Editorial

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Biographical notes: Janez Grum is founder and Editor in Chief of a new journal *Int. Journal of Microstructure and Materials Properties – IJMMP* and editor of the *Journal News of Society for Nondestructive Testing*, Slovenian Society for Non-Destructive Testing, Ljubljana, Slovenia (since 1994). He is editor of the six NDT Conf. Proceedings, two ASM and Marcel Dekker book chapters, and five books with several reprints. He has also published more than 90 refereed journals and more than 300 conference papers on heat treatment, laser materials processing, materials testing including non-destructive testing.

Here is the first special issue on a very specialised subject, 'Non-destructive testing and failure preventive technology'. In various fields of engineering experts are increasingly becoming aware of the importance of material testing in the present day industrial manufacture, which is becoming increasingly computer-aided. Thus non-destructive testing of materials and structures is gaining importance both in the manufacture of different components and structures and in the in-service testing of components and structures. The use of non-destructive testing methods is well established in the periodic testing of public transportation means such as planes and railway vehicles as well as of nuclear power stations. Periodic testing is frequently prescribed already by the manufacturer of the equipment concerned. He prescribes the method, devices, and instruments to be used.

Present-day quality assurance of products requires that the control of products be adapted to the level of production. Automated production requires as high a level of control of material quality and the flow of the manufacturing process as possible, which means manufacture without any disturbance. Consequently, one should be aware that the introduction of automated and computer-aided manufacturing systems requires the automated non-destructive testing of materials. For the detection of individual material properties and material defects, an adequate testing method should be selected. This means that after the recognition of a certain material property or/and a defect, a decision is to be taken, considering the criteria set, whether the size of the defect is critical and whether a machine part concerned shall be discarded or not. Nowadays numerous devices for automated detection and assessment of material defects based on ultrasonic, electromagnetic, penetrant and radiographic testing are known. Such systems have numerous advantages over common non-destructive testing methods, i.e.:

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- considerably increased testing rates
- a subjective assessment by an operator in assessing material properties is excluded
- defects in a material or a structure can be efficiently visualised
- a critical defect size can be predicted and, consequently, a defective product discarded or repaired
- in combination with a suitable repair technique, they ensure, after re-testing, undisturbed operation of the part or structure concerned
- computer-aided testing devices permit efficient record of examined areas of products and structures and serve as evidence in case of a reconstruction of the initial state
- relevant devices permit online or periodic data processing of tests performed, which ensures a good control of the state of product manufacture and/or of the state of a structure
- the systems developed offer a good starting point for improvement of structural and/or technological solutions, which entails a boost in research and development of products and structures
- the systems developed are efficiently applied to development of new materials and/or products including hybrid manufacturing technologies and improved operating properties
- the systems developed are increasingly employed in system and online control of various expensive machines and devices as well as for ecologically safer operation of devices and installations.

Over the recent decade numerous non-destructive methods for materials have been developed and established. The development of non-destructive testing methods has been stimulated mainly by the automation of production, which is expected to provide an adequate product quality and eliminate discarding of products. It has been the development in the field of sensors, electronics, microprocessor engineering and computer engineering that has contributed a great deal to the harmonisation of the automation of production with the introduction of non-destructive testing of materials. For every non-destructive testing method, basic characteristics of the testing device employed are very important. They should, namely, permit the detection of individual properties of materials and/or structures, the detection and assessment of various types of defects, and offer the options of visualisation and record of defects.

The present special issue includes 13 voluntary papers, which were all subjected to a critical review procedure to finally exhibit the content and form desired.

The first paper by Scarponi and Valente deals with testing of jute composite laminates, which are cheap and suitable for the production of various products. In testing a suitably instrumented device for impact testing was used to search for a relation between the energy and internal damages in the form of delamination. For the detection of the internal damages, ultrasonic testing based on a comparison of signals produced by undamaged specimens and those produced by damaged specimens was used. The test results combined with good visualisation indicate the exceptional applicability of the impact test and ultrasonic testing to the automobile industry in terms of the assessment of the behaviour of composite materials under impact loads.

A paper by Gucunski et al. deals with the quality assessment of coatings at concrete bridge structures and the identification of corrosion damage and delamination. The main goal of the research was to ensure the cost-effective monitoring of such structures, which is important from the viewpoint of safety in operation and of maintenance costs. The ultrasonic method including various integrated ultrasonic seismic devices such as Portable Seismic Pavement Analyser (PSPA) was applied. An ultrasonic body-wave (UBW) and an ultrasonic surface-wave (USW) were used for the characterisation of concrete structures and the impact echo (IE) method for the identification of delamination in such structures. It is an advantage of this method that it may detect both initial cracks and damage and that already propagating and with time causing more important damage. In this research the 3D visualisation permitting the detection and assessment of delamination in the loaded state was very important.

Kourkoulis et al. treat the assessment of damages to marble slabs, which may be carried out using destructive methods based on a three-point bend test. As such tests are time-consuming and exacting, the authors presented a theoretical description of mechanical damage that may propagate in the course of the bend test. For this purpose they considered the strength theory of Saint Venanós, which depends on the magnitude of strain and which at first approximation shows linear dependence. The authors combined the performance of the common destructive bend test with a model of a simple description of elastic deformation and with a 2D numerical analysis, and then verified the results obtained by the ultrasonic non-destructive testing method.

