

Preface

The Third International Conference of the Serbian Ceramic Society on Advanced Ceramics and Applications, held in Belgrade (Serbia), 29th September–1st October, 2014, was organized by the Serbian Ceramic Society with full support of European Academy of Sciences and Arts in cooperation with the Institute of Technical Sciences of SASA, Institute of Chemistry Technology and Metallurgy, Institute of Physics, Vinča Institute of Nuclear Sciences, Institute for Technology of Nuclear and Other Raw Mineral Materials, Institute for Testing of Materials and Archeological Institute of SASA, College of Technical Sciences Belgrade, College of Applied Technical Sciences Nis, and Arts and Conservation Academy of the Serbian Orthodox Church. Serbian Ceramic Society was initiated in 1995/1996 and fully registered in 1997 as Yugoslav Ceramic Society, with strong support from the American Ceramic Society. In 2009 it continued as Serbian Ceramic Society, in accordance to the Serbian laws. Serbian Ceramic Society is almost the only Ceramic Society in the Southeast Europe, with members from more than 20 Institutes and Universities, active in 16 sessions, by program and the frames which are similarly defined by the American Ceramic Society activities. Recently, the Serbian Ceramic Society has become Endorsed Society of the American Ceramic Society.

The aim of this international symposium was to discuss global advances in the research and development of advanced processing and applications, manufacturing technologies for a wide variety of non-oxide- and oxide-based structural ceramics, particulate and fiber-reinforced composites, and multifunctional materials. This year symposium also honored Academician Momčilo M. Ristić, honorary president of Serbian Ceramic Society, recognizing his outstanding contributions to sintering science and technology of advanced structural and multifunctional ceramics and his tireless efforts in promoting their wide-scale applications. A total of 120 papers, including plenary (15), keynote (12), invited talks (8), oral presentations, and posters (85), were presented, with participants from 21 countries (USA, Japan, Germany, UK, France, Switzerland, Belgium, Italy, Portugal, Spain, Hungary, Poland, Romania, Bulgaria, Iran, Ukraine, Czech Republic, Slovakia, Slovenia,

Republic of Srpska (BiH), Serbia) representing universities, institutes, research laboratories, and industries. These papers covered the following topics:

Basic Ceramics Science

Nanostructural, Bio- and Opto-ceramic Materials and Nanotechnologies

Multifunctional and Electroceramic Materials

Magnetic and Amorphous Materials

Construction Materials and Eco-ceramics

Composite Materials, Catalysis and Electrocatalysis

Artistic Ceramics and Design and Archeological Heritage

Sintering processes (kinetics, microstructure, thermodynamics, modeling)

Young Researchers

Ceramics for today's engineering applications can be considered nontraditional. Whereas traditional ceramics are the older and more generally known types, such as porcelain, brick, earthenware, etc, the new and emerging family of ceramics are referred to as advanced, new or fine, utilizing highly refined materials and new forming techniques. Advanced ceramics possess several properties which can be viewed as superior to metal-based systems, including high resistance to abrasion, excellent hot strength, chemical inertness, high machining speeds (as tools), and dimensional stability. Research results in the area of electronic ceramics, in most cases, directly, depend on the knowledge of the processes of consolidation (pressing and sintering) of ceramic powders that observed from the point of view of nature, points to the universality of this process. In accordance with it, in the papers of some scientists (for example, M.M. Ristić), the relationship of the whole nature and intellect of the man-researcher, as well as the cognition of the logic of the world begins with an inductive research of the natural processes in the correlation with the causative-consequent occurrence in the Universe.

Advanced Ceramics play a vital role in the European Union's scientific development plan to enable the transition towards to a knowledge-based low-carbon, cost-competitive, and efficient societies. The evolution of the ceramics materials and the associated materials technologies has been accelerating rapidly, with each new technological development supplying more knowledge. As new materials technologies are developed, the methods of handling, forming, and finishing are required to be devised to maintain pace with this rapid rate of development. One of the most prominent examples of this rapid and accelerating technological progress is the electronics industry, where the pace of its development and the development of the associated materials and processing technologies has been quite astounding, with the goal of packing the maximum amount of performance into the smallest possible space.

