Innovation Center of Faculty of Mechanical Engineering

Faculty of Mechanical Engineering, University of Belgrade

Center for Business Trainings

CNN TECH

„International Conference of Experimental and Numerical Investigations and New Technologies“

Sponsored by:

MINISTRY OF SCIENCE, TECHNOLOGICAL DEVELOPMENT, AND INNOVATION OF THE REPUBLIC OF SERBIA

Programme

and

The Book of Abstracts

26-28 May 2026

Belgrade, Serbia

„International Conference of Experimental and Numerical Investigations and New Technologies“

CNN TECH 2026

26-28 May 2026

University of Belgrade – Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

http://cnntechno.com

Programme

and

The Book of Abstracts

Organised by:

Innovation Center of Faculty of Mechanical Engineering

Faculty of Mechanical Engineering, University of Belgrade

Center for Business Trainings

Sponsored by:

Ministry of Science, Technological Development, and Innovation of the Republic of Serbia

Title:	International Conference of Experimental and Numerical Investigations and New Technologies – **CNN TECH 2026** **PROGRAMME AND THE BOOK OF ABSTRACTS**
Publisher:	University of Belgrade - Faculty of Mechanical Engineering Kraljice Marije 16, 11120 Belgrade 35 tel: (+381 11) 3302-346, fax 3370364 e-mail: cnntechno@gmail.com web site: http://cnntechno.com
Editors:	Dr Aleksandra Mitrovic, Assistant Professor *University of Criminal Investigation and Police Studies, Department of Forensic Engineering, Belgrade* Dr Isaak Trajkovic, Scientific Researcher *Innovation Center of the Faculty of Mechanical Engineering in Belgrade* Dr Milan Travica, Teaching Assistant *University of Belgrade - Faculty of Mechanical Engineering*
Technical editor:	Dr Goran Mladenovic, Full Professor *University of Belgrade - Faculty of Mechanical Engineering*
Cover page:	Dr Isaak Trajkovic, Scientific Researcher
Printed in:	University of Belgrade - Faculty of Mechanical Engineering Kraljice Marije 16, 11120 Belgrade 35 tel: (+381 11) 3302-346 Approved for printing by decision of the Dean of the University of Belgrade – Faculty of Mechanical Engineering, Decision No. 7/2026 dated May 12, 2026.
License:	All abstracts in this volume are published under the Creative Commons Attribution 4.0 International (CC BY 4.0) license, permitting unrestricted use, distribution, and reproduction in any medium, provided the original authors and source are properly cited (https://creativecommons.org/licenses/by/4.0/).
Circulation:	150 copies. The end of printing: May 2026.

ISBN: 978-86-6060-246-8

Copyright© 2026 International Conference of Experimental and Numerical Investigations and New Technologies – **CNN TECH 2026**

“International Conference of Experimental and Numerical Investigations and New Technologies”

CNN TECH 2026

SCIENTIFIC COMMITTEE:

Nenad Mitrovic, Serbia (chairman)
Milos Milosevic, Serbia (co-chairman)
Aleksandar Sedmak, Serbia
Milos Djukic, Serbia
Hloch Sergej, Slovakia
Drazan Kozak, Croatia
Nenad Gubeljak Slovenia
Monka Peter, Slovakia
Snezana Kirin, Serbia
Samardzic Ivan, Croatia
Martina Balac, Serbia
Mládková Ludmila, Czech Republic
Johanyák Zsolt Csaba, Hungary
Igor Svetel, Serbia
Aleksandra Mitrovic, Serbia
Valentin Birdeanu, Romania
Goran Mladenovic, Serbia
Luis Reis, Portugal
Zarko Miskovic, Serbia
Tozan Hakan, Turkey
Traussnigg Udo, Austria
Katarina Colic, Serbia
Peter Horňak, Slovakia
Róbert Huňady, Slovakia
Martin Hagara, Slovakia
Marija Djurkovic, Serbia
Tsanka Dikova, Bulgaria
Ján Danko, Slovakia
Ognjen Pekovic, Serbia
Jelena Svorcan, Serbia
Adriana Peles, Serbia
Jelena Zivojinovic, Serbia
Nebojsa Manic, Serbia
Zorana Golubovic, Serbia
Vera Pavlovic, Serbia
Aleksandra Dragicevic, Serbia
Dragan Milkovic, Serbia
Bojan Cudic, Bosnia and Herzegovina
Vesna Miletic, Australia
Natasa Obradovic, Serbia
Branislav Sredanovic, Bosnia and Herzegovina
Dragana Vujicic Stefanovic, Bosnia and Herzegovina
Bosko Mekinjic, Bosnia and Herzegovina
Milena Milosevic, Serbia
Jelena Jovanovic Sakovic, Montenegro
Aleksandar Vulovic, Montenegro
Nikola Mirkov, Serbia
Ivana Vasovic, Serbia
Jovana Zvicer, Serbia
Isaak Trajkovic, Serbia
Dragica Manojlovic, Serbia

ORGANIZING COMMITTEE:

Milos Milosevic (chairman)
Nenad Mitrovic (co-chairman)
Aleksandar Sedmak
Martina Balac
Igor Svetel
Goran Mladenovic
Aleksandra Mitrovic
Milan Travica
Aleksandra D. Dragicevic
Isaak Trajkovic
Toni Ivanov
Snezana Kirin
Ivana Vasovic Maksimovic
Nina Obradovic
Ivana Filipovic
Jasmina Milenkovic
Ivan Zlatanovic
Jelena Vucicevic
Katarina Telebak

enterprise europe network
Business Support on Your Doorstep

ACKNOWLEDGEMENT

The organizing committee of the 10th International Conference of Experimental and Numerical Investigations and New Technologies – CNN TECH 2026 wishes to sincerely thank all the institutions and individuals who, by means of personal engagement and constructive action, helped organise this conference.

We would like to extend our gratitude to the **Ministry of Science, Technological Development, and Innovation**, as well as the **Ministry of Education, Government of the Republic of Serbia**, for their ongoing support.

We are also grateful to companies, **3D Republic**, **Shimadzu**, **Novos**, **Superlab, Coca-Cola Serbia, Thermax Chemical Europe A/S, Technovia Engineering Solutions, Flux Pro** and **Svoksen** who have significantly contributed to the organization and realization of the conference.

PREFACE

Dear Friends and Colleagues,

welcome to the CNN Tech 2026 Conference, this year again in Belgrade!

With 64 papers (14 by international authors) and contributions by authors from different countries, the International Conference of Experimental and Numerical Investigations and New Technologies CNN Tech 2026 successfully sets a high level for future conferences. Participation of a large number of domestic and international authors, as well as the diversity of topics, justifies our efforts to organize this conference and contribute to the exchange of knowledge, research results and experience of industry experts, research institutions and faculties which all share a common interest in the field in experimental and numerical investigations.

This year CNN Tech 2026 focuses on the following topics:

- Mechanical Engineering,
- Engineering Materials,
- Chemical and process Engineering,
- Experimental Techniques,
- Numerical Methods,
- New Technologies,
- Clear Sky,
- Dental Materials and Structures,
- Artificial intelligence,
- Student session.

The organizing committee of CNN Tech 2026 would like to express gratitude to the Ministry of Education and the Ministry of Science, Technological Development and Innovation for the financial support of the Conference. On behalf of the Innovation Center of the Faculty of Mechanical Engineering, Faculty of Mechanical Engineering and Center for Business Trainings, we wish this to be a splendid CNN Tech conference filled with many memorable moments.

PROGRAMME AND ORGANIZING COMMITTEE

CONTENTS

PROGRAMME

Tuesday, May 26, 2026

Arrival of conference participants to Belgrade

Wednesday, May 27, 2026

Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade

09:30 to 10:00	**Registration – Congress Hall 211– II floor**	
10:00 to 10:45	**Opening Ceremony – Conference Hall 211 – II floor** *dr Nenad Mitrovic, Conference Co-chair* *dr Vladimir Popovic, Dean of the Faculty of Mechanical Engineering in Belgrade* *dr Nenad Zrnic, Director of the Innovation Center of Faculty of Mechanical Engineering in Belgrade* *dr Aleksandar Sedmak, Professor Emeritus*	
10:45 to 12:15	**REGIONAL INNOVATION FORUM 2026** – *presentations and panel discussions* **Conference Hall 211 – II floor** TURNING RESEARCH INTO REALITY: ENTREPRENEURSHIP, TECHNOLOGY, AND LEGAL SAFEGUARDS 1. dr Stevan Vrbaski, Vinaver Medical — “Revolutionize Diagnostics and Therapy” 2. dr Ivica Dimkic, BIOCOMBACT — “Biocontrol-Based Agricultural Solutions” 3. dr Mladen Terzic, MOTIQUM — “Smart Wearable and Motion-Tracking Technologies” 4. dr Uros Kovacevic, Lab EEBEE – “The Journey from Idea to Commercialization” 5. Luka Obradovic, Attorney at Law – “How to Protect IP, when a Dispute Arises, and How to Initiate One”	
12:15 to 13:00	**Coffee break** **Library Hall – I floor**	**B2B meetings** **Library Hall – I floor**
13:00 to 14:00	**REGIONAL INNOVATION FORUM 2026** – *presentations and panel discussions* **Library Hall – I floor** AI, INFRASTRUCTURE, AND DEEP-TECH: BUILDING SERBIA'S INNOVATION ECOSYSTEM 1. dr Nenad Filipovic, Full Professor – “STRATIFYHF project: Artificial Intelligence-based Decision Support System for Risk Stratification and Early Detection of Heart Failure	

	2. dr Aleksandra Dragicevic, C4IR Serbia – “Advancing AI Innovation in Healthcare and Biotech” 3. Bogdan Stesevic – “National AI Infrastructure in Serbia: Supercomputing Capabilities for Science and Industry” 4. Marjan Nikolovski – “Beyond Innovation: Why Deep-Tech Entrepreneurship Requires Strategic Foresight – The TECHSIGHT Perspective”	
14:00 to 15:00	**Lunch break**	
14:00 to 16:00	**POSTER SESSION (all papers)**	**B2B meetings**
15:00 to 16:00	**WORKSHOP**	
16:00 to 19:00	**Free time**	
19:00 to 23:00	**Gala dinner for Conference participants**	

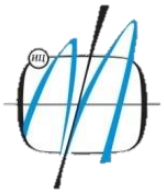
Thursday, May 28, 2026

Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade

11:00 to 11:30	**Registration – Library Hall – I floor**
11:30 to 12:00	**PLENARY LECTURES – Library Hall – I floor** **Computational Engineering & Bioengineering** dr Milos Kojic, Full Professor – “A selection of solutions obtained during 50 years of the development and application of our Finite Element Program PAK in engineering and bioengineering”
12:00 to 12:30	**REGIONAL INNOVATION FORUM 2026** **Machine Learning in Biomedicine** 1. dr Miljana Tanic – “Principles of Developing ML Models in Biomedicine” 2. dr Marina Popovic Krneta – “Principles of Interpreting ML Models in Biomedicine”
12:30 to 13:15	**Coffee break**
13:15 to 14:15	**PLENARY LECTURES – Library Hall – I floor** **Structural Integrity & Materials Science** 1. dr Aleksandar Sedmak, Professor Emeritus – “Integrity of Pressure Vessels — Case Studies” 2. dr Milos Djukic, Full Professor – “Hydrogen Embrittlement Phenomena in Metallic Materials”
14:15 to 15:00	**INVITED LECTURES** 1. dr Aleksandar Kartelj, “From Data to Equations: Symbolic Regression in Science and Engineering” 2. dr Tina Pajevic – “Direct Printed Aligners- Current Advantages and Disadvantages in Clinical Practices”

	3. dr Nikola Karlicic – “Reliability of Multiphase Flow Numerical Models: Validation and Industrial Experience from Large-Scale Fly Ash Pneumatic Conveying Systems in Thermal Power Plants”
15:00 to 17:00	**Closing Ceremony and final remarks** **Cocktail party – Restaurant at V floor**

Supported by:



Republic of Serbia
MINISTRY OF SCIENCE,
TECHNOLOGICAL DEVELOPMENT
AND INNOVATION

CENTER FOR
THE
PROMOTION
OF SCIENCE

PRIVREDNA
KOMORA
SRBIJE

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
Progress by innovation

THE ACADEMY OF APPLIED
STUDIES POLYTECHNIC

Институт техничких наука
САНУ

MAŠINSKI
FAKULTET
PODGORICA

Sponsored by:

ABSTRACTS

Mechanical Engineering

Invited lecture

RELIABILITY OF MULTIPHASE FLOW NUMERICAL MODELS: VALIDATION AND INDUSTRIAL EXPERIENCE FROM LARGE-SCALE FLY ASH PNEUMATIC CONVEYING SYSTEMS IN THERMAL POWER PLANTS

Nikola Karlicic[1*] [0000-0002-5510-9500]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11120 Belgrade, Serbia

**Corresponding author e-mail: nkarlicic@mas.bg.ac.rs*

Abstract

The reliable operation of thermal power plants heavily depends on their ash handling systems, where pneumatic conveying often acts as a critical bottleneck. Designing these systems for highly heterogeneous bulk solids, such as lignite fly ash, remains a major engineering challenge. In practice, standard analytical calculations and classical classification diagrams, like Geldart or Dixon, often fall short when scaled up to actual industrial environments. This paper outlines the transition from theoretical assumptions to robust numerical simulations, specifically focusing on dense-phase pneumatic conveying. We will discuss two modeling approaches for predicting pressure drop along long-distance pipelines: 1D numerical models developed in FORTRAN used to evaluate different solid friction factor correlations, and more advanced 3D simulations utilizing the Euler-Euler approach within the OpenFOAM software package. The core of this study is its direct field validation. All developed models were validated against experimental data gathered from a 620 MW thermal power plant unit, on a pipeline extending nearly 600 meters. By analyzing the statistical deviations between the numerical predictions and actual measurements, we identified the most reliable modeling approaches. Ultimately, the goal is not simply to showcase mathematical models, but to understand the root causes of pipeline blockages and demonstrate how these tools can be practically applied to optimize existing installations and design new, high-capacity systems.

