UNIVERSITA' DEGLI STUDI DI PADOVA

UIE - International Union for Electricity Applications
SIG-E&R Education and Research

AMPERE - Association for Microwave Power in Europe
for Research and Education

A.E.I.T. - Sezione Veneta

HES-23

International Conference on

Heating by Electromagnetic Sources

Induction, Dielectric and Microwaves, Conduction & Electromagnetic Processing

Padua, May 10-12, 2023

Organized by
LEP – Laboratory for Electroheat - Padua
Department of Industrial Engineering
University of Padua (Italy)

Programme

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

HES - 23

International Conference on
Heating by Electromagnetic Sources

The organisers gratefully acknowledge the sponsorship and financial support received from the following Institutions and Organisations:

SPONSORS

Università degli Studi di Padova

Department of Industrial Engineering – Padova University

UIE – International Union for Electricity Application

AMPERE – Association for Microwave Power

A.E.I.T. - Sezione Veneta

CONTRIBUTORS

ATE Applicazioni Termo Elettroniche S.r.l.– Brendola (VI), Italy

FLUXTROL INCORPORATED - Auburn Hills, MI –USA

INOVA LAB – Padova - Italy

UNOX S.p.A. – Cadoneghe (PD), Italy


APPLICAZIONI
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USEFUL INFORMATION

LOCATION

The Symposium events will be held in the following locations:

MAY 9

- **Registration and Welcome Reception** - "Orto Botanico - Foyer", Via dell'Orto Botanico, 15 - Padova

MAY 10

- **Registration** - "Orto Botanico - Foyer", Via dell'Orto Botanico, 15 - Padova
- **HES-23 Conference** - "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 - Padova

MAY 11

- **HES-23 Conference** - "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 - Padova
- **Gala Dinner** - Caffè Pedrocchi, Padova (PD)

MAY 12

- **HES-23 Conference** - "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 - Padova

REFERENCE ADDRESS AND TELEPHON NUMBERS

Dept. of Industrial Engineering - via Gradenigo, 6/A - Padova

Secretariat:	+39-049.827.7514 +39-049.827.7539
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LANGUAGE

English will be the official language of the Symposium.

PROCEEDINGS

The full text of all papers presented will be published in the Conference Proceedings in electronic format (USB dongle or available on the website).

REGISTRATION

Registration of participants will take place on Tuesday, May 9 at "Orto Botanico - Foyer", Via dell'Orto Botanico, 15 Padova between 18.00 and 19.30. Late registration can be done on Wednesday, May 10 at "Orto Botanico - Foyer", Via dell'Orto Botanico, 15 Padova between 8.00 and 12.00.

WELCOME RECEPTION

All participants and registered accompanying persons are invited to the welcome cocktail party which will take place on Tuesday, May 9 between 19.30 and 21.00 at the "Orto Botanico - Terrace", Via dell'Orto Botanico, 15 Padova"

SOCIAL EVENT

Before welcome reception, the registered guests could take the tour of 'Orto Botanico', the oldest existing Botanical Garden in the world. The guided tour will start at 18.30 with a guide. Two groups of 30-35 people can enjoy this opportunity.

GALA DINNER

The gala evening will take place in the prestigious "sala Rossini" of Caffè Pedrocchi, on Thursday, May 11, starting at 19.30. Piazzetta Pedrocchi 8, Padova.
Formal wear is suggested. This event is reserved for the participants and accompanying persons who have registered to the Conference.

ROBERT S. RUFFINI INNOVATION AND ENTREPRENEURSHIP AWARD

Sponsored by Fluxtrol, Inc.

Fluxtrol and HES-23 will offer the Young Innovative Scientists/Professionals competition-based award and recognition program, seeking to encourage participation of young scientists in entrepreneurship, and to provide attractive offers and opportunities in the worldwide electrotechnology community.

IMPORTANT NOTICE

All conference attendees choosing to attend the special session will be required to sign an NDA for the session to avoid compromising any presenters intellectual property rights.

HES – 23

International Conference on Heating by Electromagnetic Sources

- **May 9**

  Time 18.00 - 19.30 – Registration
  "Orto Botanico - Foyer", Via dell'Orto Botanico, 15 – Padova

  Time 18.30 - 19.30 – Orto Botanico guided tour

  Time 19.30 - 21.00 –Welcome Reception
  "Orto Botanico - Terrace", Via dell'Orto Botanico, 15 - Padova

- **May 10**

  Time 9.00-18.30 – First day of Conference
  "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 – Padova

- **May 11**

  Time 9.00 – 18.30- Second day of Conference
  "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 – Padova

  Time 19.30 - 22.30 - Gala Dinner
  "Sala Rossini" - Caffè Pedrocchi Piazzetta Pedrocchi 8, Padova.