The twentieth century has produced the greatest advancement in ceramics and materials technology, where extensive metallurgical developments have produced almost every conceivable combination of metal alloys and the capabilities of those alloys are fairly well known and exploited. The drive for faster, more efficient, inexpensive production techniques continues as the limits of metal-based systems are surpassed and new materials capable of operating under higher temperatures,

higher speeds, longer life factors, and lower maintenance costs are required to maintain pace with technological advancements. Metals, by virtue of their unique properties: ductility, tensile strength, abundance, simple chemistry, relatively low cost of production, ease of forming, ease of joining, etc. have occupied the vanguard position in regard to materials development. By contrast ceramics: brittle by nature, having a more complex chemistry, and requiring advanced processing technology and equipment to be produced, perform best when combined with other materials, such as metals and polymers which can be used as support structures. This combination enables large shapes to be made; the Space Shuttle is a typical example of the application of advanced materials and an excellent example of the capability of advanced materials. However, it is only during the last 30 years or so, with the advances of understanding in ceramic chemistry, crystallography, and the more extensive knowledge gained in regard to the production of advanced and engineered ceramics, that the potential for these materials has been realized. Techniques previously applied to metals are now considered applicable to ceramic systems and phase transformations, alloying, quenching, and tempering techniques were applied to a range of ceramic systems. Significant improvements to the fracture toughness, ductility, and impact resistance of ceramics were realized, narrowing the gap in physical properties between ceramics and metals, with more recent developments in non-oxide and tougher ceramics (e.g., nitride ceramics) closing the gap even further.

The chosen conference topics open the new frontiers in designing of advanced ceramic materials since they cover fundamental theoretical research, modeling and simulation, controlled nanostructured materials synthesis, and optimization of the consolidation process, which all together should provide practical realization of the new ideas towards device miniaturization, energy–materials–information integration and preservation of cultural heritage.

The development of modern electronic ceramic materials is enabled with the help of the multidisciplinary research and contribution of the research in different areas, such as materials science, physics, chemistry, and electronics, but also the mathematical modeling and simulation. Results of scientific and technological research are published in different scientific publications, which is the sign of great importance of electronic ceramics in the modern technique. Some components that are got on the basis of barium-titanate ceramics: varistors, PTC-resistors, condensers, dielectric resonators, microwave filters, piezoelectrical and pyroelectrical components, as well as sensors and detectors on the basis of different kinds of electronic ceramics. Components on the basis of electronic ceramics use the unique and optimal characteristics of ceramics, and first of all the electric, ferroelectric, and electro-optical properties. Miniaturization and reducing of the cost contribute to their greater use, which, in the last 25 years, increases constantly. The progress and development of electronic components on the basis of ceramics depend on understanding the chemical and physical characteristics of materials, on the type of technological process for getting materials, as well as on components designing. Most attention is paid to the research of dependence between the crystal structure, stoichiometry, additives influence, microstructure and final characteristics of

ceramics. For getting the optimal characteristics of device on the basis of ceramic components, processes of preparing the powder and processes of getting the sintered components have to be well planned and well done. The basic technique of getting ceramic materials includes the process of sintering, although there are other techniques too, such as sol-gel processes in the technology of getting the thin ferroelectric films.