Keywords

Pneumatic conveying, Fly ash, Multiphase flow, Numerical simulation, Experimental validation.

Acknowledgement

The research is supported by Ministry of Science, Technology Development and Innovation of Republic of Serbia, Contract No. 451-03-34/2026-03/200105.

Type of publication

Original Research Article.

INFLUENCE OF INLET CHAMBER GEOMETRY ON COOLING EFFICIENCY FOR A SPECIFIC ELECTRONIC MODULE

Ljubomir Nesovanovic[1] [0000-0002-7265-1596], Aleksandar Stepanovic[1] [0000-0002-6928-1125], Ivana Vasovic Maksimovic[1] [0000-0002-8310-7588], Julija Maletic[1] [0000-0002-4465-7552], Marko Ristic[2] [0009-0005-9621-4584]

[1]Lola Institute, Kneza Viseslava 70a Belgrade, Serbia,

[2]University of Belgrade, Institute Mihailo Pupin, Volgina 15, 11000 Belgrade, Serbia

Corresponding author's email: ivanavvasovic@gmail.com

Abstract

Equipment used in the electrical industry is frequently exposed to elevated temperatures and significant thermal fluctuations, which can adversely affect performance and reliability. A primary challenge is overheating of critical components, which demands the development of effective solutions. This paper presents the design and development of a specific cooling system tailored for electronic modules operating under demanding conditions. Due to the specificity of the considered unit, the cooling system must be carefully adapted to meet performance requirements. Using the numerical and experimental approaches, a comprehensive methodology is established aimed at maximizing cooling efficiency. In particular, computational analyses are conducted to evaluate fluid flow behavior within the system, while experimental validation ensures the reliability of the obtained results. Special attention is given to the influence of inlet chamber geometry on flow distribution and heat dissipation characteristics. Variations in the shape of the inlet chamber are systematically analysed to determine their impact on overall system performance. The results presented in this research show that optimized geometric configurations significantly improve cooling efficiency by enhancing fluid flow uniformity and heat transfer. The findings provide valuable insights for the design of advanced cooling systems in electrical and electronic applications. This research contributes to improving the operational reliability and lifespan of equipment exposed to unfavorable thermal environments.

Keywords

Numerical Simulation; Experimental Validation; Cooling Efficiency; High-Temperature Environments, Fluid Flow Analysis.

Acknowledgement

This research was funded by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia through contract 451-03-33/2026-03/200066.

Type of publication

Original Research Article.

TRANSITION FROM BRITTLE TO DUCTILE STATE IN POROUS SOLIDS USING RHEOLOGICAL DYNAMICS AND DRUKER-PRAGER CRITERION

Dragan Milasinovic[1*] [0000-0001-8318-5159]

[1]University of Novi Sad, Faculty of Civil Engineering Subotica, 24000 Subotica, Serbia

*Corresponding author e-mail: ddmilasinovic@gmail.com

Abstract

A pressure-dependent model is proposed that is capable of describing the transition from the brittle to the ductile state in porous solids. The model predicts the behavior of the material, both in the case of strain hardening and in the case of strain softening. The model is based on a rheological-dynamic analogy that bridges the behavior of viscoelastoplastic materials with dynamic models and thus transforms the complex, time-dependent deformation of materials into solvable, linear dynamic problems. For general stress situations, the yield conditions are generalized by the Drucker-Prager criterion for associative flow. In this study, the parameters for the Mohr-Coulomb hypothesis and the Drucker-Prager criterion are theoretically and experimentally investigated for the case of normal and high strength concrete. Concrete cylinders without and with the influence of porosity are analysed. The results show that the creep coefficient plays a key role in the transition from brittle to ductile behavior with a significant influence of porosity thresholds.

Keywords

Rheological dynamics, Brittle-ductile transition, Porosity thresholds, Drucker-Prager criterion, Associated flow.

Type of publication

Original Research Article.

TESTING AUTOCLAVABILITY AND PERMEABILITY OF PLA AND PLA-LIKE MOLDS

Nikola Matic[1]*, Bozica Bojovic[1] [0000-0002-3798-1020], Aleksandra Jaukovic[2] [0000-0003-2686-7481], Hristina Obradovic[2] [0000-0003-4626-7184]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Manufacturing Engineering, 11000 Belgrade, Serbia

[2]University of Belgrade, Institute for Medical Research, Hematology and Stem cells Research Group, 11000 Belgrade, Serbia

*Corresponding author e-mail: matic.s.nikola@gmail.com

Abstract

This study evaluates the autoclavability and permeability characteristics of additively manufactured molds produced from polylactic acid (PLA) and PLA-like photopolymer resins. The work addresses a practical constraint in laboratory and biomedical fabrication contexts, where low-cost, rapidly prototyped molds must withstand sterilization while enabling controlled mass transport. Fused filament fabrication (FFF) PLA molds were first investigated. Specimens were subjected to standard autoclave cycles and assessed for structural integrity and dimensional stability. Furthermore, permeability was observed in these samples and was found to be inconsistent and non-design-driven, arising primarily from microstructural defects inherent to the layer-by-layer deposition process. Subsequently, masked stereolithography (mSLA) molds fabricated from PLA-like resins, which are materials with mechanical properties analogous to PLA but distinct polymer chemistry were examined. The resilience of these specimens to autoclave conditions was also analysed. Crucially, mSLA fabrication enabled the deliberate introduction of permeability through geometric design rather than incidental defects. Iterative design evolution, progressing from regular hexagonal perforations to irregular Voronoi-based architectures, facilitated improved control over pore distribution and effective permeability. The findings establish that both FFF PLA and mSLA PLA-like molds can be compatible with autoclave sterilization under appropriate conditions. However, only mSLA-based approaches offer reliable and design-controllable permeability. This distinction has implications for applications requiring predictable transport properties, such as tissue engineering scaffolds and casting molds for porous constructs.

Keywords

Bioprinting, Biocasting, Additive manufacturing, Stereolithography, Autoclavability.

Type of publication

Original Research Article.

SELECTING MATERIAL FOR ELECTRICAL CONTACTS IN AUTOMATED SYSTEMS - GOOD PRACTICE RECOMMENDATIONS

Nada Ratkovic Kovacevic[1*] [0000-0001-6398-4391], Zoran Karastojkovic[2*] [0009-0007-0852-1897],

Milesa Sreckovic[3]

[1]The Academy of Applied Studies Polytechnic, Novi Beograd Section, Department of Electrical and Computer Engineering, 11070 Belgrade, Serbia

[2]Society for Ethics and Evaluation in Culture and Science, 11000 Belgrade, Serbia

[3]University of Belgrade, Faculty of Electrical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: nratkovickovacevic@politehnika.edu.rs and zoran.karastojkovic@gmail.com

Abstract

Electrical contacts are critical component in automated systems. They enable current and/or signal flow, and consequently provide the function of devices such as connectors, connector systems, sensors, switches, relays, circuit breakers, complex contact assemblies, etc. Electrical contact points are conductive components that establish, maintain, or break electrical connections in circuits. In electromechanical assemblies, electrical contacts act as the interfaces between two conductive parts and their material makes high impact on properties and performance of the switching operation. The properties and most important characteristics (either surface or core ones) of electrical contacts include high conductivity (both electrical and/or thermal), wear resistance, corrosion resistance, controlled behavior under arcing, and stable mechanical performance. Selecting material to make electrical contact points is neither simple nor trivial. One type of classification is regarding material used: noble metal contacts; pure metal contacts; alloy contacts; contacts made from composite materials. The material selected and contact points manufactured should ensure high reliability under repeated use, in varying environments, and under different current loads. All of these are directly impacting efficiency, safety, and lifespan of the electrical equipment and the entire automated system. Paper elaborates and investigates the good practice recommendations in selecting material for electrical contact point production with emphasis made on achieved physical properties. In contact engineering, simplified assumptions can lead to functional issues, unnecessary cost or waste/ loss. Material selection is application specific. Technical (e.g. application-specific) criteria for selecting the contact material are current type (AC or DC); switching and continuous current; electrical load type (resistive, inductive, capacitive); contact force and contact geometry; required electrical and mechanical life; environmental conditions (temperature, atmosphere, contamination). A robust material selection approach considers both engineering and purchasing perspectives. Engineering requirements focus on function, lifetime and process stability, while purchasing emphasizes cost stability, availability and consistent quality of the manufactured electrical contacts.

Keywords

Automated Devices, Contact Material, Mechatronics, Physical properties, Operating Requirements.

Acknowledgement

Acknowledgements are extended to The Academy of Applied Studies Polytechnic, Belgrade for their support.

Type of publication

Review Article.

PLANNING OF PRODUCTION RESOURCES IN CONDITIONS OF UNCERTAINTY

Marija Milanovic[1] [0000-0001-5240-665X]

[1]Innovation Center of the Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: mdmilanovic@mas.bg.ac.rs

Abstract

The aim of this paper is to plan production resources under conditions of uncertainty by applying modified optimization models. In the paper, the integration of existing models of modern production in conditions of risk was carried out, while solutions sensitive to changes in business conditions were applied. Numerous methods and techniques are defined in the literature that are applied in the optimization of production resources. Planning production resources under conditions of uncertainty requires the application of FLP (fuzzy linear programming) and FAHP (fuzzy analytical hierarchical process) methods for estimating the parameters of the objective function during optimization. Data on production resources, materials, machines and personnel were collected from the company Insa Zemun. These resources were observed and analysed as product demand uncertainty, machine capacity uncertainty and human resource uncertainty. The conducted research also includes the material as a stochastic function under conditions of uncertainty. A significant contribution to the optimization of production resources in conditions of uncertainty was achieved by including uncertainty in the process of planning production capacities through the application of fazzy linear programming. The results of classical linear programming and fuzzy linear programming are shown in comparison. The objective function is designed to optimize profit and production task time. The obtained research results enable effective planning of production resources in conditions of uncertainty, in order to ensure optimal management of the enterprise. The identification of the cause-and-effect relationship between criterion values and the alternatives enabled the design of a model for optimal management of the enterprise in real conditions. A scheme of methodological steps of the analysis of production resources in which uncertainty is present, crucial for the optimization of the planning process, was proposed. The projected production plan in conditions of uncertainty indicates the realization of higher profits if the postponed solutions are applied.

Key words

Production planning, uncertainty, optimization, production resources, fuzzy linear programming.

Type of publication

Review Article.