- **May 12**

  Time 9.00 - 14.00 – Third day of Conference
  "Orto Botanico - Auditorium", Via dell'Orto Botanico, 15 – Padova

Time schedule HES-23

PADOVA **May 9**	**PADOVA** **May 10**	**PADOVA** **May 11**	**PADOVA** **May 12**
	8.30-12.00 ***Late Registration***	9.00-10.00 **PANEL SESSION** **A.I & ELECTROHEAT TECHNOLOGIES**	
	9.00–9.15 **Welcome address**	10.00-11.00 **Oral Session SA** **SPECIAL APPLICATION**	9.30-10.00 **Oral Session MW** **Microwaves**
	9.15-11.00 **Special Session ETS** **ETS**	11.00 -11.30 *Coffee break*	10.00-11.15 **Oral Session EPM 2** **Electromagnetic Processing of Materials 2**
	11.00 -11.30 *Coffee break*	11.30-12.15 **Oral Session SA** **SPECIAL APPLICATION**	11.15 -11.45 *Coffee break*
	11.30-13.00 **Oral Session EPM 1** **Electromagnetic Processing of Materials**	12.15-13.15 **Oral Session IH 2** **Induction Heating 2**	11.45-12.30 **Oral Session IH 3** **Induction Heating 3**
	13.00-14.00 *Lunch*	13.15-14.30 *Lunch*	12.30-13.00 **Closing Session**
	14.00-15.30 **Oral Session NM 1** **Numerical Modeling of Induction Heating Processes 1**	**14.30-15.30** **Oral PE** **POWER ELECTRONICS**	13.00-14.30 *Lunch*
	15.30-16.00 *Coffee break*	15.30-16.00 *Coffee break*	
18.00-19.30 ***Registration***	16.00-17.30 **Oral Session IH 1** **Induction Heating 1**	16.00-17.15 **Oral Session NM 2** **Numerical Modeling of Induction Heating Processes 2**	
18.30-19.30 ***Botanical Garden guided tour***		17.15 **ROBERT S. RUFFINI INNOVATION AND ENTREPRENEURSHIP AWARD**	
19.30-21.00 ***Welcome reception***		***19.30 – 22.30*** ***Gala Dinner***	

TECHNICAL PROGRAM

I DAY

May 10, 2023 (Wednesday)

Welcome address

9:00 - 9:15

Chairman:
Prof. F. Dughiero – University of Padova – Italy

Session ETS **Special Session – ELECTROTECHNOLOGIES FOR SUSTAINABILITY**

9:15 – 11:00

Chairman:
Prof. M. Forzan – University of Padova - Italy

J. Kimme, J. Gruner, A. Fröhlich, M. Kroll
Experimental investigation of an additive manufacturing technology with reduced energy input using inductive wire melting

K. Van Reusel
The European projects LEILAC and DESTINY: Two complementary examples of electrification in the cement industry

E. Baake
Future potentials and challenges for decarburization of industrial heating processes using electrotechnologies

F.Dughiero, M. Forzan

Technical, economic and social advantages of using electroheat technologies in a pathway to electrification for FF55 and NZE fulfillment.

Coffee Break (11:00-11:30)

Session EPM 1 **Electromagnetic Processing of Materials**

11:30 - 13:00

Chairman:
Prof. E. Baake – University of Hannover – Germany

Z. Ren, J. Wang, C. Chen
Research on solidification of alloys in strong static magnetic field

M. Milgrāvis, I. Kaldre, M. Kalvāns, I. Krastiņš, A. Bojarevičs, T. Beinerts
Particle dispersion in aluminium matrix composites by electromagnetic processing

V. Bojarevics
Non linearity of magnetically levitated liquid droplet oscillations and the effect on material properties measurements

R.Nikoluskins, I.Kaldre, M.Milgravis, T.Beinerts, M.Kalvans, A.Bojarevics
Continuous Directional Solidification of Aluminium Alloys Under Combined Electromagnetic Interaction

