Editorial

Janez Grum

The papers collected in the present issue of the IJMMP were presented at the 8th International Conference on the *Application of Contemporary Non-Destructive Testing in Engineering* organised by the Slovenian Society for Non-Destructive Testing. The Conference was organised with a financial assistance of the Slovenian Agency of Research.

The Conference took place in Portorož from 1st to 3rd September, 2005. Portorož is a tourist resort lying at the East coast of the Northern Adriatic. It has a typical Mediterranean climate.

At the Conference 79 papers, i.e., 50 as oral lectures and 29 as posters were presented. The scientific board of the Conference selected 27 papers for publication, of which 15 for the publication in the *International Journal of Microstructure and Materials Properties* (IJMMP) and 12 for the *International Journal of Materials and Product Technology* (IJMPT). All the papers selected were strictly reviewed and selected on the recommendation of reviewers taking account of the subject matter of the two journals.

Material testing is a very important task in the modern industrial production characterised by increasing computerisation. Non-Destructive Testing (NDT) of materials and structures plays a very significant role in the production of various parts and structures as well as in their in-service testing. Very common applications of NDT are periodical control of aircraft and rolling stock as well as testing in nuclear power stations. Frequently periodical checking is specified by the manufacturer of equipment. He will specify the testing method, devices, accessories to be used as well acceptance criteria.

Nowadays the product quality assurance requires that the relevant product control is adapted to the type of production. Automated production requires as complete as possible material quality control and monitoring in the course of production itself to ensure production without disturbances. Consequently, one should be aware that the introduction of automated and computer-aided production systems requires automated material testing as well, the only option being automated NDT of materials and structures. Detection of various material properties and various types of defects in materials requires the selection of an adequate testing method. The detection of a given material property and/or material defect shall be followed by an assessment of its size and acceptability based on relevant criteria for the acceptability or rejection of a machine part or product. Currently numerous devices for automated detection and assessment of material defects based on ultrasonic, electromagnetic, penetrant, Acoustic Emission (AE) and radiographic testing are available. Such systems offer numerous advantages over the classical, destructive material testing, i.e., considerably increased testing speed, exclusion of subjective influences of an operator in the assessment of material properties and defects, and sufficiently reliable insight in the product quality.

It was the development of the technologies mentioned that contributed to the computer-aided product quality and material defect assessment. Non-Destructive Evaluation (NDE) methods comprise numerous applications to production technologies, monitoring of production processes and, finally, to in-service inspection. Nowadays NDT and NDE are closely related since they make it possible to capture signals and indications from materials and structures, to process and store them. Thus it is possible with every part or structure to check its history, which enables the prediction of its life. The methods concerned also permit statistical processing of the data obtained in NDT and NDE, which, in turn, permits the evaluation of the production in terms of manufacturing-process quality and the remaining life of a part or a system in in-service inspection.

The extension of applications by combining NDT and NDE made it possible to adjust the existing NDT methods to the known global evaluation methods. Consequently, in the recent decade a number of new techniques with individual NDT methods including perfect visualisation and classification of material defects have been introduced.

The papers submitted treat ultrasonic testing (4), various electro-magnetic methods (4), AE (4) and numerical modelling of corrosion damages from the viewpoint of state of stress (1).

Djordjevic presented material degradation and properties changing for different stages of damage, which can be obtained by a hybrid non-contact remote laser ultrasonic sensing and air-coupled detection arrangements. The sensing technology is based on an application of guided waves such as plate or surface waves for direct material testing of complex components. Signal processing of recorded signals allows assessment of the material state. Such laser generation of ultrasonic sensing makes NDT technology used for structural integrity assessment and life service inspections of metal or composite structures. Paris et al. study development of a phased array equipment for ultrasonic testing of concrete structures. The aim is to detect and characterise the presence of cracks that can be responsible for the loss of structural capacity. They are studying specific techniques of reconstruction such as SAFT processing and phased array method. They presented first measurements and reconstructions performed on an artificial crack in a concrete block and the study for the development of simulation tools. Mikulič et al. studied hardening process as a critical phase during construction works influencing the properties of a concrete structure. Their research was based on ultrasonic waves propagation through media as transversal, longitudinal and Rayleigh waves. Material properties are determined at phase, velocity, frequency, attenuation, relaxation and reflection measurements. With ultrasonic methods the kinetics and degree of hydratation, setting time, compressive strength and dynamic modulus of elasticity were determined. Borozovsky et al. deal with measuring results owing to utility of selected non-destructive methods of testing interlocking paving blocks and blended cements for strength with ultrasonic method. Calibration relations show a very tight correlation between an ultrasonic parameter and the relevant strength. Thus, preconditions for usage thereof by manufactures and for rationalisation of experimental works, particularly connected with development of blended cements, are available. Mazal et al. researched possibilities of damage tracing of a material exposed to cyclic mechanical loading using AE technique. In the signal monitored on the surface of material, it is possible to identify processes on the surface and inside the material of the construction. The proposed method provides information about fatigue damage and allows us to specify residual fatigue life. Experimental measuring results have shown possibilities of identification of various stages of the fatigue process with the help of AE technique. Pazdera et al. presented actual behaviour and general load carrying capacity of timber structures, depending on the load bearing capacity of joints. They presented deals with slotted-plate steel-to-timber joints. AE method records only active defects in the structure under study. AE method responds to the defect generation much sooner than the visual or any other NDT methods.

