digital processing of scanning electron microscope (SEM) images. The data indicates that both microwave and conventionally-heated annealing resulted in a decrease of surface porosity and an apparent increase in the number of pores. However, microwave annealing consistently resulted in a 4-5% greater reduction in porosity and a greater increase in the number of (small) pores than conventionally-heated annealing. These results are consistent with a non-thermal mechanism for microwave-enhanced surface diffusion, although the complex morphology of the pores precluded a quantitative theoretical analysis.

TWO NOVEL SOURCES OF VARIABLE FREQUENCY MICROWAVE ENERGY

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ABSTRACT

Two novel sources of variable frequency microwave energy with increased efficiency are described in this paper - a backward wave oscillator (BWO) with auto-modulation of electron emission and - a two-section BWO, which second section operates in the traveling wave tube (TWT) mode. In the first case, the BWO output is connected through a section of a slow-wave structure to the control electrode of the gun providing a modulation of the current emitted by cathode. This leads to a significant increase in the BWO output signal. In the second case, the electron beam, modulated in the first section (BWO section), excites an electromagnetic wave in the second section (TWT section) and interacts with this excited wave converting its DC energy to the RF signal. It is shown that in both cases the BWO efficiency can be increased 3-4 times. The analysis of above mentioned BWOs is done using the non-linear theory and mathematical calculations, the result of which is presented in this paper.

TECHNOLOGY

By John Gerling

The evolution of technologies in microwave and RF applications is much the same as in other highly technical and specialized fields. Some of us may be lucky enough to be on the cutting edge in certain applications, but few have broad exposure to trends in all areas. So for this inaugural edition of the newsletter, it seems appropriate to highlight some areas where ongoing changes in microwave and RF technologies are having a broad impact.

We all use microwave and/or RF generators in one form or another. A few decades ago, almost all generators utilized linear power supplies that were large and heavy, and few could deliver the high performance necessary for the most demanding applications. Power supplies have since evolved to utilize inverter (switch mode) technologies having significantly reduced size and weight yet increased performance. Initially too expensive for most industrial applications, costs have plummeted so that inverter power supplies are often the most practical and economical choice.

For many years the only practical choices of microwave frequencies for industrial applications were 915 MHz and 2.45 GHz, the latter largely due to the economies of scale brought by the consumer microwave oven. But now we have a third choice, 5.8 GHz, made practical by the 5.8 GHz magnetron introduced a only few years ago. Advances in solid state amplifier devices continue to increase their output (gain) so that the now very costly high power solid state generators at these frequencies might eventually become economically practical.

Semiconductor plasma processing has often been called the latest “killer application” for microwave and RF technology. Initially the exclusive domain of RF frequencies, microwaves were found to offer significant benefits and quickly became the technology of choice for many plasma processes. But lately both microwave and RF technologies have been displaced in many processes by lower frequency methods that offer similar performance in a smaller, lighter and lower cost package. Although such a trend may signal the end of microwave’s semiconductor boom, new applications such as in wafer and fluid heating continue to emerge (a good topic for the newsletter’s Application section!).

No doubt there are some interesting technology trends worth highlighting in many other application areas, including:

- Medical applications (e.g. ablation using 2.45 GHz)
- Chemistry (e.g. nanomaterials synthesis)
- Waste remediation (e.g. adsorbent regeneration)
- Materials processing (e.g. atmospheric plasma)

We encourage readers to submit suggestions for specific technologies and/or trends to be highlighted in future newsletter editions. Those submitting selected topics will then be invited to expand their thoughts to an article for publication.

APPLICATIONS

RAPID AND EFFECTIVE BAKE OUT FOR MOISTURE SENSITIVE DEVICES

Submitted by:
Iftikhar Ahmad and Zak Fathi
Lambda Technologies

The combination of larger chip sizes, smaller devices, newer materials and shorter development cycles are leading to a rapid increase in the number of moisture-sensitive devices (MSD). Moisture is a leading cause for defects and failures electronic packages. As the moisture sensitivity of plastic encapsulated components increases, an innovative approach to moisture removal is needed. As moisture and/or water are the root cause of the problem, the ideal approach would be to target water molecules directly. The use of microwave heating to remove water in food and plastics has been widely recognized for several decades. It is believed that the polar molecules that make up water respond to microwave energy by rotating with the alternating field thereby heating quite efficiently. Because of this microwave energy has been applied to dry numerous materials such as: timber, ceramics, powders, pharmaceuticals, flowers, foods, as well as textile and paper products. In most cases processing was accomplished with standard 2.45GHZ or 915MHz applicators. However, removing moisture from an electronics package is a bit more complicated. Most conventional multi-mode cavities create fields that are non-uniform. The non-uniformity can lead to uneven heating and arcing between the metal components destroying the package. The Variable Frequency Microwave approach is substantially different than fixed frequency microwave because it sweeps through a bandwidth of frequencies in a fraction of a second. Each frequency has a standing wave pattern and the resident time for this pattern is in microseconds. As the frequency changes the wave pattern also changes and provides controlled and uniform distribution of microwave energy over an average time basis. In addition to the uniform energy distribution the rapid sweeping does not allow charge build up even on metallic and electronic components making it possible to bake out and process delicate electronic devices without damage. Data suggests processing with the VFM results in a higher weight loss and a shorter process time. The VFM process has been used consistently without damage to wafers, CMOS devices and various electronic packages, with functionality and reliability of the devices rigorously tested by numerous major electronic manufacturers. The data suggests that VFM has enormous potential and opportunity to address a serious issue of bake out of moisture sensitive devices for the electronic packaging market. For more information on this exciting technology please visit www.microcure.com or contact (919) 462-1919.

ASK THE EXPERTS

This section is specifically designed for the reader who may not be familiar with RF or MW technology, or someone working in the field with an equipment or processing challenge. If you have a question about microwave or radio frequency processing, equipment, or research, and

you would like it answered by qualified experts in the field, please send your inquiry to the editor. Selected questions will be answered in the next newsletter. All questions received will be answered on the MWG website. If you require a speedier answer, just let us know how to contact you and we will do our best to match you with the group or company that can best solve your problem!