COMPARATIVE ANALYSIS OF PERFORMANCE AND DESIGN CHARACTERISTICS OF VEHICLE AND AIRCRAFT PISTON ENGINES

Dragana Velimirovic[1*] [0000-0002-5638-3165], Vojkan Dimitrijevic[1] [0009-0007-6961-0017], Milan Markovic[1] [0009-0002-6515-8813], Andrijana Djurdjevic[1] [0009-0000-7233-5748]

[1]Academy of Applied Studies Polytechnic, Katarine Ambrozic 3, 11000 Belgrade, Serbia

*Corresponding author e-mail: dvelimirovic@politehnika.edu.rs

Abstract

The paper provides a comparative analysis of aircraft and vehicle piston engines from several aspects. As representative aircraft engines, those from the Lycoming and Continental families are considered, which are installed in light school and sport aircrafts such as the Cessna 152 and 182 as well as the Cirrus. Aircraft engines are considered in the category with frequently used carburetor formation of the mixture versus direct fuel injection which is dominant in vehicle engines. From the performances that are compared, the liter power is considered, which is higher in the vehicle engine, about 45-70 kW/l versus 15-30 kW/l at aircraft engines. The ratio of power to the mass of the engine is higher in the aircraft engine, approximately 1 kW/kg versus 0,5-0,7 kW/kg in vehicle engine concept. The projected power range of the cruising flight is approximately constant in the ratio 0,8-0,85 P_{max} versus projected power range of 0,9-1 P_{max} for passenger cars maximum speed. Also, the work considers the aspect of the type of fuel, where gasoline of octane number 95 and 100 is dominant in vehicle engines and engines with the OTTO cycle, while aviation gasoline (AVGAS) is present in aviation applications, with octane number of 100 and higher. The aspects also represented, in addition to the above, are the application of turbo charging in both engines, as well as the trend of greater representation of diesel aircraft engines, as opposed to vehicle engines in passenger cars. The paper also covers the aspect of the speed characteristics of these two categories of engines, whereby aircraft engines achieve their maximum torque in the zone of lower revolutions, unlike engines in passenger cars. The rpm range of aircraft engines is between 2200-2700, while in vehicle engines exceeds 6000 rpm, when reaching maximum speed. From the aspect of reliability, the thermal load of the aircraft engine is lower. The differences in the construction design, cooling system, transmission, linear and radial conception of aircraft and vehicle engines are considered. This paper also analyses hybrid propulsion systems in both categories.

Keywords

Piston engines, Light aircrafts, Passenger cars, Fuels, Design characteristics, Efficiency.

Type of publication

Review Article.

RISK-BASED INSPECTION AND INTEGRITY MANAGEMENT OF SUBSEA EQUIPMENT IN OFFSHORE ENVIRONMENTS

Lazar Jeremic[1*] [0000-0002-9568-2766], Branislav Djordjevic[1] [0000-0001-8595-6930], Aleksandar Jovanovic[2] [0009-0009-6539-1325], Nikola Budimir[1] [0000-0001-9359-9240]

[1]Innovation Center of the Faculty of Mechanical Engineering, 16 Kraljice Marije Street, Belgrade, Serbia

[2]Mont R, Meljak, Belgrade, SERBIA

Corresponding author e-mail: ljeremic@mas.bg.ac.rs

Abstract

Risk-Based Inspection (RBI) and integrity management represent essential approaches for ensuring the safe and reliable operation of subsea equipment throughout its service life. Subsea systems operate under harsh environmental conditions with limited accessibility, making inspection and maintenance activities technically challenging and cost intensive. The primary objective of this paper is to analyses the role of subsea inspection in supporting integrity management and RBI strategies for subsea equipment. The study focuses on commonly applied inspection methodologies, including General Visual Inspection (GVI), Close Visual Inspection (CVI), cathodic protection (CP) assessment, and inspections performed using Remotely Operated Vehicles (ROVs). Typical degradation mechanisms affecting subsea equipment, such as corrosion, mechanical damage, fatigue, and degradation of protective systems, are considered in relation to risk evaluation and inspection planning. Furthermore, the integration of subsea inspection data into integrity management systems and RBI frameworks is discussed, enabling optimized inspection intervals and risk-informed decision-making. The paper demonstrates that a systematic application of RBI principles, supported by reliable subsea inspection data, significantly enhances the integrity management of subsea equipment and contributes to the reduction of operational risk over the lifecycle of offshore subsea assets. By integrating inspection data on crack size, orientation, and growth rates into the Risk-Based Inspection (RBI) assessment, the study demonstrates a measurable reduction in crack-driven probability of failure and enables a technically justified reassessment of the remaining safe operating life of subsea equipment.

Keywords

Subsea inspection, Integrity management, ROV, Risk-Based Inspection, Offshore structures.

Acknowledgement

This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia under contracts No. 451-03-33/2026-03/200213 and No. 451-03-33/2026-03/200051.

Type of publication

Original Research Article.

Engineering Materials

GRAPHENE AND GRAPHENE OXIDE AS MODERN DRUG CARRIERS

Srdjan Vukovic[1*] [0000-0001-7573-5712], Danijela Vukovic[1] [0000-0002-1169-5755], Svetlana Pelemis[1] [0000-0001-9682-5899]

[1]University of East Sarajevo, Faculty of Technology, Karakaj 34a, 75400 Zvornik, Bosnia and Herzegovina

*Corresponding author e-mail: srdjan.vukovic92@gmail.com

Abstract

The discovery of graphene, in the field of new carbon nanomaterials, has triggered worldwide research into biomedical applications of this material since 2004 due to its unique properties and possible structural modifications. Graphene and graphene oxide (GO) represent important nanostructured materials in modern nanomedicine, thanks to their two-dimensional structure, large specific surface area, tunable surface chemistry, and the possibility of chemical functionalization. These properties enable the effective binding of various therapeutic molecules through covalent and non-covalent interactions, thus forming stable and high-capacity drug nanocarriers. The paper provides an overview of modern research on the structure, physico-chemical properties and applications of graphene and graphene oxide in drug delivery systems, with an emphasis on the delivery of anticancer drugs, genes, and other bioactive molecules, as well as on drug loading, encapsulation, and controlled release mechanisms. In particular, the advantages of targeted and stimulus-responsive delivery, including pH-sensitive, thermal, photo-induced, and magnetic release approaches, are discussed in relation to increased therapeutic efficiency and the reduction of side effects compared to conventional therapeutic strategies. The main conclusion is that graphene- and GO-based nanocarriers show considerable potential for the development of drug delivery systems, especially in cancer therapy, due to their high loading capacity, surface functionalizability, and multifunctional behavior. However, for their wider clinical application, important open issues remain, including colloidal stability in physiological media, protein corona formation, biocompatibility and toxicity, biodistribution, biodegradation, and the need for better standardization of graphene-based materials.

Keywords

Graphene, Graphene oxide, Drug nanocarriers, Biocompatibility, Drug delivery systems.

Acknowledgement

The authors acknowledge the financial support of the Ministry of Scientific and Technological Development and Higher Education of the Republic of Srpska (19.032/961-90/24).

Type of publication

Review Article.

TURNING MATERIALS DATA INTO IMPACT: COLLABORATION PATHWAYS FOR SCIENCE AND INDUSTRY

Isaak Trajkovic [1*] [0000-0001-6671-4733], Milos Milosevic[1] [0000-0002-2418-1032], Francesco Mercuri[2] [0000-0002-3369-4438], Goran Mladenovic[3] [0000-0003-1706-7503]

[1]Innovation center of Faculty of Mechanical Engineering, 11000, Belgrade, Serbia

[2] ISMN-CNR, Bologna, Italy

[3]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

Corresponding author e-mail: trajkovicisaak@gmail.com

Abstract

Materials innovation is increasingly underpinned by data—including experimental results, simulations, digital imaging, process parameters, and performance measurements—yet the pathway from “more data” to measurable industrial impact remains highly fragmented. Data are often dispersed across laboratories and organizations, described using inconsistent metadata, stored in non-interoperable formats, and insufficiently aligned with the concrete decision-making needs of end-users. Consequently, promising research outcomes frequently struggle to translate into scalable processes, validated technologies, and market-relevant solutions. This paper examines how materials data can be systematically converted into impact through clearly defined science–industry collaboration pathways. Building on the objectives of COST Action CA22143 (EuMINe – European Materials Informatics Network), the study identifies key mechanisms that accelerate technology transfer: (i) establishing a shared terminology and metadata framework to enable dataset reuse and comparability; (ii) aligning experimental and computational workflows to enhance reproducibility and trust; (iii) forming interdisciplinary teams that integrate materials science, engineering, and data/AI expertise; and (iv) engaging stakeholders early to define application-driven requirements, validation routes, and barriers to adoption. Furthermore, the paper proposes practical steps to operationalize collaboration, including targeted workshops, B2B interactions, shared demonstrators, and stakeholder mapping, with the explicit aim of bridging academic outputs with industrial needs. In conclusion, converting materials data into impact requires not only advanced analytics, but also coordinated communities, shared standards, and sustained collaboration across the broader science–industry ecosystem.

Keywords

Engineering Materials, EuMINe, Technology Transfer, Metadata.

Acknowledgement

This publication is based upon work from COST Action EuMINe, CA22143, supported by COST (European Cooperation in Science and Technology), Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contr. 451-03-33/2026-03/200213) and CBC IT-SRB (proj. no. 00203859320251344000300000000102002).

Type of publication

Original Research Article.

SIMULATION-BASED ASSESSMENT OF AGING-INSPIRED PETG-CF DEGRADATION SCENARIOS IN ELECTRICAL INSULATION STRUCTURES

Ezgi Güney[1*] [0000-0003-4868-0626], Isaak Trajkovic[2] [0000-0001-6671-4733], Milos Milosevic[2] [0000-0002-2418-1032]

[1]Sinop University, Department of Electrical and Energy, 57000 Sinop, Turkey

[2] Innovation Center of the Faculty of Mechanical Engineering in Belgrade, Kraljice Marije 16, 11000, Belgrade, Serbia

*Corresponding author e-mail: eguney@sinop.edu.tr

Abstract

Carbon-fiber-reinforced PETG (PETG-CF) is an additively manufactured thermoplastic composite that has recently attracted attention for structural and insulation-support applications due to its mechanical rigidity, chemical stability, and compatibility with fused filament fabrication technologies. However, the influence of aging-induced degradation mechanisms on the electrical insulation performance of PETG-CF-based components remains insufficiently investigated, particularly under low-temperature operating conditions. This study presents a preliminary simulation-based framework for evaluating aging-inspired degradation scenarios in PETG-CF structural insulation components intended for gas-insulated electrical systems. Low-temperature exposure at −18°C was considered as an aging-conditioning environment that may contribute to material degradation phenomena such as interfacial weakening, micro-void formation, and localized surface irregularities. A previously developed 2D COMSOL Multiphysics transformer model was adapted to incorporate PETG-CF as a solid insulation-support component located within a C_4F_7N/CO_2 gas-insulated environment. Aging-inspired defect scenarios were represented through simplified geometrical and interfacial degradation features, including internal micro-voids, localized interface gaps, and surface irregularities associated with material aging processes. Electrostatic analyses were performed to investigate the influence of these degradation scenarios on electric field distribution and local electric field intensification within the insulation structure. The preliminary results indicate that aging-inspired defects in PETG-CF components can produce localized electric field enhancement in specific regions of the gas-insulated structure, potentially increasing susceptibility to partial discharge initiation. The proposed framework establishes a methodological basis for integrating aging-related material degradation concepts into electrostatic insulation assessment and provides guidance for future experimental validation studies involving low-temperature-conditioned PETG-CF samples.

Keywords

PETG-CF, Gas-insulated transformer, Aging-inspired defects, COMSOL Multiphysics, Electric field distribution.

Acknowledgement

This work is based upon work from COST Action CA22110 (LIAISE), supported by COST (European Cooperation in Science and Technology). The first author acknowledges support received through an STSM grant (Reference: E-COST-GRANT-CA22110-762fe339).

Type of publication

Original Research Article.