The time-frequency analysis can play a central role in the signal analysis. Nikulin et al. applied the AE method to study the processes of surface crack initiation and evolution in surface protective coatings. They also investigated fracture mechanism and kinetics of three types of electrolytic chrome coatings on multifilamentary superconductoring wire. The AE parameters characterise the oxide resistance to cracking during tests and operation. Slabe et al. treats the results obtained in simultaneous measurements of AE with PZT AE sensors and of deformations with resistance measuring rosettes carried out during and immediately after laser cutting-out of a deep-drawn sheet product, i.e., mudguard. The ‘true’ AE occurring during the laser-cutting process and immediately after cutting of the mudguard is related to the release of the residual stresses present in the deep-drawn sheet product and to the processes in material generated by the absorbed laser light. The energy of the AE signals recorded during the cutting process and immediately after cutting, the number of AE hits detected by individual sensor in a unit of time and their cumulative value indicate a significant connection with the phenomena in the material. Acosta et al. discuss basic mechanisms of radiation embrittlement of steels and welds, which are due to matrix damage. They measured thermoelectric voltage using a specially developed non-destructive method, STEAM, to assess the embrittlement state of materials, which was regularly performed. The positron annihilation spectroscopy in lifetime setup was used for a study of microstructural changes of matrix due to embrittlement process. Žerovnik and Grum presented measurements of residual stresses obtained using the standard relaxation method based on a continuous electrochemical removal and with measurement of strain with resistance measuring rosettes in comparison to the determination of residual stresses with the magnetic method based on the Barkhausen noise. A comparative analysis of the results obtained was carried out with flat specimens made of heat-treated structural steel C45E that were, after oil quenching, additionally high-tempered. Bergheul et al. presented the structure and magnetic properties of nano-crystalline $Fe_{(1-x)}CO_x$ mixtures prepared by mechanical alloying. The structural effects of powders were studied by SEM, X-Ray diffraction and bench of microwaves. Experimental results show that fine nano-crystalline Fe-Co alloy powders prepared by mechanical milling are very promising for microwave applications. Anastasiadis et al. deal with the use of Dielectric Spectroscopy or Impedance Spectroscopy techniques for identification of damages in geometrical structures. Uniaxial stress was applied to introduce damages in a geomaterial at a constant temperature. They emphasised the damage caused to marble samples and its influence on the dielectric loss angle. Kytopoulos et al. study damaging effects induced by creep loading under normal ambient as well as transient moisture condition in glass fibre-reinforced polyester matrix composite. They used two experimental techniques. The first was based on the influence of the creep-induced damaging effect, whereas the second type on the influence on a relevant physicochemical parameter such as moisture diffusivity. They compared the applied techniques which seems reasonable to assume that the ‘diffusive’ technique is able to ‘detect’ microstructural changes on a much lower scale. Aleshin et al. presented methods which allow to reveal corrosion defects. Simplified techniques are widely used for evaluation of the remaining strength of the corroded pipeline segments. The paper presents computation technology for a numerical analysis of the multiaxial nonlinear stress state of the corroded pipeline segments. All procedures of pipeline numerical analysis are completely automated. Developed computation technology along with the modern inline inspection tools predict the high accuracy values of burst and safe maximum pressures of the corroded pipeline segments.

It allows, to decrease accidents, to provide maximal economical effectiveness of technical inspection and repair of pipeline networks.

The present overview offers a reader numerous scientific results obtained in the field of NDT and evaluation 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 IJMMP. 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 BSc, and Ms. Nevenka Majerle, who took care of the coordination among the reviewers and the authors, and prepared the papers for the publication.

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