



AMPERE NEWSLETTER

A Newsletter devoted to RF and MW heating in the range 1MHz to 20 GHz

ISSN 1361-8598

ISSUE 56
APRIL 2008

EDITORIAL

IN THIS ISSUE

In this issue we are highlighting the work on HEPHAISTOS carried out at Institute of Pulsed Power and Microwave Technology in Karlsruhe. This entails a modular microwave system line which shows an excellent homogeneous field distributions developed within a system that can replace the conventional autoclave technology. Dr Lambert Feher is a member of the Management Committee for AMPERE.

As the 1st Global Congress on Microwave Energy Applications is fast approaching I hope that most readers of this Newsletter are making arrangements to participate and contribute to its proceedings. For details see the Events section of this issue.

AMPERE'S 12TH INTERNATIONAL CONFERENCE IN 2009 SWITCHES TO KARLSRUHE

Following the recent AMPERE Committee meeting in Leuven, Belgium it was decided to switch the venue of the 12th International AMPERE conference on Microwave and High Frequency Heating from Leuven to Karlsruhe. Therefore the organization and management of this conference will now be in the hands of Dr Lambert Feher whose work on HEPHAISTOS is described in the following pages.

The Committee of Management of AMPERE is extremely grateful to Dr Lambert and his group for their willingness to undertake this task.

Ricky Metaxas, Editor

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HEPHAISTOS - ENERGY EFFICIENCY AND INNOVATION BY MICROWAVE TECHNOLOGY FOR THE INDUSTRIAL PRODUCTION OF COMPOSITE MATERIALS

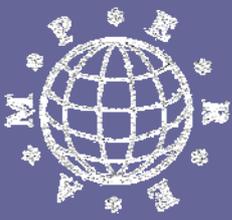


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1. Introduction

High mobility and resources consumption today characterize a global, export-oriented economy. Increasing scarcity of resources and energy, however, will influence the cost structure of products, services, locations, and mobility. Provident,

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HEPHAISTOS - ENERGY EFFICIENCY AND INNOVATION BY MICROWAVE TECHNOLOGY FOR THE INDUSTRIAL PRODUCTION OF COMPOSITE MATERIALS

innovative developments give rise to new, resources-efficient production processes, systems, and materials. For some years now, innovative approaches have been pursued by the KIT (Karlsruhe Institute of Technology, Institute for Pulsed Power and Microwave Technology IHM of the Forschungszentrum Karlsruhe) to opening up energy-efficient applications with microwaves by technology transfer to industry. Technical applications of microwaves have already become a natural part of modern life (e.g. kitchen microwave). Compared to conventional heating methods, microwaves have clear advantages.

Generation of very homogeneous fields so far has been a key problem of microwave process technology, while it is an indispensable prerequisite for many industrial applications. In 1997 already, this problem was solved and the solution patented based on fundamental studies at the Forschungszentrum Karlsruhe. Under certain conditions, a hexagonal geometry of the microwave applicator was found to be ideal for the homogenization of the microwave fields. Another important step of technical development was the calculation of temperature responses of materials in electromagnetic fields. It was possible to predict, for instance, that process fields with disappearing thermal gradients can be generated in carbon fiber-reinforced composites.

For this industrial application, a modular microwave system line HEPHAISTOS with excellent homogeneous field distributions was developed. **HEPHAISTOS** means **H**igh **E**lectromagnetic **P**ower **H**eating **A**utoclaveless **I**njected **S**tructures

Oven System and refers to the future time- and energy-efficient alternative to autoclave technology (thermal ovens under very high pressure). By the way, already in ancient times, HEPHAISTOS was responsible for metal and oven processing. He is identical with Daedalus, famous for his “first mythological flight” and the “pasted wings”.

2. Decreasing Resources Consumption by Airplanes, Cars, and Wind Energy Plants

The problem faced by Daedalus and Icarus is of crucial importance to present aeronautical research, in particular since airplanes and wing components have been made of synthetic lightweight construction materials to an increasing extent. Use of the correct “paste”, or better, plastic material for wings, of course, is of primary significance. After about 80 years of expensive technical development, the potential of improved lightweight construction has been nearly exhausted for metals. In case of carbon fiber-reinforced composites, however, development is in full swing. Due to their low density of 1.55 g/cm³ compared to aluminum with 2.8 g/cm³, these materials are particularly suited for lightweight construction.