WATER TOWERS-CONFIGURATIONS AND MATERIALS

Marko S. Jaric [1*] [0000-0002-3052-1056], Sanja Petronic[2] [0000-0002-1205-081X]

[1]Innovation Centre of the Faculty of Mechanical Engineering Belgrade, Kraljice Marije 16, Belgrade, Serbia

[2] Institute of General and Physical Chemistry, Studentski trg 12/V, 11000, Belgrade, Serbia

*Corresponding author e-mail: mjaric81@gmail.com

Abstract

The paper deals with the water towers as a process equipment widely used in Europe, Asia, Australia and Africa for water distribution in water feeding systems and in industrial plants installed in their flat land areas. Classification of this equipment has conducted according to their shapes, including cones, rectangular, spheroids, ellipsoids, cylindrical, spherical, polyspheroid, toroid, disk shaped, mushroom shaped and specific shapes of water towers. Beside to that analysed of using of modern industrial PLCs equipment (Programmable Logic Controllers) like a system for needs of leading of water distribution process in which RTC (Real Time Clock) is integrated for the needs of holding date and time information, even when the main power is off. Special attention has dedicated to materials which are using for the water towers construction, and they are in general case classifying into: woods, bricks, reinforced concrete, steels and composites while recently years more often using of Polyurethane and glass reinforced polyester (GRP) for water towers construction. Nowadays, using of polyurethane and GRP water towers have found advantages for low capacities and temperatures in which will be installed and especially for domestic needs. Guideline and recommendations for water towers construction are also have given in related with earthquake areas.

Keywords

Water towers, PLC, Materials, Earthquake areas.

Type of publication

Original Research Article.

THE MICROSTRUCTURAL STABILITY AND SERVICE RELIABILITY OF CENTRIFUGALLY CAST HP40NB HEAT-RESISTANT ALLOY

Olivera Eric Cekic[1,2*] [0000-0002-4702-1728], Petar Janjatovic[4] [0000-0002-3779-9341], Milica Timotijevic[3] [0009-0004-6735-090X], Dragan Rajnovic[4][0000-0002-5303-4402]

[1]Innovation Center of Mechanical Engineering Faculty, University of Belgrade, 11000 Belgrade, Serbia,

[2] Faculty of Mechanical and Civil Engineering, University of Kragujevac, 36000 Kraljevo, Serbia,

[3]Academy of Applied Studies Polytechnic, Katarine Ambrozic 3, 11000 Belgrade, Serbia

[4]Department of Production Engineering, Faculty of Technical Science, University of Novi Sad, Trg Dositeja Obradovica 6, 21000 Novi Sad, Serbia

*Corresponding author e-mail: oeric@mas.bg.ac.rs

Abstract

This study aims to evaluate the service reliability of HP40Nb centrifugally cast austenitic steel by examining its microstructural stability under prolonged exposure to high temperatures. Particular attention is given to the carbide network and its role in preserving mechanical integrity during service. An HP40–1.5%Nb alloy, exposed to 100,000 hours of continuous operation in an industrial processing plant, was characterized using Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS). The results indicate that the microstructure of the failed tube consists of an austenitic matrix and a continuous network of primary eutectic carbides of two types: niobium-rich carbides (bright particles) and chromium-rich carbides (dark particles), identified as NbC and complex M_7C_3 (M = Cr, Ni, Fe). Secondary carbides are also present within interdendritic regions, exhibiting a stable distribution and appearing as bright, continuous plate-like forms and darker particles. No transformation of primary niobium carbides into the brittle G-phase was observed, even after long-term service exposure, indicating a high degree of microstructural stability. The retention of NbC and Cr-rich carbides confirms the persistence of strengthening mechanisms and contributes to the preservation of mechanical properties, while quantitative analysis of carbide volume fractions supports their uniform distribution. These findings highlight the importance of alloy design and process control in suppressing deleterious phase transformations and provide a reliable basis for remaining life assessment and predictive maintenance in industrial applications.

Keywords

HP40Nb alloy, Microstructural stability, Secondary carbides, Nb-carbides, Service reliability.

Acknowledgement

This work was supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia, Contract No. 451-03-34/2026-03/200156, 451-03-34/2026-03/200108, 451-03-33/2026-03/200213; and by the Faculty of Technical Sciences, University of Novi Sad, through project “Scientific and Artistic Research Work of Researchers in Teaching and Associate Positions at the Faculty of Technical Sciences, University of Novi Sad 2026”, Contract No. 01-3609/1. The work titled “Microstructural Stability and Service Reliability of HP40Nb Cast Austenitic Steels” primarily aligns with Sustainable Development Goal (SDG) 9 Industry Innovation and Infrastructure from the UN’s Agenda 2030.

Type of publication

Original Research Article.

4D PRINTING IN SOFT ROBOTICS

Milan Misic[1] [0000-0002-9695-7776], Strahinja Djurovic[1*] [0000-0002-5629-6221], Nikolaj Velikinac[2] [0009-0007-2115-5799], Milan Ivkovic[3] [0000-0003-3971-7984]

[1]Academy of applied studies Kosovo and Metohija, Leposavic, 38218, Republic of Serbia

[2]Faculty of Science and Engineering, Sorbonne University, Paris, French Republic

[3]Faculty of Engineering, University of Kragujevac, Kragujevac, 34000, Republic of Serbia

*Corresponding author e-mail: strahinja.djurovic@akademijakm.edu.rs

Abstract

Soft robotics utilizes flexible materials and compliant structures to achieve adaptive and biomimetic motion. Recently, 4D printing has emerged as a promising manufacturing method for soft robotic systems, enabling the creation of structures with programmable shape transformation in response to external stimuli. This review examines recent progress in 4D printed soft robotics, focusing on commonly used materials, additive manufacturing techniques, and actuation mechanisms driven by thermal, moisture, and light stimuli. Emphasis is placed on applications including soft grippers, self-bending actuators, and biomimetic locomotion systems. The analysis highlights the advantages of 4D printing for creating lightweight, multifunctional, and self-actuating robotic structures, while also addressing current challenges such as motion control, response repeatability, material durability, and slow actuation speeds, which hinder broader industrial adoption. The review concludes that advancements in smart materials, multi-material printing, and control strategies are necessary to enhance the reliability and practical deployment of 4D printed soft robotic systems.

Keywords

4D printing, Soft Robotics, Materials.

Type of publication

Review Article.

MATERIALS IN 4D PRINTING

Strahinja Djurovic[1*] [0000-0002-5629-6221], Milan Misic[1] [0000-0002-9695-7776], Nikolaj Velikinac[2] [0009-0007-2115-5799], Dragan Lazarevic[3] [0000-0001-5106-554X], Bojan Stojcetovic[1] [0000-0001-7418-6985], Martina Petkovic[1] [0000-0003-3210-3250]

[1]Academy of applied studies Kosovo and Metohija, Leposavic, 38218, Republic of Serbia

[2]Faculty of Science and Engineering, Sorbonne University, Paris, French Republic

[3]Faculty of Technical Sciences, University of Pristina, Kosovska Mitrovica, 38220, Republic of Serbia

*Corresponding author e-mail: strahinja.djurovic@akademijakm.edu.rs

Abstract

4D printing is an advanced form of additive manufacturing in which printed parts can change their shape or properties over time when exposed to external stimuli. These transformations are achieved through the use of smart materials, such as shape memory polymers, hydrogels, and shape memory alloys, which respond to changes in temperature, moisture, light, or pH. This review evaluates the most widely used smart materials in 4D printing, focusing on their functional behavior, advantages, limitations, and compatibility with additive manufacturing technologies. The influence of printing parameters, including layer orientation, printing temperature, and material composition, on actuation performance and responsiveness is examined. Representative applications in various industries such as biomedical devices, drug delivery systems, soft robotics, and adaptive engineering components are highlighted. Challenges related to material durability, response precision, multi-material integration, and manufacturing repeatability are addressed. The review concludes that advancing smart materials and optimizing printing processes are critical for enhancing the reliability and expanding the industrial adoption of 4D printed systems.

Keywords

4D printing, Smart materials, Additive manufacturing, Industrial applications

Type of publication

Review Article.

Chemical and Process Engineering

CONSTRUCTION AND EXPERIMENTS ON TEMPERATURE REGULATION OF A DEVICE GENERATING TEMPERATURE GRADIENT IN A MICROTITER PLATE

Nikola Mirkov[1*] [0000-0002-3057-9784], Dusan Radivojevic[1] [0000-0003-1959-3152], Dusan Nikezic[1] [0000-0002-8885-2683], Martina Balac[2] [0000-0002-2135-0179]

[1]University of Belgrade, Institute of Nuclear Sciences VINCA, 11000 Belgrade, Serbia

[2]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: nmirkov@vin.bg.ac.rs

Abstract

In recent years there has been a surge of interest in using low-cost electronic components and microcontrollers to the design of devices for temperature control which are low-cost alternatives to commercial devices. One of the application fields is microbiology research which requires accurate temperature control. This work is based on an attempt to design, construct and evaluate a device which would apply thermoelectric (Peltier) cells for creating the environment similar in temperature range to metabolic conditions. The device is designed to thermally condition microbiological cultures by generating and controlling temperature gradient on a plate which is in contact with a microtiter plate containing microbiological cultures. The purpose is to enable in vitro investigations of the influence of temperature on microbiological cultures. In an open-hardware approach we discuss the characteristics of a device. Important aspects are discussed such as temperature gradient control implementation using the proportional-integral-derivative (PID) control, temperature sensing circuitry and switching circuitry. Important aspect of software upgrade of the device functionality is considered. Furthermore, the potential for the improvement of the device using numerical simulation of heat transfer, and the challenges it sets is discussed.

Keywords

Thermoelectric heater, PID control, Raspberry Pi, Temperature gradient, Microbiological cultures.

Acknowledgement

This research was funded by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia through contract 451-03-33/2026-03/ 200105 and 451-03-33/2026-03/ 200017.

Type of publication

Original Research Article.

BRIDGING RESEARCH AND INDUSTRY: AI-SUPPORTED NUMERICAL ASSESSMENT OF CUMULATIVE MAGNETIC-FIELD EXPOSURE IN INDUSTRIAL ENVIRONMENTS

Violeta Djordjevic[1*] [0009-0007-9478-5433], Mladen Vuruna[2] [0000-0002-3558-4312], Mina Ristic[3] [0009-0001-9183-1832], Predrag Gorgic[4] [0009-0009-4253-0054]

[1] Ministry of Environmental Protection, Belgrade, 11000 Belgrade, Serbia

[2] Faculty of Information Technologies and Engineering, 11000 Belgrade, Serbia

[3] Secondary Music School “Josip Slavenski”, Department of Informatics, 11000 Belgrade, Serbia

[4] Office of the Council for National Security and Protection of Secret Data, 11000 Belgrade, Serbia

*Corresponding author e-mail: djordjevic.violeta1404@gmail.com; violeta.djordjevic@eko.gov.rs

Abstract

Modern industrial systems increasingly operate with multiple electrical installations generating low-frequency magnetic fields, creating complex exposure scenarios that challenge conventional occupational safety assessment methods. Translating electromagnetic research results into practical industrial tools represents an important step toward safer and innovation-driven workplaces. This work presents an application-oriented framework for cumulative magnetic-field exposure assessment based on numerical modelling and engineering implementation principles. The proposed approach integrates spatial distribution of electromagnetic sources, worker positioning, exposure duration, and magnetic-field superposition effects into a unified cumulative exposure index (CI). The model enables transformation of complex electromagnetic data into a single decision-support parameter suitable for industrial safety management. Numerical simulations performed for representative industrial environments demonstrate how cumulative effects originating from multiple 50 Hz sources may significantly influence local exposure conditions and reveal previously unrecognized high-risk zones. The methodology supports optimisation of equipment layout, preventive risk management, and compliance verification with ICNIRP 2020 occupational exposure reference levels. Beyond theoretical analysis, the presented framework emphasizes technology-transfer potential by enabling practical deployment in industrial monitoring systems, safety engineering procedures, and smart manufacturing environments. The proposed solution contributes to bridging the gap between scientific electromagnetic modelling and real industrial implementation, supporting innovation, workplace safety improvement, and collaboration between academia and industry.

Keywords

Electromagnetic exposure, Industrial safety, Numerical modelling, Artificial intelligence, Cumulative exposure.

Type of publication

Original Research Article.