Lorenzi et al. presented the application of an artificial neural network to the interpretation of ultrasonic signals, which turned out to be, with reference to the model proposed, an efficient tool for the interpretation of results obtained on concrete structures. It was shown that it is possible to create flexible and non-linear neural models, which have better adherence to experimental data than traditional regression models. Moreover, it is possible to acquire and store knowledge in a dynamic configuration, creating models that can be constantly updated for different situations.

Prassianakis describes the use of non-destructive ultrasonic methods and sees them as an exceptional tool for solving problems in the field of fracture mechanics. The fracture mechanic method permits a quantitative approach and indicates relations among stress, toughness and the size of defect.

Buiochi et al. treats modelling of ultrasonic fields generated by mono- and multi-element transducers. An ultrasonic field can be calculated by applying the Rayleigh integral method, which is related to the transmission coefficient. The reflected and incident ultrasonic fields are then calculated by applying the Huygens's principle. The method is valid for all field regions, may be performed for any excitation form, and can be easily applied in the case of arrays. In order to validate the method, the simulated field from a single piston-like transducer is compared to an experimentally measured field considering the wave evolution caused by planar interfaces between two media. Finally, computation examples using phased arrays are also shown in the paper.

Prassianakis describes an investigation of mechanical properties in an epoxy system with randomly distributed fibres using destructive and non-destructive tests to determine the properties of the so-prepared composite with randomly distributed fibres. On the one hand, the velocity of elastic waves and the acoustic attenuation coefficient are investigated, and on the other hand, a relation between the elastic module, shear module, Poisson ratio and the damage parameter is searched for. All the properties from the non-destructive test correlate with those from the destructive tests. Finally, for an epoxy resin system, the effect of the plasticiser content and the fibres on the moisture absorption behaviour were investigated. In this context, it was shown that the moisture absorption test based on diffusion mechanisms can be used as a non-destructive test for microstructural damage evaluation in the polymeric system.

Dobmann presents the results of R&D of material degradation due to thermal ageing. For the characterisation of materials very extensive tests of material fatigue, as well as electromagnetic and micro-magnetic non-destructive testing extended to an assessment technique for the material condition, were carried out. The material degradation was also investigated with hardness testing, on impact toughness test and the determination of the transition temperature in the impact test. The proposed NDT/NDE techniques are based on spot defects and dislocations, and also finally on the knowledge of the microstructure occurring under mechanical and magnetic loads. The two techniques described turned out to be very sensitive, usable and reliable in the in-service inspection of materials.

Lindgren and Lapistö deal with cyclic loading and deformation of materials using the micro-magnetic method. From the RMS values of the Barkhausen noise and the existing residual stresses, the number of loading cycles was determined in the alternating bending fatigue test of high-strength steel. The results demonstrated clearly that more meaningful and reliable information can be gathered when Barkhausen noise is measured in several directions. The increase in anisotropy was shown to be a potential parameter for fatigue damage evaluation, although the increase was not entirely linearly related to the number of the loading cycles. This approach to carry out measurements in several directions would also be advantageous if the loading direction remained unknown. The simultaneous elucidation of several Barkhausen noise parameters as a function of loading cycles might give more insight into the complex phenomena taking place during cyclic loading and thus provide a more suitable parameter for fatigue damage assessment.

Grum and Pečnik treat the development of new sensors for the micro-magnetic testing of materials. The paper gives a comparison of a classical sensor unit having the magnetising and detecting sections separated and a compact sensor unit. The aim was to reduce the volume of the passive sensor unit and possibly increase the accuracy, sensibility and reliability of calibration curves. To this end two compact sensor units were developed. The first one consists of a detection coil integrated into a gap of the magnetic yoke. A comparison was made of the results obtained with a compact sensor unit having an additional ferrite core and a detection section integrated as well in the magnetic yoke. The sensor units were tested using the so-called calibration curves showing the dependence between an individual parameter searched for and a degree of cold deformation known in advance.

Grum and Žerovnik treat the efficiency of the micro-magnetic non-destructive method based on the Barkhausen noise in predicting material hardness after heat treatment. The captured voltage signals were used to determine a power frequency spectrum and the variance was selected as a characteristic value. A statistical analysis of the voltage-signal variance was used to assess the reproducibility of the latter at the specimens treated in the same way in a temperature range. In addition to the assessment of reproducibility of results the discriminatory power of the variance in determining the hardness achieved was determined by means of the statistical t-test. The statistical treatment of the Barkhausen-noise voltage-signal variance was used to assess two neighbouring specimens showing a difference in the tempering temperature.

Grimberg et al. in their first paper treat the application of eddy currents with an internal transducer with a rotating magnetic field to the examination of pressure tubes in a nuclear power plant. This paper presents this transducer and the equipment used. To detect the garter spring position, a neuro-fuzzy system trained with artificial data obtained from an analytical model using dyadic Green's function and afferent numerical code is used. Here, the results of pressure tubes specimen inspection, emphasising position, localisation and shapes of slots are presented.

The second paper by the same authors deals with idealised defects, i.e. cracks, in electrically conductive materials as an inverse problem of a scattered magnetic field. The study allows the solving of the forward problem from diffraction data, solving the inverse problem, the depth of surface breaking cracks or the distance between surface and the edge of subsurface cracks could be determined.

Starting from diffraction experimental data, in the presence of measuring noise, the estimation maximum error for the case of surface breaking crack and subsurface crack is 7%.

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 non-destructive testing and failure preventive technology will be a valuable source of information to researchers in various scientific fields, and users in the field of materials and production.