Research of the problem of material structure level lasts as long as the science is occupied with the material structure. Since, the microstructure, even today with the development of the structure analysis technology, and nanostructure research on the one side, and on the other side the astronomical research, on the level of dimension and mass of matter and material which exists in the universe, progress in both directions, the problems of the precision of determining the structure levels appear. Hierarchically observing from the structure levels in nucleus and atom electrons, through molecules, crystal lattice, grains, and pores, different levels of the integration of materials and functions in them to the bodies of planetary and star systems, and in the frontiers of people's knowledge, the challenge of unreachable substructures, really existing, has always opened. This is due to the fact that the known levels of structure are globally discovered according to the known and applicable canons, conditionally speaking, "symmetrical view" of the world or the view based on the arrangement of points sets. However, there is a question how the need for the regularity and arrangement, which man takes from the nature, can be formed on the levels of substructures which have the character of disorganization. Different methods made important steps toward the definition and research of these problems, and among them, the most distinct leap in the scientific mind is made by the correlation of methods of fractal geometry and chaos of abstract and real points. Methods and nature of fractals open the way that the methods of symmetrical and arranged view of the world can be applied to the disordered configuration in materials. Further goals of research give the possibility to combine appropriately the results of optimization of prognosis of electronic ceramic materials properties and possible levels of the integration of electric (R, L, C) and other electronic parameters in future electronic ceramic circuits.

This issue contains 25 invited and contributed papers, all peer reviewed according to The Serbian Ceramic Society review process. These papers discuss the most important aspects necessary for understanding and further development of processing and manufacturing of ceramic materials and systems. They can be divided into several broad categories based on their topic and general scope: general interest papers, followed by papers on functional ceramic materials, applied ceramics, and ceramic preparation and characterization techniques. This proceedings opens with a paper from Dr. Sheldon Wiederhorn, "[An Historical Perspective on the Toughness of Ceramics](#)," providing a historical overview of the development of fracture mechanics and how modern techniques of microstructural analysis enabled the solution of mechanical problems associated with the ceramics in modern applications. This is followed by a paper from Prof. Rainer Gedow, "[Electrical Discharge Machining \(EDM\) of High-Performance Ceramics](#)," on the use of electrical discharge machining (EDM) for machining of zirconia-toughened

alumina. The paper by Dvovyan et al. “[Electronic States and Absorption of Light in a Lemniscate Shaped Quantum Dot Molecule](#)” discusses double quantum dot molecule, shaped like a Cassini lemniscate revolution, as a model for highly selective and sensitive biochemical sensors, based on a charge transfer between nonorganic nanoceramic structure and analyte molecules. The paper by Rakovsky et al. “[Plasma Devices and Preparing of Nonconductive Materials](#),” describes the technological parameters of two pilot plasma installations and demonstrates their potential in preparation of different carbon nanomaterials. The products range from amorphous carbon and graphite to fullerenes C60 and C70. The paper from Dr. Nešković titled “[FAMA—Facility for Modification and Analysis of Materials with Ion Beams](#)” provides an overview of FAMA, the low energy part of the TESLA Accelerator Installation, in the Vinča Institute of Nuclear Sciences. Its research program is primarily directed at development of new materials and nanotechnology.