NEUTRALIZATION OF WASTEWATER IN THE MINERAL WOOL PRODUCTION PROCESS

Stanko Stankov[1*] [0009-0002-4264-3111]

[1]University of Nis, Faculty of Electrical Engineering, Department of Automation, 18000 Nis, Serbia

*Corresponding author e-mail: stanko.stankov@elfak.ni.ac.rs

Abstract

The mineral wool production process generates complex wastewater streams containing suspended and dissolved pollutants, including oils, phenols, fibers, and mineral particles originating from raw materials such as basalt, dolomite, and quartz. The variability in the composition of these wastewaters, caused by changing plant operating regimes, represents a significant challenge for the effective management of treatment processes, particularly in the chemical neutralization stage. In this work, an automatic pH control system based on fuzzy logic was developed with the aim of improving the stability of the neutralization process under conditions of pronounced nonlinearity and variable load. The designed Mamdani/Sugeno-type fuzzy controller uses input variables representing the deviation of the pH value from the set reference and the rate of change of this deviation, based on which it generates a control signal for acid and base dosing. The system was implemented and tested in a real industrial plant, with a comparative analysis against a conventional PID controller. The results show that the proposed fuzzy approach reduces pH oscillations and provides a faster system response compared to PID control. A reduction in chemical reagent consumption was also achieved, along with improved process stability under variable load conditions. These results indicate the significant potential of intelligent control strategies in industrial wastewater treatment systems. The application of the proposed system enables the recirculation of treated water within the production cycle, thereby reducing freshwater consumption, decreasing the load on receiving water bodies, and improving the overall environmental performance of the plant.

Keywords

Fuzzy logic, pH control, Wastewater, Process optimization.

Type of publication

Review Article.

RADIOTRACER APPLICATIONS IN ENVIRONMENTAL SYSTEMS: SEDIMENT TRANSPORT AND WASTEWATER TREATMENT

Svetlana Pelemis[1*] [0000-0001-9682-5899], Srdjan Vukovic[1] [0000-0001-7573-5712], Danijela Vukovic[1] [0000-0002-1169-5755], Aleksandar Vukovic[2] [0000-0003-0549-6183]

[1]University of East Sarajevo, Faculty of Technology Zvornik, Karakaj 34a, 75400 Zvornik, Bosnia and Herzegovina

[2]University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovica 6, 21000 Novi Sad, Serbia

*Corresponding author e-mail: alannica@gmail.com

Abstract

Radiotracer techniques represent a powerful and versatile tool for investigating complex environmental systems in which direct observation of transport, mixing, and retention processes is difficult or impossible. This review examines the application of radiotracers in two major environmental domains: sediment transport studies and wastewater treatment systems. In sedimentary environments, radiotracers are used to determine transport pathways, bedload and suspended sediment dynamics, dredged material dispersion, silting processes in navigation channels, and sediment movement in coastal, riverine, and reservoir systems. In wastewater treatment plants, radiotracer methods are applied to characterize residence time distribution (RTD), detect dead zones, short-circuiting and hydraulic bypassing, evaluate mixing efficiency, and diagnose the hydrodynamic performance of units such as clarifiers, aeration tanks, digesters, and filters. The reviewed studies demonstrate that radiotracers provide highly sensitive, on-line, and non-invasive measurements under real operating conditions, offering significant advantages over conventional tracers, particularly in multiphase, opaque, and geometrically complex systems. Despite differences in scale and environmental setting, both application areas share a common methodological framework involving tracer selection, injection, detection, data acquisition, signal processing, and process interpretation. The review also highlights the growing importance of integrating radiotracer experiments with computational fluid dynamics and other complementary methods for improved system understanding and process optimization. Overall, radiotracer applications in environmental systems are of considerable scientific and practical importance, as they enable reliable diagnosis of complex processes, support more efficient engineering design and operation, and contribute to environmental protection and the sustainable management of water and sediment-related systems.

Keywords

Radiotracers, Sediment transport, Wastewater treatment, Residence time distribution (RTD), Hydrodynamic diagnostics.

Acknowledgement:

The authors acknowledge the financial support of the Ministry of Scientific and Technological Development and Higher Education of the Republic of Srpska (19.032/966-40/25).

Funded:

This paper is funded through the EIT's Higher Education Initiative A-SIDE project, coordinated by EIT Raw Materials, funded by the European Union.

Type of publication

Review Article.

Experimental Techniques

OPPORTUNITIES OF USING EQUIPMENT FOR FOOD TEXTURE ANALYSIS

Mihajlo Grba[1*][0009-0000-1986-6531], Ivan Zlatanovic[1][0000-0002-6949-7305], Milos Milosevic[2][0000-0002-2418- 1032]

Zorana Golubovic[1][0000-0002-1156-0703], Isaak Trajkovic[2][0000-0001-6671-4733], Katarina Telebak[2][0009-0001-5689-6745]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Agriculture, Kraljice Marije 16, 11000 Belgrade, Serbia

[2] Innovation Center of the Faculty of Mechanical Engineering in Belgrade, Kraljice Marije 16, 11000 Belgrade, Serbia

*Corresponding author e-mail: ing.mihajlo.grba@gmail.com

Abstract

The rapid development of technology has led to increasing overlap among scientific disciplines, making their integration essential for further progress. This interdisciplinary approach is particularly evident in food texture analysis, where materials science and food engineering converge. By applying modern testing equipment, specifically a universal testing machine, relevant mechanical and textural parameters can be obtained to support food material characterization and problem-solving. Alongside conventional material properties such as strength, elasticity, plasticity, hardness, stiffness, toughness, and brittleness, food-specific texture parameters have been defined as new descriptors or combinations of existing properties. These include hardness (force required to deform or bite food), cohesiveness (ability of a sample to remain intact during chewing), elasticity (capacity to recover shape after deformation), adhesiveness (force required to detach food from a surface), chewiness (energy required to chew solid food, combining hardness, cohesiveness, and elasticity), and gumminess relevant for semi-solid foods, combining hardness and cohesiveness. The evaluation of these parameters is based on instrumental texture analysis methods using specialized equipment for determining the mechanical behavior of food materials. Common methods include compression, shear and cutting, tensile testing, penetration, extrusion, and bending or flexural tests. The application of universal testing machines enables standardized, repeatable, and objective measurements of food texture. The use of such equipment offers significant opportunities in both scientific and commercial contexts. In scientific research, texture analysis supports the investigation of structure–property relationships, optimization of food formulations, development of novel and functional products, and validation of sensory evaluation. In commercial practice, instrumental texture analysis contributes to quality control, product consistency, shelf-life assessment, process optimization, and the alignment of product texture with consumer expectations and market demands. The aim of this paper is to present the opportunities and potential of using universal material testing equipment for comprehensive food texture analysis in research and industrial applications.

Keywords

Food texture analysis, Universal testing machine, Mechanical properties, Instrumental texture analysis, Food material characterization.

Type of publication

Review Article.

SELECTED CHEMICAL AND METALLURGICAL PROPERTIES OF MATERIAL USED FOR CONTACTS IN SWITCHGEAR FOR AUTOMATION

Djordje N. Dihovicni[1] [0000-0003-0961-2540], Zoran Karastojkovic[2*][0009-0007-0852-1897],

Nada Ratkovic Kovacevic[1*] [0000-0001-6398-4391]

[1]The Academy of Applied Studies Polytechnic, Novi Beograd Section,
Department of Electrical and Computer Engineering, 11070 Belgrade, Serbia

[2]Society for Ethics and Evaluation in Culture and Science, 11000 Belgrade, Serbia

*Corresponding author e-mail: nratkovickovacevic@politehnika.edu.rs and zoran.karastojkovic@gmail.com

Abstract

Contemporary electrical devices are controlled by electrical components that almost always utilize electrical contacts. The switchgear is expected to provide reliable make-and/or-break operation of electrical circuit, to have long life in exploitation, etc. It seems that chemical properties of contact materials like resistance to oxidation, including the metallurgical processes which may take place even at the non-corrosive environment are in close relation to wearing of the contact material. So, various materials are in use for making the electrical contact points. To fulfil the complex demands by those contacts and used materials various approaches exist. Paper explores and describes material composition in relation to chemical properties that provide desirable and specified characteristics in accordance with appropriate performances of an electrical contact. From a set of chemical properties here are chosen and presented some of the most important as oxidation and corrosion resistance, which are vital requirements. The pure metals are not dominant in electrical contacts - alloys (frequently on copper or silver base) are favourable in implementation. These alloys are designed and their parameters are tailored according to some stringent metallurgical rules and principles. Some oxides (CdO, Al_2O_3), even carbides (WC) have shown remarkable properties when mixed with other metals, so this became valuable electrical contact material. Demands and specified properties of electrical contacts are achieved by taking into consideration the metallurgical nature or possibilities and feasibility in production. The nature of an alloy could not be understood without information regarding the miscibility of constituents and their phase diagram(s). Each phase possesses different and specific properties, including the metallurgical production schedule: kind of chosen metal, melting procedures, refining procedures, casting properties, including the powder production, pressing with sintering, etc. Metallurgical properties are investigated and elaborated here as well as the technological processes and manufacturing operations which provide high quality electrical contact points.

Keywords

Contact materials, Chemical and metallurgical properties, Mechatronic design, Service demands.

Acknowledgement

Acknowledgements are extended to The Academy of Applied Studies Polytechnic, Belgrade for their support.

Type of publication

Review Article.

DESIGN AND IMPLEMENTATION OF HYDROMETEOROLOGICAL STATION NETWORKS ON THE DANUBE AND SAVA RIVERS IN SERBIA

Marko Ristic[1*] [0009-0005-9621-4584], Marko Batic[1] [0000-0002-8443-3932], Zeljko Despotovic[1] [0000-0003-2977-6710], Marko Tajdic[1] [0009-0000-1187-2988], Ivana Vasovic-Maksimovic[1] [0000-0002-8310-7588]

[1]University of Belgrade Institute Mihailo Pupin, 11060 Belgrade, Serbia

*Corresponding author e-mail: marko.ristic@pupin.rs

Abstract

The paper presents the design and implementation of a hydrometeorological monitoring system based on a network of 38 stations installed along the Danube and Sava rivers in the Republic of Serbia. The system enables continuous monitoring of meteorological parameters and river conditions, while also supporting early warning and public information in cases of floods, storms, sudden temperature changes, and other natural hazards. In addition, it provides relevant authorities with timely information on navigation conditions and the status of inland waterways. The core element of the system is the Atlas Hydra programmable logic controller (PLC), which operates as a local data concentrator. Each station is equipped with meteorological sensors mounted on a pole for measuring key atmospheric parameters. Atmospheric visibility is monitored using a visibility sensor, while river water level and temperature are measured by a combined pressure and temperature sensor installed at the riverbed and connected via a wired interface. A buoy equipped with sensors for wave activity and movement communicates with the station through a LoRa modem. Reliable data transmission to the central command and control center is ensured through a satellite modem. Measured data are locally collected and processed at each station before transmission to the central system, where further monitoring, processing, and analysis are performed. The stations are powered exclusively by a 415 W photovoltaic panel, a 12 V/265 Ah battery, and associated power electronics, providing an autonomy of up to 10 days on battery power alone. The project was jointly financed by the European Investment Bank (EIB) and the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia. The end user is the Directorate for Inland Waterways – Navigational Bulletin of the Republic of Serbia.

Keywords

Hydrometeorological station, Monitoring, HMS network, PLC, Off-grid power.

Acknowledgement

Ministry of Science, Technological Development and Innovation of the Republic of Serbia and the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia.

Type of publication

Original Research Article.

EXPERIMENTAL EVALUATION OF FORCE ATTENUATION IN DRUM-WOUND WIRE ROPE SYSTEMS

Milan Blagojevic[1*] [0000-0003-0710-5297], Zivce Sarkocevic[1] [0000-0001-5110-6620], Milan Bojovic[2] [0009-0007-3522-3182], Ivica Camagic[1] [0000-0003-4706-6333], Dragan Lazarevic[1] [0000-0001-5106-554X]

[1]University of Pristina, Faculty of Technical Sciences, Department of Mechanics, Kosovska Mitrovica, Serbia

[2]University of Pristina, Faculty of Medicine, Department of Dentistry, Kosovska Mitrovica, Serbia

*Corresponding author e-mail: milan.blagojevic@pr.ac.rs

Abstract

This paper presents the development of a dedicated experimental tool and the investigation of force reduction in a 3 mm steel wire rope wound around a drum. Wire ropes of this type are used in compact cable-driven mechanisms, including aerospace systems, medical devices, telescopic assemblies, winches, lifting systems, and other applications in which reliable force transmission, compact design, and operational safety are essential. The main objective of the study was to determine how the transmitted force changes as a function of the number of complete turns around the drum under controlled tensile loading conditions. The experimental tool was designed to provide stable positioning of the drum–wire rope assembly, controlled load introduction, and repeatable measurement of the force at the free end of the rope. The testing procedure was performed using a universal tensile testing machine, while the output force was recorded by an external load cell connected to a data acquisition system. Several winding configurations were examined, with the number of complete turns gradually increased during the experimental campaign. The obtained results showed a decrease in transmitted force with an increasing number of turns. The observed trend indicates an exponential-type decay and confirms the dominant influence of frictional interaction between the wire rope and the drum surface. This behaviour is important for the design of mechanisms in which a small cable diameter, limited installation space, and predictable load transfer must be achieved simultaneously. The developed experimental setup provides a practical and repeatable methodology for evaluating load transmission in drum-based wire rope systems. The proposed approach may support the analysis, design, and verification of safety-critical and precision cable-driven mechanisms, particularly in aerospace and medical applications. Future investigations may include different rope diameters, drum materials, surface roughness conditions, winding geometries, and loading regimes in order to improve predictive models of force attenuation.