Current airplanes still consist mainly of metal. In the Airbus A320, the weight fraction of fiber-composite materials already amounts to 15%. While each A380 still contains around 60% of aluminum and 22% of carbon fiber-reinforced composites, the share of the latter material shall rise to 52% in the new long-range aircraft A350 XWB that is comparable to the new 787 of Boeing. Today, CFC materials are still hardened in heavy industry ovens at high pressure, the so-called



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autoclaves. The internationally patented HEPHAISTOS systems, by contrast, work without additional pressure in principle and heat the component only in an inertia-free manner (selective heating) - the oven environment is no longer heated actively. Novel, highly efficient antenna systems have been developed for the HEPHAISTOS systems, by means of which nearly the complete microwave power generated can be coupled in the oven modules without any losses. Moreover, the microwaves act volumetrically, i.e. without heat conduction, the microwave enters the material to be heated and immediately leaves a heat input inside. In this way, a high heating rate is generated directly in the component by the microwave at low energy consumption. In synergy with the HEPHAISTOS technology, aeronautical research is developing new, lower-cost processes to inject polymer resins as "paste" between dry carbon fibers. Even the production step of resin injection will be accelerated and improved by novel, small, compact microwave injectors in the future. Methods used to save weight in the airplane may also be used to reduce weight in vehicles. In the Formula 1, for instance, CFCs are applied in a way that is similar to that in aviation. Considering the wide application of composite materials in the automotive sector, where it is not only focused on synthetic carbon fibers, but also on natural fibers, such as flax and sisal, for car bodies, microwave technology opens up similar use and saving potentials. Apart from technical developments for industry up to large-scale industrial systems, fundamentals are being studied together with other KIT institutes of

the Forschungszentrum Karlsruhe to improve and accelerate the hardening of resins by specific microwave-sensitive materials and nanoparticles. Due to its modularity, the HEPHAISTOS technology is suited for very large systems and the high-quality hardening of very large technical composite structures. This is not only relevant to aircraft construction, but also to sustainable energy generation with large wind energy plants and CFC rotor blades. Since 2003, the HEPHAISTOS microwave technology has been commercialized under a technology transfer project of MAP (Marketing, Patents and Licenses Department) of the Forschungszentrum Karlsruhe with Vötsch Industrietechnik, the Institute for Aircraft Design (IFB) of the University of Stuttgart, and the Composite Research Center of EADS in Munich. In 2004, this work was granted the Innovation Award of the Karlsruhe technology region. In 2006, it was elected to be among the first ten candidates for the Future Award of the Federal President.

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ICMMT2008

**International Conference on
Microwave and
Millimeter Wave Technology**
April 21-24, 2008, Nanjing, China
Details from:
<http://www.icmmt2008.org/>

Finite Elements Workshop

**The 9th International Workshop on
Finite Elements for Microwave
Engineering**
May 8 – 9 2008, Bonn, Germany
<http://www.lte.uni-saarland.de/fem2008/>

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IEEE CEFC 2008 **13 Biennial Conference on Electromagnetic Field Computation**

Athens May 11-15 2008
Details from:
<http://www.cefc2008.gr>

IMPI's 42nd Symposium

June 26-28, 2008
**Chateau Sonesta, New Orleans, LA,
USA**
for further details visit
<http://www.impi.org/Meetings/index.html>

7th International Workshop "Strong Microwaves: Sources and Applications"

July 27 - August 2, 2008, Nizhny
Novgorod, Russia

All inquiries should be addressed to the
Scientific

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GCMEA 2008 MAJIC

**1st Global Congress on Microwave
Energy Applications**

**Otsu Prince Hotel. Lake Biwa, Otsu,
Japan**

August 4-8 2008

Organised by the Japan Society of
Electromagnetic Wave Applications

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Kokushikan University

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<http://www.jemea.org/majic2008/>

61st Annual GASEOUS ELECTRONICS 08

14-17 October 2008
Dallas Addison Marritt Quorum
by the Gallerias Dallas Texas
For more information contact
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At overset@utdallas.edu or visit
www.utdallas.edu/gec

MEP 2008

A colloquium on Modelling for Electromagnetic Processing
Hannover Oct 27-28 2008
is organized by the Institute for Electrothermal Processes of the Leibniz University of Hannover and the University of Latvia.

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<http://www.etp.uni-hannover.de/mep/index.htm>

EuMC2008

Amsterdam, the Netherlands 28-31 October
The 38th European Microwave Conference (EuMC)

is the core of European Microwave Week 2008,
the largest event in Europe dedicated to microwave electronics.

For details visit:
www.eumweek.com

12th International AMPERE Conference 09

Microwave and High Frequency Heating, September 2009
Institute for Pulsed Power and Microwave Technology (IHM)
Karlsruhe Germany

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