Functional ceramics are the focus of a group of paper dealing with the magnetic, electrical and optical properties of ceramic materials. Kilanski et al. provided a review titled “[Magnetic Interactions and Magnetotransport in \$\text{Ge}_{1-x}\text{TM}_x\text{Te}\$ Diluted Magnetic Semiconductors](#)” covering structural, magnetic, and electrical properties of Mn- and Cr-doped GeTe diluted magnetic semiconductors, showing that these materials have a significant application potential. In addition, the nature of the magnetotransport effects such as negative magnetoresistance and anomalous Hall effect in $\text{Ge}_{1-x}\text{TM}_x\text{Te}$ solid solutions was also discussed. The paper by Nikolić et al., “[A Method for Simulation of Grain Coarsening Due to Diffusion in Capillary Liquid Bridge](#),” describes the use of finite element method to calculate morphological evolution of grain coarsening in capillary liquid bridge. The model described can be used to predict the effects of physical parameters on the precipitate evolution within the capillary liquid bridge. “[Electrical Characterization of Nanostructured Ferrite Ceramics by Using AC Impedance Spectroscopy](#)” by Sekulić et al. represents a detailed impedance study of nickel and zinc ferrite ceramics, which shows the presence of both grain and grain boundary effects and negative temperature coefficients of resistance in these materials. The proposed conductivity mechanism is hopping conductivity with activation energies in 0.4–0.5 eV region. “[Piezoceramic Smart Aggregates for Active Monitoring of Reinforced Concrete Structures](#)” by Marković et al. presents the methods to allow active structural health monitoring using piezoceramic smart aggregates. One- and two-dimensional damage indices allow the determination of the damage of reinforced concrete structures. “[Electrical Characteristics of Nb Doped \$\text{BaTiO}_3\$ Ceramics](#)” by Paunović et al. investigates the influence of Nb-doping levels on electrical behavior of barium-titanate ceramics. It shows that the dielectric constant of the samples decreases with increase in dopant concentration, due to inhomogeneous distribution of the dopant in the sample. “[Vibrational Spectroscopy of SOP Modes in ZnO Doped with CoO, MnO and \$\text{Fe}_2\text{O}_3\$](#) ” by Hadžić et al. is a Raman spectroscopy study of doped zinc oxides, which shows that surface optical phonon modes shift with changes in dopant concentration and exhibit significant confinement effects. In addition, Raman spectroscopy was able to identify the presence of

some minor phases not detected by X-ray diffraction. “[Optical Properties of Plastically Deformed Copper: Ellipsometry and Raman Study](#)” by Gilić et al. identified the co-existence of nano-sized crystalline structures with three-dimensional amorphous boundary spaces in plastically deformed copper samples, showing how copper samples adapted to the plastic deformation by forming a mixed crystal-amorphous nanocomposite structure, which is known to be mechanically superior to fully crystalline and fully amorphous structures. “[Optical Properties and Electron–Phonon Interactions of CdTe_{1-x}Se_x\(In\) Single Crystal](#)” by Petrović et al. shows that the long-wavelength optical phonon modes of mixed crystals exhibit a two-mode behavior and the local In mode at about 160 cm^{-1} was observed in In-doped samples. In both un-doped and doped samples, a surface layer with a low concentration of free carriers is observed. “[Structural and Optical Studies of Oxide Single Crystals Grown by the Czochralski Method](#)” by Kostić et al. characterized pure and neodymium-doped yttrium aluminum garnet (YAG) crystals obtained through Czochralski method, showing the absence of a core and good optical quality of single-crystal samples. Nd:YAG samples contain 0.8 % Nd³⁺, which is suitable for laser materials.

The group of papers with a focus on various applications begins with the paper “[Ni–Al Layered Double Hydroxides as Precursors of Ceramic Pigments](#)” by Gabrovská et al., where Ni–Al layered double hydroxides were used to produce fine-colored cyan or pale blue nano-pigments, due to the fact that their color, varying from pale green to dark turquoise, is determined by the coordination state of the Ni²⁺ ions. They represent a less-expensive alternative to blue CoAl₂O₄ spinel for some glaze applications and can be used for preparation of nano-sized mixed oxides and well-defined NiAl₂O₄ spinel, with wide applications as pigments in ceramic, glass, plastics, rubber and paint industry. “[Modified Clays in Environmental Protection](#)” by Banković et al. is a review of preparation and functional properties of modified bentonite clays which shows that these represent a wide and versatile class of materials, all derived from an inexpensive and abundant natural material bentonite. They are particularly useful as catalytic materials and in synthesis of adsorbents for removal of pollutants. “[Polymer-Based Monolithic Porous Composite](#)” by Nastasović et al. deals with hexavalent chromium sorption kinetics in a series of new porous composite materials. It is shown that the sorption occurs on the surface and in the macro-pores of the material and that the chemisorption mechanism plays a crucial role, with intraparticle diffusion the rate-limiting step. “[SEM-EDX Analysis of Bio-Oss® Granules After Incubation In Cell Culture Medium](#)” by Stojanović et al. offers an analysis of changes in the surface and chemical composition of Bio-Oss granules after incubation in cell culture medium. It was found that calcium and phosphorus ion concentration increased after incubation, while the surface of Bio-Oss granules was smoother with smaller pore edges. “[Adaptive Neuro-Fuzzy Optimization of Wind Farm Project Investment Under Wake Effect](#)” by Petković et al. shows an optimized wind farm layout, based on both aerodynamic and economic criteria, using the adaptive neuro-fuzzy (ANFIS) method. This method allows to overcome difficulties in predicting the full range of economic parameters and provides a more accurate