Keywords

Force reduction, Friction, Tensile testing, Aerospace systems, Medical devices.

Acknowledgement

The part of this research is funded by Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Contract No. 451-03-65/2024-03/200155.

Type of publication

Original Research Article.

Numerical Methods

DEVELOPMENT OF AN OPEN-SOURCE FRAMEWORK FOR SYNTHETIC PROFILE GENERATION, NOISE IMPACT ANALYSIS, AND FILTRATION EVALUATION IN SURFACE METROLOGY

Vilim Kozuh[1*] [0009-0009-8647-9246], Vedran Simunovic[1][0000-0002-3187-7767]

[1]University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Department of Quality, 10002 Zagreb, Croatia

*Corresponding author e-mail: vilim.kozuh@fsb.unizg.hr

Abstract

Measurement noise remains a major source of bias in surface roughness and form metrology, systematically inflating key parameters such as Ra, Rq, Rt and Rz. To enable systematic study of noise effects and objective comparison of filtration methods, a modular, open-source Python-based framework is developed consisting of two interconnected tools. The first tool is a versatile interactive profile generator that allows users to create surface profiles either manually by specifying individual Fourier coefficients for each harmonic order or automatically using user-defined roughness amplitude (σ) and decay exponent (α). The user designates the type of a generated profile either as the “true” object profile or as a “noise” profile; these profiles are then combined to produce a realistic “simulated measurement” profile. All the mentioned profiles are exported as simple dataset, consisting of x, z coordinate pairs in .txt format. Multiple “noise” profiles may be generated at once, representing repeated measurements taken. These datasets are loaded by the second tool used for analysing the effect of noise. This tool accepts any combination of “true”, “noise”, and “simulated measurement” type profiles and automatically computes standard roughness parameters (Ra, Rq, Rp, Rv, Rt, Rz, Rsm) for each loaded profile. If two profiles of a different type are available, the tool further evaluates noise impact through direct comparison metrics and supports the application of ISO-standard filtration methods (Gaussian, robust Gaussian, spline etc.). The effectiveness of each filter is assessed by how closely the filtered result approaches the “true” object profile. In addition, a new metric called “Imperfection length” is introduced, which quantifies the total accumulated vertical deviation between any two profiles. For cases involving multiple “noise” or “noisy measurement” profiles, an averaging module is included to reduce random noise effects. All results are visualised and exported together with a comprehensive summary report.

Keywords

Surface metrology, Measurement noise, Fourier synthesis, Roughness parameters, Filtration evaluation.

Type of publication

Original Research Article.

SERVO CONTROL OF A DC MOTOR USING ARDUINO NANO 33 IOT, MATLAB AND SIMULINK

Nada Ratkovic Kovacevic[1*] [0000-0001-6398-4391], Aleksandar Pejicic[2, 3] [0009-0003-7872-8333], Djordje Dihovicni[1] [0000-0003-0961-2540], Dragan Kreculj[4] [0000-0003-3268-4024]

[1] The Academy of Applied Studies Polytechnic, Novi Beograd Section, Department of Electrical and Computer Engineering, 11070 Belgrade, Serbia

[2]The Academy of Applied Studies Polytechnic, Novi Beograd Section, 11070 Belgrade, Serbia

[3]Granit-Lijesce DOO, 22000 Sremska Mitrovica, Serbia

[4]The Academy of Applied Studies Polytechnic, Novi Beograd Section, Department of Mechanical Engineering, 11070 Belgrade, Serbia

*Corresponding author e-mail: nratkovickovacevic@politehnika.edu.rs

Abstract

The paper explores options available for DC motor servo control within Arduino Nano 33 IoT (Internet of Things) equipped kit - Arduino Engineering Kit Rev2 (product of Arduino Foundation, Italy). Variable speed control of a small DC motor is obtained utilizing embedded system having Arduino Nano 33 IoT board as a processor, and Arduino Nano Motor Carrier to drive motors. Arduino Nano 33 IoT is a powerful aid for cyber-physical programming i.e. control of electronic circuits. This board has 19 software programmable digital inputs/ outputs. Although it is small in size, Arduino Nano 33 IoT contains more versatile components than other microcontroller boards: 8 analogue inputs, 8 PWM (pulse width modulated) digital outputs, WiFi connectivity, and other options. Servo control of a small DC motor here is achieved in three ways. The embedded system is programmed using: microC in Arduino IDE (Integrated Development Environment); live scripts in Matlab (product of MathWorks, USA) development and programming environment; and block diagrams in Simulink (product of MathWorks, USA). The microcontroller on the Arduino Nano 33 IoT board is programmed from the lap-top computer connected to it by USB (Universal Serial Bus) cable. After uploading the code to the board over USB cable, the device can be powered with rechargeable Lithium-polymer battery. Matlab is a complex software system, developed primarily for high precision numerical calculations, control theory and system modelling and simulation. Over the decades Matlab has been expanded by numerous toolboxes suited for specialized applications. One of its toolboxes is Simulink, which provides graphical programming language to describe the system or model utilizing user friendly drag-and-drop creating and editing. In accordance with open-access and open-source incentive of Arduino Foundation, Arduino project and worldwide Arduino community, Arduino Engineering Kit Rev2 is amended with the free Matlab and Simulink licence of one year duration.

Keywords

Actuators, Embedded systems, Mechatronics, Sensors, Software simulation.

Acknowledgement

Acknowledgements are extended to The Academy of Applied Studies Polytechnic, Belgrade, for their support. Authors are thankful for the Arduino Nano 33 IoT board and Arduino Engineering Kit Rev2 provided by colleague Aleksandar Pejicic, a student of master level study programme Industry 4.0 in professional/ applied studies.

Type of publication

Original Research Article.

NUMERICAL MODEL VALIDATION OF COMPOSITE STRUCTURES FOR UAV DESIGN: A BEOAVIA STUDENT TEAM CASE STUDY

Ognjen Stojadinovic[1*], Viktor Nedic[1], Zlatko Dakic[1], Aleksa Milovanovic[2] [0000-0003-4668-8800], Milos Milosevic [2] [0000-0002-2418-1032], Toni Ivanov[3] [0000-0002-8204-4669]

[1]University of Belgrade, Faculty of Mechanical Engineering, Student team Beoavia, 11120 Belgrade, Serbia

[2]Innovation Center of the Faculty of Mechanical Engineering, 11120 Belgrade, Serbia

[3]University of Belgrade, Faculty of Mechanical Engineering, Department of Aerospace Engineering, 11120 Belgrade, Serbia

Corresponding author e-mail: ognjenstojadinovic389@gmail.com

Abstract

The student team ‘’Beoavia’’, based at the Faculty of Mechanical Engineering, University of Belgrade, has experience in the design and manufacturing of composite unmanned aerial vehicles (UAVs). While finite element method (FEM) analysis of the airframe provides valuable information on structural behaviour, experimental validation remains a key factor in ensuring the accuracy of the results. The goal of this research is to validate the previously numerically predicted mechanical properties of carbon composite specimens. The numerical data were obtained using a custom-developed MATLAB script, tailored to the specific manufacturing conditions and techniques used by the Beoavia team. The script outputs the longitudinal (E1), transverse (E2) and shear (G) moduli of the composite structures. The analysis is based on a thin-walled structure assumption with a plane stress state, resulting in a two-dimensional (2D) formulation in which the third dimension is neglected. The experimental tests include five specimens per condition with different carbon fibre reinforcements, intended for future UAV applications. The reinforcements consist of: 64 g/m² Spread Tow TeXtreme® (Oxeon Inc., Deerfield, IL, USA), 68g/m² plain, 90 g/m² plain ,160 g/m² plain 50 g/m² UD (unidirectional), 80 g/m² UD fabrics. The laminates were produced as flat panels using a vacuum infusion process with a two-component epoxy resin matrix. The panels were then cut to the required geometry, totalling 85 specimens prepared for tensile testing. Finally, the obtained results demonstrate a strong correlation between the numerically predicted properties and the experimental data, confirming the model’s reliability.

Keywords

Composite structures, FEM analysis, Tensile testing.

Type of publication

Original Research Article.

SLOBODA BRIDGE INFUENCE OF SLIDING AND SOME PROBLEMS DUE TO RECONSTRUCION

Boris Folic[1*] [0000-0003-2127-0264]

[1]Innovation Centre of Faculty of Mechanical Engineering, Belgrade, Serbia

*Corresponding author e-mail: boris.r.folic@gmail.com

Abstract

The Sloboda Bridge in Novi Sad was built in 1981. It is located at the end of Liberation Boulevard, and bridges the Danube River, so its other end is in Sremska Kamenica. The entire right side of the Danube, from the entrance to Serbia all the way to the rocky gorges of Djerdap, is considered a potential landslide. This also applies to the Sremsko Kamenicka slope. Originally, for the rehabilitation of the landslide, the construction of two drainage galleries was planned in the 70s, but as the gallery collapsed during construction, it was abandoned. The initial project of the foundation and calculation of the stability of the landslide was done by prof. Stevan Stevanovic. Subsequently, in the 1990s, the soil was rehabilitated with drainage wells with radially driven pipes and filter filling. In April 1999, the bridge was demolished by the NATO pact. Soon after that, work on diagnosing, restoration and rehabilitation of the bridge began. The new Sloboda Bridge was put into operation in October 2005. The bridge slides at a speed of about 1 cm per year, it has already accumulated 20 cm of displacement, so it will have to be repaired in 10 years. The impact of this movement of the structure can also be seen at the bottom of the pylon up to about 6m above the road plate. There were some inconsistencies between the regulations and the constructed state of the bridge. Further, vertical ribs both external and internal ones are reinforced, the anchor structure of the column, and the middle supports of the pylon as well, but for inclined cables it is necessary to add dampers and vibration dampers, which was not done. The paper shows numerical analysis of cables, and visual monitoring of pilon.

Keywords

SSI, Slide, Sloboda bridge, Drained gallery, Secondary Effect of cables.

Acknowledgement

The results presented here are the result of research supported by The Ministry of Science, Technological Development and Innovation RS under the contract 451-03-33/2026-03/from 05.02.2026. year.

Type of publication

Original Research Article.

New Technologies

APPLICATION OF 3D PRINTING IN THE CONSTRUCTION INDUSTRY

Martina Balac[1*] [0000-0002-2135-0179], Mario Sarcevic[2], Aleksandar Savic[3] [0000-0002-1777-6775]

[1]University of Belgrade, Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

[2]Progress Engineering, Hamburg, Germany

[3]University of Belgrade, Faculty of Civil Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: mbalac@mas.bg.ac.rs

Abstract

Three-dimensional printing represents a modern approach in the construction industry based on additive manufacturing technologies. This paper analyzes the application of 3D printing in the construction of residential and commercial buildings, with particular emphasis on material selection, structural systems, structural integrity, and economic feasibility. Special attention is devoted to the development of specialized cement-based composites and geopolymers with the addition of binders, fibers, and pozzolanic components, which must ensure adequate processability during extrusion as well as the required mechanical properties in the hardened state of material. Furthermore, challenges related to reinforcement integration, control of material shrinkage, and the influence of thermal bridges in printed wall elements are analysed. The structural integrity of printed structures is examined through the analysis of waterproofness, resistance to carbonation, and the effects of environmental conditions. The goal of this paper is developing of a numerical model of the printing process based on the finite element method, enabling simulation of the layer formation process and prediction of the mechanical behavior of the structure. The research results presented in this paper highlight the key parameters affecting the reliability and durability of printed structures, as well as the applicability of existing design principles in accordance with Eurocode standards. The proposed methodology provides a basis for further development of engineering tools and standardization in the field of 3D printing in construction.