B. Nycz, S. Golak, R. Przyłucki, Ł. Maliński
Optimization an inductor for electromagnetic levitation melting

Lunch (13:00-14:00)

Session NM1 **Numerical Modeling of Induction Heating Processes 1**

14:00 - 15:30

Chairman:
Prof. P. Di Barba – Università di Pavia – Italia

X. Querejeta, U. Segurajauregi, M. Areitioaurtena, M. J. Cabello, E. Ukar
Numerical simulation of heating strategies for induction tempering

T. Nakamura, K. Umetani, M. Miyake, M. Ishihara, E. Hiraki, T. Ishihara, S. Ichikawa
Semi-analytical derivation of heating material distribution for homogenizing heat generation of cylindrical catalyst

Y.Perevalov, A.Melnikov, V.Parmenov, M.Kudryash, N.Maslennikov, I.Safonov, I.Abdulkhakov
Numerical simulation and investigation of pulsed magnetic field concentrators design features

V. Demidovich
Development of Induction Heating Systems in Metallurgy Using Digital Twin Technology

Coffee Break (15:30-16:00)

Session SA 1 **Induction Heating 1**

16:00 - 17:30

Chairman:
Prof. J. Barglik - Silesian University of Technology – Poland

I. Álvarez-Gariburo, H. Sarnago, O. Lucía
A High-Performance Multi-Level Power Supply for Versatile Induction Heating Processes

O. Lucía, H. Sarnago, J.M. Burdío
A New Efficiency Figure of Merit for Induction Heating Appliances Operating Under Highly Variable Operating Conditions

D. Desisa, J. Barglik, V. Kotlan, A. Smalcerz, I. Dolezel
Model of Residual Stresses in Inductively Hardened Surfaces

G. Giard, K. McMeekin, M. Tousignant, F. Sirois
Experimental Verification of a New Power-Equivalent Model for Induction Heating

J. Barglik, V. Kotlan, A. Smalcerz, M. Kasprzak, D. Desisa, I. Dolezel
Improved Hardening Model for Gear Wheels

II DAY

May 11, 2023 (Thursday)

PANEL SESSION AI & ELECTROHEAT TECHNOLOGIES

9:00 – 10.00

Prof. F. Bay – Ecole des Mines de Paris – France
Prof. P. Di Barba – Università di Pavia – Italia
Prof. F. Dughiero – University of Padova – Italy
Prof. O. Lucia – University of Zaragoza – Spain

Session SA **Special Applications**

10.00 – 12.15

Chairman:
Prof. I. Doležel - University of West Bohemia - Czech Republic

A. Pascual, J. Acero
Study of magnetic nonlinearities in FeNiCrMn alloys with low Curie temperature

S. Panhale, C. Hofmann, M. Kroll, P. Rochala, A. Kunke
Investigation of intermetallic compound formation with transient material simulation of inductive chip level bonding for microelectronic applications

Sean M. Muyskens, Christopher J. Yakey, David R. Morris, Robert C. Goldstein
Physical Simulation and Computational Modelling for Validation of Soft Magnetic Composite Impeder Performance

Álvarez-Gariburo, Enrique Cordero García-Galán, Marina Medel Plaza, Enrique Gómez Barrena, Jaime Esteban, H. Sarnago, J. Acero, J.M. Burdío, and O. Lucia
A Portable Induction Heating System for Implanted Prosthesis Disinfection

Coffee Break (11:00-11:30)

K. Kim, A. Panychev , I. Karpova
Innovative milk pasteurization unit using induction heating

A. Narvaez, C. Carretero, J. Acero
Performance Evaluation of Homogenization Techniques for Proximity Losses in PCB Coils applied to Induction Heating Systems

Session IH **Induction Heating II**

12:15 – 13.15

Chairman:
Prof. A. Nikanorov - Leibniz Universität Hannover – Germany

V. Kotlan, I. Petrasova, I. Dolezel
Proposal of model of laser and small-scale induction hardening and its calibration

A. Nikanorov, E. Baake, I. Niedzwiecki
Numerical simulation for advanced designing of induction heat treatment systems with magnetic flux concentrators

D. Günther, M. Kroll, A. Kunke, J. Gruner
Influence of real weld vee geometry on the FE simulation of the HFI welding process

P. Rochala, M. Kroll, S. Panhale, C. Hofmann, A. Kunke
Simulation and validation of an induction based silver sintering bond process for die-attach applications