prediction for the overall wind farm project investment. “[TRIZ Creativity Approach to the Design of an Innovative Wind Turbine System](#)” by Mitić et al. offers a review of the theory of inventive problem solution (TRIZ) and highlights the advantages of this approach using a wind turbine system design process as a case study. “[The Sintering Temperature and the \$\text{Ho}_2\text{O}_3\$ Concentration Influence on \$\text{BaTiO}_3\$ -Ceramics Microstructure Fractal Nature](#)” by Bastić et al. offers a new correlation between microstructure and properties of doped barium-titanate ceramics, based on fractal geometry. It points to application of three-dimensional fractality as the next step in investigation and development ceramic electronic materials.

The final group of papers focuses on preparation and characterization of ceramic materials. “[Sintering of Zinc-Titanate](#)” by Obradović studies the sintering kinetics of mechanically activated powder mixtures of zinc oxide and titanium oxide, using dilatometer measurements up to 1100 °C with a constant heating rate. It was found that activation time of only 15 min is sufficient to promote solid-state reaction, significantly lowering the required sintering temperature. “[The Effects of the Phosphates’ Mechanical Activation](#)” by Andrić et al. shows the effect of different methods of mechanical activation on phosphate ore as a way to improve its reactivity and solubility, which would allow its exploitation. Vibratory mill is shown to be the best method, allowing extraction of around 44 % of phosphate from the sample. “[The Use of X-ray Diffraction Analysis in Different Forensic Disciplines](#)” by A. Radosavljević-Mihajlović reviews the use of X-ray diffraction analysis in criminal forensic analysis. This technique is shown to be of immense value in forensic analysis from material analysis and identification to analysis of human remains. This proceedings closes with the paper “[Alkali-Aggregate Reactions in Concrete](#)” by Topličić-Čurčić et al., a review of alkali-aggregate reactions (AAR) in concrete, which provides an overview of mechanisms of AARs, testing methods, effects and prevention, along with insights into future developments in both testing and prevention of AARs in concrete.

The editors wish to extend their gratitude and appreciation to all the authors for their cooperation and contributions, to all of the conference participants and session chairs for their time and efforts, and to all the reviewers for their valuable comments and suggestions. Support from the Atlantis press (Springer-Verlag), Serbian Academy of Sciences and Arts digital and printing department, designing and reviewers team of Serbian Ceramic Society was essential in the publication of these proceedings. We are especially indebted to Professor Dr. Dr. h.c. Marcel Van de Voorde, Professor at the University of Technology Delft for the idea, the initiative and the support given to the publication of these proceedings. His input and guidance based on his broad knowledge in materials science, technology, and innovation were much appreciated. His advice and assistance through the entire process, insisting on the high quality of the proceedings, the creation of an

international reviewing committee, and his long-standing experiences in recognized European- and International research organizations assure the quality of these proceedings.

We finally hope that this issue will serve as a useful reference for the researchers and technologists working in the field or interested in processing and manufacturing of ceramic materials and systems.

Proceedings of the III Advanced Ceramics and
Applications Conference

Lee, W.E.; Gadow, R.; Mitic, V.; Obradovic, N. (Eds.)

2016, XIX, 383 p. 236 illus., 99 illus. in color., Hardcover

ISBN: 978-94-6239-156-7

A product of Atlantis Press