Keywords

3D printing, Construction Industry, Additive manufacturing, Structural integrity, Finite element method.

Acknowledgement

This research was funded by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia through contract 451-03-33/2026-03/ 200105 and 451-03-33/2026-03/ 200092.

Type of publication

Original Research Article.

OPTIMIZATION OF CASTING PARAMETERS AND SELECTION OF REFRACTORY COATING TO REDUCE ERRORS IN CASTING

Ljiljana Trumbulovic[1] [0009-0001-5498-4522], Marko Pavlovic[2*] [0000-0002-7098-6421], Ivana Cekovic[1] [0000-0002-5332-2965], Aleksandar Milovanovic[3], Nikola Vukovic[4] [0000-0002-3607-5907], Branko Drndarevic[1]

[1]Western Serbia Academy of Applied Studies, 31000 Uzice, Serbia

[2] Innovation Center of the Faculty of Mechanical Engineering,11000 Belgrade

[3]Velesstroy LLC, 2nd Leningradskiy Avenue 72k3, 125315 Moscow, Russia

[4]Institute for technology of Nuclear and Other Mineral Raw Materials, Franse D'Eperea 86, 11000 Belgrade, Serbia

*Corresponding author e-mail: pavlovic.marko38@gmail.com

Abstract

The aim of the research is to examine the influence of the process parameters of the technology of casting with volatile polystiren models (EPC process) on the structural and mechanical properties of silumin castings, in order to define the optimal process conditions and increase the quality of the casting. The influence of the following process parameters was monitored: the quality of the polymer for making the model, the permeability of dry quartz sand of different granulations for molding, the construction of the pouring system. The tests were carried out with the AlSi10Mg alloy, which has good casting properties, corrosion resistance and weldability. Cordierite $2MgO{\cdot}2Al_2O_3{\cdot}5SiO_2$ was chosen for coating with a thickness of 0.2 mm and 0.7 mm. With an increase in the thickness of the coating, the porosity is expressed to a greater degree, due to the reduced permeability of the coating. To obtain high-quality castings by the EPC process, it is necessary to harmonize all technological parameters in order to enable complete decomposition and evaporation of the model and avoid the occurrence of casting errors, such as surface porosity, granular surface of the casting, lunkers, wrinkled uppper surface of the casting, metal penetration. During the EPC process, large amounts of gases are generated during casting, that's why the impact of porosity on the quality of castings is examined: visual, ultrasound and radiographic examination. The goal of the work is to define the optimal combination of casting parameters and coating characteristics (adhesion, coating thickness, permeability) in order to minimize errors such as gas porosity, metal penetration and surface irregularities. The practical significance of the research is reflected in the possibility of applying the EPC process in the automotive industry, which is characterized by large series, the need for the lowest possible production costs, and the demand for high quality castings.

Keywords

Casting quality, Casting errors, Casting with polystyrene models, Coating.

Acknowledgement

This work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract No. 451-03-33/2026-03/200213 and 451-03-33/2026-03/200023) since 05.02.2026.

Type of publication

Original Research Article.

HAND MOVEMENT TRACKING SYSTEM BASED ON STRETCHABLE SENSORS

Milan Subotic[1*] [0009-0009-4655-3122]

[1]University of Belgrade, Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: d10-2024@studenti.mas.bg.ac.rs

Abstract

Stretchable sensors have emerged as a promising platform for human motion monitoring because of their ability to conform to curved and moving surfaces while maintaining reliable electrical and mechanical performance. This paper presents a hand movement tracking system based on stretchable sensors designed to detect finger bending, joint motion, and overall hand posture in real time. The proposed system integrates flexible sensing elements with a signal processing unit to convert mechanical deformation into measurable electrical signals. As the hand moves, the sensors deform accordingly, producing signal changes that can be mapped to specific gestures and motion patterns. By using stretchable sensors placed on key regions of the hand, the system can capture subtle and continuous movement with high comfort and minimal restriction to natural motion. The tracked data can be processed to identify individual finger positions, grip intensity, and gesture sequences, enabling accurate motion interpretation. Such a system has potential applications in rehabilitation monitoring, sign language recognition, virtual reality control, human machine interaction, robotics, and sports performance analysis. Overall, the proposed hand movement tracking approach demonstrates how stretchable sensing technology can support wearable, adaptive, and low-profile motion capture systems for practical use in biomedical and interactive technologies.

Keywords

Stretchable sensors, Wearable electronics, Robotics.

Type of publication

Original Research Article.

DEVICE FOR LIVE LINE TESTING OF INSTRUMENT TRANSFORMERS WITHOUT POWER INTERRUPTION

Uros Kovacevic[1*] [0000-0002-3182-6628], Vladeta Milenkovic[2]

[1]Innovation Centre of the Faculty of Mechanical Engineering, Belgrade, Serbia

[2]Netico Solutions doo, Nis, Serbia

*Corresponding author e-mail: ukovacevic@mas.bg.ac.rs

Abstract

This paper aims to present the development, validation, and practical implementation of an innovative device for testing instrument transformers without de-energizing the power system. The work addresses key aspects of the complete project lifecycle, including research and development activities, experimental validation, team organization, patenting procedures, commercialization pathways, and access to funding mechanisms, while also highlighting the main technical and organizational challenges encountered during the process through a representative R&D project. The paper introduces novel, patented, experimentally validated, and commercially deployed methodologies and technologies that enable real-time, live-line high-voltage measurement of instrument transformer ratio and phase displacement errors. Particular emphasis is placed on the system architecture, which integrates subsystems for primary and secondary current and voltage measurements, advanced wireless communication solutions, and modern information and computing technologies for data acquisition and processing. In addition, the paper presents key findings derived from comprehensive laboratory testing, focusing on measurement accuracy, repeatability, and system robustness. The applicability of the proposed solution is further demonstrated through field testing conducted on high-voltage current and voltage transformers in distribution substations up to the 110 kV voltage level. The results confirm that the developed system provides a reliable, accurate, and operationally efficient solution for live-line testing, significantly improving diagnostic capabilities while eliminating the need for power outages, thereby contributing to enhanced reliability and availability of power systems.

Keywords

Live line, Instrument transformers, Testing, Innovation.

Type of publication

Original Research Article.

3D TECHNOLOGIES USED AT TECHLAB TEHNOPOLIS

Tihomir Cuzovic[1*], Djordjije Brkuljan[1]

[1]Innovation and Entrepreneurship Center Tehnopolis, 81 400 Niksic, Crna Gora

*Corresponding author e-mail: tihomir@tehnopolis.me

Abstract

The Laboratory for Industrial Design — TechLab Tehnopolis was founded to serve as a center equipped with modern technologies that will streamline the process of developing new products and improving existing ones, thereby increasing the quality and competitiveness of domestic production. When developed to full capacity, it will drive and support the adoption of new production technologies, act as a link between academia and industry, and serve as a training center for mastering modern technologies and using the newest equipment available on the market. TechLab's capabilities are available to innovators, SMEs, start-ups, professors, students, and other parties that need the laboratory's technologies. The prototyping equipment includes certified software for CAD modeling and CAM preparation, four CNC machines (router, milling machine, lathe, and machining center), nine 3D printers (FDM – Fused Deposition Modeling, SLA – Stereolithography, SLS-Selective Laser Sintering, and metals), and a 3D scanner capable of digitizing medium-sized objects with industrial precision. All this equipment enables high-quality support in producing technical documentation and prototypes, as well as transferring the knowledge and competencies the laboratory's staff have acquired through many years of work with additive technologies. Since its inception, the Laboratory has supported several dozen multidisciplinary projects across medical, agricultural, metallurgical, and mechanical engineering domains, and has organized numerous training sessions, workshops, and dissemination activities to transfer technical competencies to a broad community of practitioners and students.

Keywords

3D modeling, 3D scanning, 3D printing, Functional prototyping.

Type of publication
Original Research Article.

DESING OF GUI FOR PARAMETRIC PRODUCT DESING IN COMMERCIAL CAD SOFTWARE

Mladenovic Goran[1*] [0000-0003-1706-7503], Filipovic Ivana[2] [0000-0002-7977-2980], Milos Milosevic[1] [0000-0002-2418-1032], Isaak Trajkovic[2] [0000-0001-6671-4733], Popovic Mihajlo[1] [0000-0003-3607-9243], Pjevic Milos[1] [0000-0002-4454-8663], Angelina Dragicevic[1] [0009-0009-9856-5141]

[1]University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia

[2]Innovation Centre of the Faculty of Mechanical Engineering, Belgrade, Serbia

Corresponding author e-mail: gmladenovic@mas.bg.ac.rs

Abstract

There are many practical applications of 3D modeling with specially designed GUI (Graphical User Interface) for user parameters input. Today many of commercial CAD software have possibility to design GUI for manual input od product parameters for given product family. In these ways of design, company define product topology based on variables which values should be read from text box on also designed GUI. Based on this procedure GUI can be implemented with some web-based applications (e.g., via the World Wide Web) which can allow 3D model generation based on predicted topology where product dimension depends only from values of input parameters. Topology designer can predict some product variations which can be described by if than statement in input parameters. In this study, it was designed 3D virtual model of family product representative which was complete described by parameters. All of parts models are analytically described and all addictions are formed and after that implemented in CAD system. All of models were paired in 3D assembly model and GUI was created for designed parameters input. At the end, it was experimentally tested usage of generated 3D virtual product with many od arbitrary input parameters which was entered on generated GUI. All of obtained 3D models were satisfying in shape and dimension which is pretrained by designing rules which was implemented in analytical equations which were implemented in CAD model background. Projected system gives opportunity to users without CAD expertise to interact with product models which is particularly in the context of Industry 4.0 where customers want specially customized products in a short time period.

Keywords

CAD Systems, GUI, Parametric Modeling, Rule-Based Design.

Acknowledgement

The research work is funded by the Ministry of Science, Technological Development and Innovation of Republic of Serbia. Project Contract 451-03-34/2026-03/ 200105 from 05.02.2026.

Type of publication

Original Research Article.

ACCELERATING REVERSE ENGINEERING USING SUPPORTING ALGORITHMS

Marko Horvatek[1*] [0000-0001-7480-1394], Marko Katic[2] [0000-0001-6494-8704]

[1] Protosfera d.o.o., Zagreb, Croatia

[2] Faculty of Mechanical Engineering and Naval Architecture, Department of Measurement and Control, University of Zagreb

*Corresponding author e-mail: m.horvatek@protosfera.hr

Abstract

In applied reverse engineering workflows, the introduction of new engineers often reveals a gap between formal engineering education and the practical demands of product development. Although new team members possess modelling skills, they frequently struggle with selecting appropriate reconstruction strategies, structuring their workflow, and avoiding common methodological errors when working with complex geometries. Motivated by these recurring challenges, we initiated the development of RE4E: Reverse Engineering for Everyone, a decision-support software designed to lead engineer through customized and streamlined reverse engineering workflow. Program analyses STL mesh geometric characteristics and suggests following steps for working with defined stages of the reverse engineering process: (1) analysis of scanned geometry, (2) preparatory mesh operations, (3) definition of reconstruction objectives, (4) CAD-based geometry reconstruction, and (5) evaluation of results. The educational and methodological impact of RE4E was evaluated during a structured testing programme conducted as part of Protosfera's summer internship programme. During this program the students with no previous knowledge in reverse engineering have been split in 2 groups of 3 students and tasked to design the different 3D scanned parts. One group had RE4E program continuously helping them in reverse engineering and another group had initial standard (1 hour) training from the mentor. Comparative assessment against a conventional, mentor-driven onboarding approach showed that the use of RE4E reduced the effective learning period required for independent task execution by approximately 50%. Also, analysis of completed reconstruction tasks indicated a 30% reduction in additional iteration steps after interns called "job done", which is traditionally caused by methodological errors, demonstrating improved workflow stability and decision consistency.

This work demonstrates that embedding structured expert knowledge into an interactive decision-support system can significantly enhance both educational efficiency and methodological robustness in reverse engineering.

Keywords

Reverse engineering, support software, 3D scans, reconstruction.

Type of publication

Original Research Article.