S. Pavlovs, A. Jakovics, A. Chudnovsky
Numerical modelling of heating and melting of metal in mini industrial direct current electrical arc furnace

Lunch (13:15-14.30)

Session PE **Power Electronics**

14:30 – 15.30

Chairman:
Prof. C. Carretero – University of Zaragoza – Spain

I. Álvarez-Gariburo, H. Sarnago, O. Lucía
A Versatile plasma generation power supply featuring a multi-level converter for arbitrary waveforms generation

P.Briz, B.López-Alonso, H.Sarnago, O.Lucía, J.M. Burdío
Nanosecond pulsed electric field generators, a review

B. López-Alonso, R. Estema, P. Briz, H. Sarnago, O. Lucía and J.M. Burdío
Optimizing IRE Targeting Using Multi-Electrode Structure and Biomedical Multi-Output Generator

P. Guillén, H. Sarnago, O. Lucía, J. M. Burdío
Induction Heating Load Detection Based on Short Pulse Response for a Multi-Output Inverter with Shared Power Devices

Coffee Break (15:30-16:00)

Session NM 2 **Numerical Modeling of Induction Heating Processes 2**

16:00 - 17:15

Chairman:
Prof. F. Bay – Ecole des Mines de Paris – France

J. Ortega, O. Lahuerta, C. Carretero, J.P. Martínez, J. Acero
Nonlinear Impedance Boundary Condition from Linear Piecewise BH-Loop Applied to Induction Heating Systems

O. Lahuerta, J. Ortega, C. Carretero, J.P. Martínez, J. Acero
Numerical Modelling of Induction Heating Systems based on IBC from Fröhlich Model

P. Di Barba, M.E. Mognaschi, A.M. Cavazzini, M. Ciofani, F. Dughiero, M. Forzan, M. Lazzarin, D.A. Lowther, J.K. Sykulski
Construction of a database of results of TEAM Workshop Problem 36 suitable for training a CNN

Garcia C. Jesus O., Alves Z. José R., Ripert Ugo, Barlier Julien, Bay François
Adaptive error-estimator based modelling for induction heating processes

ROBERT S. RUFFINI INNOVATION AND ENTREPRENEURSHIP AWARD
17.15
Robert Ruffini - Fluxtrol President – USA

Gala Dinner (19:30 – 22.30)
Caffè Pedrocchi, Padova (PD)

III DAY

May 12, 2023 (Friday)

Session MW **Microwaves**

9:30 – 10.00

Chairman:
Prof. K. Van Reusel – KU Leuven – Belgium

M.C. Robinson, J.A. Molles, V.V. Yakovlev, Z. Popovic
Phase Effect on the Microwave-Induced Temperature Field: Computational and Experimental Evidence

A. Zanoletti, A. Cornelio, I. Alessandri and E. Bontempi
New technologies for spent lithium-ion batteries recovery, based on microwave

Session EPM 2 **Electromagnetic Processing of Materials 2**

10:00- 11:15

Chairman:
Prof. A. Jakovics – University of Riga - Latvia

V. Dzelme, A. Jakovičs, E. Baake
Dynamics of liquid metal surface in AC magnetic field

Engang Wang, Jie Hao, Shuai Gao, ZhongXin Zhai, Yunchao Li
Effect of electromagnetic stirring method on the distribution of TiN inclusion in Incoloy 825 alloy

S. Pavlovs, A. Jakovics, A. Chudnovsky
Melt azimuthal rotation in direct current electric arc furnace without external axial magnetic field

M. Guglielmi, E. Holzmann, A. Köppen, E. Baake, S. Herbst
Investigation of an alloying process for NbSi-based composites in cold crucible furnace

Coffee Break (11:15 – 11.45)

Session IH 3 **Induction Heating 3**

11:45 – 12.30

Chairman:
Dr. R. Goldstein – Fluxtrol Inc – USA

A. Mendi-Altube, I. Villar, C. Carretero, J. Acero
Electro-thermal Modelling of an Induction Hardening Process of 42CrMo4 Steel Probes

M. Giangolini, G. Betti Beneventi, A. Babini
Assessment of thermographic tools for the validation of physics-based models addressing fast induction heating processes

A. I. Aliferov, A.E. Morev
Peculiarities Of Modeling Of Electromagnetic Processes Of A Cy-Lindrical Induction System With Permanent Magnets

Closing Session
12.30-13.00

Lunch (13:00-14:30)