Editorial

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Biographical notes: Janez Grum is a Professor for Department of Materials Science and Technology of Materials at Faculty of Mechanical Engineering, University of Ljubljana, Slovenia. He graduated with PhD in technical cybernetics, manufacturing systems and computer technology at Faculty of Mechanical Engineering, University of Ljubljana, Slovenia. His interests are machining of materials with emphasis on surface integrity, heat treating, laser processing, analysis of materials, non-destructive testing and residual stresses after mechanical machining. He has authored/co-authored many books and has published more than 90 refereed journals and 300 conference papers.

George Totten received his BS and MS degrees from Fairleigh Dickinson University in New Jersey and his PhD from New York University. Dr. Totten is Past-President of the International Federation for Heat Treating and Surface Engineering (IFHTSE) and a Fellow of IFHTSE, ASM International and SAE International. He is also Chairman of the ASTM Committee on Publications. Currently, George Totten is a Visiting Professor at Portland State University and he is also President of G.E. Totten & Associates LLC, a research and consulting firm specialising in Thermal Processing and Industrial Lubrication problems. Dr. Totten has over 400 publications including patents, technical papers and books among which include: *Handbook of Hydraulic Fluid Technology, Handbook of Quenchants and Quenching Technology, Steel Heat Treatment Handbook, Handbook of Residual Stress and Deformation of Steel, Handbook of Metallurgical Design and the ASTM Fuels and Lubricants Handbook*: *Technology, Properties, Performance, and Testing (MNL 37)* – among others.

The first special issue gives a review of investigations conducted in the field of quenching and distortion in terms of quenching agents, quenching issues, and results of quenching such as hardness, residual stresses, volume changes, distortion, and cracking.

The processes of heat treatment of steel are closely related to heating and overheating of machine parts of different size and shape to an adequate temperature, which are then followed by quenching in a suitable quenching agent. With the heat-treatment processes applied to machine parts engineering personnel will often encounter numerous

difficulties, which most often consist of volume changes of parts, their distortion and presence of residual stresses. It is very important to know the volume changes of machine parts in the course of a heat-treatment process applied since only in this way a product having the right size can be obtained at the end of heat treatment. In case the actual size of a machine part after heat treatment exceeds the right size, additional or final grinding to size will be needed. Even greater difficulties are encountered due to non-uniform cooling, i.e., quenching, of the machine part and/or cooling of a machine part having an asymmetric shape since, in addition to volume changes, minor or major distortions will occur after heat treatment. Such minor or major distortions often require preliminary straightening of machine parts, which is followed by frequently exacting and time-consuming grinding.

In all the cases where after heat treatment not only volume changes but also distortion occur, there are residual stresses in the machine part. The residual stresses due to thermal and thermo-chemical treatments of the machine part occur because of non-uniform microstructural changes across the entire cross section. The residual stresses in the surface layer, if they are of compressive character, are advantageous since they prevent the occurrence of new cracks and possible propagation of the existing ones.

Elevated compressive stresses at the surface and in the surface layer and a suitable gradient of residual stresses in the subsurface provide certain advantages since with elevated compressive stresses and small stress gradients low tensile stresses will be obtained at the surface under load. They are of little importance and ensure long-lasting and undisturbed operation of the machine part. The whole heat-treatment process shall be performed in a way causing as little as possible deviation of the mass from the right value and as small as possible distortion accompanied by a favourable through-thickness profile of the compressive stresses.

The authors of a paper titled “Overview of distortion and residual stress due to quench processing” treated this issue from several viewpoints, i.e.,

- distortion and quality control
- problems related to quenchant selection and use
- quench cracking
- implementation of modelling and simulation technologies
- residual stress in heat treatment components
- residual stress and distortion of induction hardened gears
- residual stress after induction surface hardening and finish grinding
- residual stress in carburised machine parts.

The problems of quenching and distortions of machine parts are known and always present, which results in a permanent search of new opportunities to reduce such distortions. Consequently, the papers in the present overview have been selected from the most recent studies by the authors. Particular attention should be drawn to the papers presented at the conferences on *Quenching and The Control of Distortion*, the first being held in 1992 (Chicago), and the next ones in 1996 (Cleveland), 1999 (Prague), and 2003 (Beijing). In addition to the conferences on *Quenching and Distortion* organised periodically by the American Society for Materials (ASM), the annual conferences of the

ASM also included contributions from the field of heat treatment processes and surface engineering, particularly those dealing with quenching. Further contributions dealing with the theme of quenching and heat treatment titled *International Conference on Thermal Process Modelling and Computer Simulation (ICTPMCS)* were periodic conferences held in Shanghai in 2000 and at Nancy in 2003. They treated simulations and modelling of the heat-treatment process and phenomena in materials. In addition to these papers, papers published at the conferences organised by the International Federation of Heat Treatment and Surface Engineering should also be mentioned. And last but not least are the papers dealing with the problems concerned in various scientific journals dealing with materials, heat treatment, and surface engineering.

One cannot but express appreciation of the drive Dr. G.E. Totten has shown in organising numerous thematic conferences on *Quenching and Distortion* and chairing many other important conferences on the theme concerned.

The present overview offers to a reader numerous scientific results obtained in the field of Quenching and Distortion and provides him with numerous references of the researchers treating the problems concerned in a comprehensive way. It also gives him a good insight into the present state of research in the field, widens his knowledge of the issues and is as such, very suitable as a study aid to undergraduate students and even more so to postgraduate students.

Special thanks are due to the authors contributing their papers to this special issue of the IJMPT. They are a result of very critical work of reviewers and the authors. It can be said that the papers satisfy high standards of quality.

Our great thanks are due also to our co-workers, Mr. Franc Ravnik and Ms. Nevenka Majerle, who took care of the coordination among the reviewers and the authors, and prepared the papers for the publication.

Finally, we wish to thank the journal IJMPT and the Editor Professor Dr. Dorgham, who accepted and endorsed our invitation to prepare a special issue. Many thanks are also due to the team of the Inderscience Publishers for the assistance offered in preparing the special issues.

We sincerely hope that the papers presented on quenching and distortion will be a valuable source of information to researchers in various scientific fields, and users in the field of materials and production.