Editorial

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Biographical notes: Egbert Baake is Professor at the Leibniz University of Hannover and Academic Director of the Institute of Electrotechnology. He received his PhD in Induction Melting and Stirring Processes of Metals in 1993. He is teaching in Theory of Electromagnetic fields and Magnetofluiddynamics (MFD). His major interests are MFD processes, numerical simulation and experimental investigations of liquid metal flows in induction applications, and energy aspects of electrothermal processes. He has co-authored about 300 papers. He was appointed as Honorary Professor at the Technical University of Clausthal (Germany) in 2004 and Samara (Russia) in 2010. He is President of the International Union of Electricity Applications (UIE).

Yuliya Pleshivtseva is Full Professor teaching graduate and postgraduate courses at Heat-and-Power Engineering Department of Samara State Technical University, Russia. She is also the member of Editorial Board of the *International Journal of Microstructure and Materials Properties (IJMMP)*. She has received an engineering degree (1987), PhD (1996), and Doctor of Science Degree (2009) in the field of optimal control of heat-mass transfer processes from Samara State Technical University. Her current research interests include simulation and optimisation of induction heating processes based on the optimal control theory for systems with distributed parameters. Her work appears in more than 150 scientific and engineering publications and in three monographs: *Optimal Control of Induction Heating Processes* (CRC Press, 2007), *Optimal Control of Induction Heating of Metals Prior to Warm and Hot Forming* (ASM Handbook, Volume 4C, Induction Heating and Heat Treatment, 2014).

The present issue of *International Journal of Microstructure and Materials Properties* comprises nine revised and extended papers presented at *XVIII International UIE-Congress on Electrotechnologies for Material Processing* held in Hannover (Germany), June 6–9, 2017.

The following papers have been included in this issue:

Barglik et al. studied the complex technological process of induction surface hardening of gear wheels that makes possible to obtain a thin hardened surface zone of the tooth and to keep soft their internal part. This process requires triply coupled simulation of non-linear, transient physical fields mostly in 3D formulation. The paper deals with the analysis of the single frequency induction heating of gear wheels made of steel 41Cr4. The special attention is paid to the analysis of various factors influencing on accuracy of computations including material properties, heat transfer parameters and modified values of critical temperatures. The main goal of the paper is to evaluate an influence of three material properties: electric conductivity, specific heat and thermal conductivity on the accordance between computations and measurements. Exemplary investigations are provided for the single frequency induction hardening of gear wheels made of steel 41Cr4.

Bay et al. presented a computational model and numerical tool developed in laboratory of *Centre for material forming* of *MINES ParisTech, PSL-Research University* for simulation of electromagnetically-coupled manufacturing processes such as magnetic pulse forming processes or induction heat treatment processes taking into account their specificities. The numerical simulation is based on finite element approximation and couples the solving of a Maxwell electromagnetic model with a heat transfer and solid mechanics model. The optimisation algorithm has been applied to optimise heating rate of an axisymmetric workpiece.

Ebel et al. analysed the high frequency welding process for cladded pipes and estimated the main process parameters in order to solve the inconvenient power proportion between the cladding layers. Full 3D-numerical model including all relevant material properties is used to understand the physical relations in the process. To reduce the extent of required calculations, a 2D model of HF pipe or profile welding was developed by authors to consider the most important parameters of the longitudinal HF-welding process of thin walled cladded pipes. Effects of welding speed, current frequency and material properties are discussed. The results have been compared to an available experiment and to gain the basic validation of the model. An approach is proposed to facilitate high frequency welding of cladded pipes under consideration of industrial requirements for a chosen material combination.

Baldan et al. researched optimal inductor design for induction heating applied to a tailored heating forging problem. The first part of this paper shows the advantages of adopting a tailored inductive heating, compared to a homogeneous one. In addition to a significant simplification, results of simulation have shown that it is possible to save energy and enhance the overall efficiency. The developed model was then experimentally validated and used for a more rigorous inductor design. The aim of the second part is to perform an optimisation procedure in order to design an inductor able to provide the desired tailored temperature profile.

Pleshivtseva et al. carried out the researches in the field of multiple-criteria optimisation of induction heaters' design based on numerical coupled electromagnetic and temperature fields' analysis. The main goal of the studies is the application of different optimisation methods and numerical finite element method (FEM) codes to solve the multi-criteria optimisation problems formulated mathematically in terms of the typical optimisation criteria: maximum temperature uniformity, minimum heating time, maximum energy efficiency and minimum scale formation. Standard genetic algorithm, non-dominated sorting genetic algorithm NSGA-II, migration NSGA algorithm, and

alternance method of the optimal control theory are applied as effective optimisation tools in practically oriented applications.

Aliferov et al. studied a technology that allows a fast surface induction hardening of workpiece of relative small dimension by means of a single current shot. This technology was proposed already in fifties but at that time the availability of power converters limited its industrial application to the hardening of very small surfaces. Nowadays, the process can be applied in automotive industrial applications thanks to the availability of power converters in the megawatt range. Pulse induction hardening process is characterised by high power densities, heating times in the range of tens to hundreds of milliseconds and cooling rates attained by self-quenching without the use of external quenching means. In the paper, authors give some practical diagrams for the preliminary definition of the heating parameters that could help the design of this type of process.

Bukanin et al. investigated a very complicated technology of induction heat treatment of gear. A great deal of researches using experimental methods and 3D computer simulation has been carried out to obtain required mechanical properties of steel. In order to perform these tasks more efficiently the authors offered to use a new version of ELTA with a special Gear Application. The main approach to 2D simulation, methods and structure of program are described. ELTA 7.0 can calculate integral parameters of inductor and temperature in the cross-section of gears for heating and cooling stages simpler and faster than in the case of 3D simulation. Several examples of induction hardening with single and double variable frequencies of power source are presented.

Kotlan et al. described an alternative way of induction clamping, consisting in heating of the sleeve by its rotation in static magnetic field generated by suitably arranged permanent magnets. The most important dimensions of the heating system are optimised with the aim to reach the required increase of the bore of the clamping head at the highest possible efficiency and shortest time of heating.

Russell et al. presented recent inverter and inductor innovations that have advanced the performance and capability of modern scan and single-shot induction hardening equipment. The physics and critical design elements of both of these induction heat treatment processes are discussed in detail and practical case studies featuring numerical computer simulation are referenced throughout.

All papers have been reviewed according to the journal procedures and standards. We sincerely thank all authors for their valuable contributions and having observed all reviewers' comments and suggestions. We are also grateful to all reviewers for their effort in reviewing the papers.

We sincerely hope that the papers published will be a useful source of information for engineers and researchers at their professional work.