Clear Sky

ON THE NUMERICAL AND EXPERIMENTAL CHALLENGES IN DESIGNING NEW AIRFOIL FAMILIES

Zorana Z. Dancuo[1*] [0000-0001-6121-2283], Ivan A. Kostic[2] [0000-0003-1708-3853], Olivera P. Kostic[2] [0000-0003-0304-9494], Aleksandar C. Bengin[2] [0000-0002-9225-8601], Goran S. Vorotovic[2] [0000-0003-2606-7142]

[1]Innovation Centre of Faculty of Mechanical Engineering, Belgrade, Serbia

[2]University of Belgrade, Faculty of Mechanical Engineering, Aerospace Department, 11000 Belgrade, Serbia

Corresponding author e-mail: zdancuo@mas.bg.ac.rs

Abstract

The development of new airfoil families remains a significant challenge in aerodynamic research, where numerical predictions must be reliably assessed through experimental observations. Despite advances in computational fluid dynamics (CFD), discrepancies between simulations and wind tunnel data persist, particularly in configurations involving forced boundary-layer transition and moderate Reynolds number flows. This motivates continuous reassessment of modeling assumptions and constraints to improve airfoil design reliability. This paper presents a part of the research conducted within the scope of a doctoral dissertation on bionic-inspired airfoil development, focusing on the numerical assessment of non-standard modification strategies and their experimental verification. The study investigates modifications of Taposu's Dolphin airfoil, a mathematically defined bionic model that, to the best of the author's knowledge, has not been further developed beyond its original formulation. A numerical approach was employed, while experimental wind tunnel data were used for verification of the proposed design. The numerical analysis was performed using Reynolds-averaged Navier–Stokes (RANS) simulations with the k–ω SST turbulence model. The study introduces two novel optimization approaches, both demonstrating consistent aerodynamic performance improvements. The results indicate that significant deviations from the original geometry may occur during optimization to enhance lift, reduce drag, and improve overall aerodynamic efficiency. However, approximately 70% of the original profile was preserved in the rear domain of the airfoil, indicating a reasonable level of geometric fidelity despite the applied modifications. The proposed methods demonstrate that meaningful aerodynamic improvements can be achieved without fully abandoning the baseline geometry, highlighting the trade-off between geometric preservation and performance enhancement in bionic airfoil design. Challenges arising from the need to develop and apply original optimization methods tailored to this airfoil class, as well as from this trade-off, were successfully overcome in this study.

Keywords

Bionic-inspired airfoils, design challenges, optimization, RANS SST, Dolphin airfoil.

Acknowledgement

The results presented in this paper are based on research supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia under Contract No. 451-03-33/2026-03/200213, dated 05 February 2026.

Type of publication

Original Research Article.

EXPERIMENTAL STUDY OF A MULTIROTOR ARM USING SHEAROGRAPHY AND DIGITAL IMAGE CORRELATION

Rakic Z. Milan[1*] [0009-0001-1898-9326], Ivanov Toni[2] [0000-0002-8204-4669]

[1]Innovation Center of Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

[2]University of Belgrade, Faculty of Mechanical Engineering, Department of Aerospace Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: mzrakic@mas.bg.ac.rs

Abstract

This study investigates the application of shearography for deformation analysis and crack propagation in additively manufactured multirotor components, complemented by results obtained using Digital Image Correlation (DIC). The research focuses on four drone arm specimens fabricated by additive manufacturing with varying infill densities. To ensure controlled damage initiation, each specimen incorporates a predefined internal void designed to act as a stress concentrator and a potential crack propagation origin.

Experimental testing involves static loading using calibrated weights of known mass, while the deformation behaviour is monitored through laser interferometry based on shearography. Measurements are performed using the Dantec Dynamics Laser Shearography System Q-800, which enables highly sensitive detection of displacement gradients, particularly in regions with material discontinuities.

The primary objective is to evaluate the capability of shearography to detect localized deformation and identify early stages of damage in 3D-printed structures. In a subsequent phase, the experimental setup is complemented by the DIC system GOM ARAMIS System, which provides full-field quantitative displacement measurements on the specimen surface. The combination of these two methods enables correlation between local deformation gradients identified by shearography and absolute displacement fields obtained through DIC analysis.

The expected results will contribute to a better understanding of the mechanical behaviour of 3D-printed components with internal voids, as well as to the validation of shearography as a reliable non-destructive technique for early damage detection. Furthermore, the study highlights the advantages of an integrated experimental mechanics approach through the combination of interferometric and optical full-field measurement techniques.

Keywords

Shearography, Digital Image Correlation, multirotor arm, 3D-printed parts, deformation analysis.

Type of publication

Original Research Article

NUMERICAL ANALYSIS OF AIRFOIL INFLUENCE ON THE PERFORMANCE OF AIRBORNE WIND TURBINES AT HIGH ALTITUDES

Dragoljub Tanovic[1*] [0000-0002-7806-1458], Katarina Telebak[2] [0009-0001-5689-6745], Ermina Cosovic[1] [0009-0002-7285-2977]

[1]University of Belgrade, Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

[2]Innovation Centre of Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: dtanovic@mas.bg.ac.rs

Abstract

Growing environmental concerns, particularly regarding global warming, have intensified the shift toward renewable energy sources. While solar, hydro, and conventional wind energy remain the most prominent pillars of this transition, they still necessitate significant technological advancements. In the context of wind energy, turbine control and optimization are paramount for ensuring high efficiency and economic viability. Consequently, research in this field is critical for the development of next-generation, high-performance turbines. A primary challenge in optimizing turbine design and operation lies in the accurate prediction of performance, especially for Airborne Wind Turbines (AWT) operating at high altitudes. Compared to conventional land-based turbines, AWT of similar dimensions can generate significantly higher electrical power by utilizing aerodynamically optimized blades. These systems operate at altitudes inaccessible to traditional turbines, utilizing tethered balloons or wings connected to the ground via cables. This configuration further facilitates deployment in remote or inaccessible locations. Wind turbine blades utilize specific airfoils to generate mechanical power. The selection of an airfoil is highly dependent on the turbine configuration; for instance, certain profiles (such as the S809) yield superior results and enhanced performance in Horizontal Axis Wind Turbines (HAWT) compared to Vertical Axis Wind Turbines (VAWT). This paper presents a numerical analysis investigating the influence of various airfoil profiles at altitudes suitable for AWT operation. The study provides comparative diagrams of lift (C_l) and drag (C_d) coefficients relative to the angle of attack (α), as well as the aerodynamic efficiency. Furthermore, the correlation between power output and wind speed at high altitudes is examined. Finally, the analysis evaluates the blade pitch angle and its impact on the overall performance of the system.

Keywords

Numerical, Airfoil, Blade, Wind, Turbine.

Acknowledgement

This research work was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia through contract No. 451-03-33/2026-03/200105 and No. 451-03-33/2026-03/200213 from 5 February 2026.

Type of publication

Original Research Article.

THE ROLE OF TUNNEL BORING MACHINE (TBM) TECHNOLOGY IN SUSTAINABLE METRO CONSTRUCTION

Zeljko Zugic[1*] [0000-0002-0208-4450]

[1]Innovation Center of the Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: zzugic@gmail.com

Abstract

The rapid urbanization of modern cities has significantly increased the demand for sustainable, efficient, and minimally disruptive underground transportation systems. Tunnel Boring Machine (TBM) technology has become one of the most important advancements in contemporary metro construction, enabling safer excavation, higher construction efficiency, improved environmental protection, and reduced impact on urban infrastructure. This paper presents recent advances in the application of TBM technology in large-scale metro projects, with a particular focus on the Belgrade Metro project as a representative case study of complex urban tunneling conditions in Southeast Europe. The study analyzes the implementation of TBM excavation within highly variable geological and geotechnical conditions, including soft cohesive soils, layered sediments, groundwater influence, and densely urbanized environments. Special attention is given to modern approaches in geotechnical investigation, numerical modeling, diaphragm wall support systems, groundwater control, monitoring systems, and logistics related to TBM launching and retrieval shafts. The paper also discusses the integration of advanced digital engineering tools, Building Information Modeling (BIM), and real-time monitoring technologies that improve construction control and risk management during underground excavation. Furthermore, the paper highlights the importance of optimized excavation support systems, geotechnical calibration using laboratory and in-situ testing, and adaptive construction management in achieving safe and economically efficient metro development. The presented research contributes to the understanding of modern TBM applications in urban metro systems and provides practical recommendations for future underground infrastructure projects in complex geological and urban conditions.

Keywords

TBM technology, Metro construction, Environmental and structural monitoring.

Type of publication

Review Article.

Dental Materials and Structures

Invited lecture

DIRECT PRINTED ALIGNERS- CURRENT ADVANTAGES AND DISADVANTAGES IN CLINICAL PRACTICES

Tina Pajevic[1*] [0000-0002-6185-7409]

[1]University of Belgrade, School of Dental Medicine, Department of Orthodontics, 11000 Belgrade, Serbia

**Corresponding author e-mail: tina.pajevic@stomf.bg.ac.rs*

Abstract

The aim of this review was to present properties of the direct 3D printed aligners (DPA) in comparison to the thermoformed aligners (TFA) used in the orthodontic treatment. Computer assisted design (CAD) and computer assisted manufacturing (CAM) contributed to expansion of the aligner treatment at the end of the twenty centuries. Although treatment was planned digital, each aligner was thermoformed over printed dental casts. Thermoforming decreased material thickness in an unpredictable manner and influenced aligner mechanical properties. Recently, DPA was presented as an appliance directly manufactured from the liquid resin. Direct printing was suggested as a superior procedure, reducing the material waste, minimizing errors and accelerating the manufacturing of the appliance. One of the major advantages from the orthodontic perspective was the ability to modify the aligner thickness according to the patient's tooth and gum morphology and treatment needs. Another feature is the shape memory, a feature that would theoretically provide continuous force exerted to the tooth. Similar to TFA, DPA absorbs water from the saliva, which leads to polymer degradation influencing shape memory effect and leading to decreased forces. The ability to adjust aligner thickness in the different areas, could improve their treatment efficiency, but there are no long-term studies comparing effects of TFA and DPA. Improvement of the manufacturing procedures provides opportunity for using DPA incorporating antibacterial components, enamel remineralisation or drug delivery systems. Biocompatibility of the DPA remains an issue, which requires further investigation, because of the potential to release residual monomers and microplastic in the oral cavity.

Keywords

Clear aligner appliance, 3D printing, Shape memory polymers.

Type of publication

Review Article.

MECHANICAL PROPERTIES OF PETG MATERIALS FOR ORTHODONTIC USE PRIOR TO THERMOFORMING

Jelena Markovic[1]* [0009-0003-1259-0335], Tina Pajevic[1] [0000-0002-6185-7409], Aleksandra Mitrovic[2] [0000-0002-5183-6276], Milan Travica[3] [0000-0003-1156-6563], Aleksa Milovanovic[4] [0000-0003-4668-8800], Nenad Mitrovic[2] [0000-0001-9296-2669]

[1]University of Belgrade, Faculty of Dental Medicine, Department of Orthodontics, 11000 Belgrade, Serbia

[2]University of Criminal Investigation and Police Studies, Department of Forensic Engineering, 11000 Belgrade, Serbia

[3]University of Belgrade, Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

[4]Innovation Center of Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: jelenamarkovic182@gmail.com

Abstract

Polyethylene terephthalate glycol (PETG) is commonly used for orthodontic aligner therapy due to its transparency, thermoforming ability, and favorable mechanical properties. The aim of this study was to compare the tensile properties of four PETG materials frequently used for aligner fabrication: Leone, Iconic, Erkodur, and Duran. Tensile testing was performed on a universal testing machine using specimens cut from original material sheets according to ISO 527-5A geometry prior to thermoforming. Three specimens of each material were tested at a crosshead speed of 1 mm/min. Strain distribution and deformation behavior were additionally analysed using the Digital Image Correlation (DIC) method. The evaluated parameters included elastic modulus, maximum force, maximum stress, and maximum displacement. Among all tested materials, Iconic showed the highest mechanical performance, with the greatest average elastic modulus (8166.20 MPa), maximum force (282.26 N), and maximum stress (80.65 MPa), indicating the highest stiffness and resistance to tensile loading. Leone showed intermediate values, with an average elastic modulus (5618.81 MPa) and maximum stress of 52.38 MPa, suggesting good mechanical strength but lower rigidity than Iconic. Duran demonstrated moderate values (4550.48 MPa; 43.84 MPa) with a high standard deviation, indicating variability between specimens. Erkodur showed the lowest tensile performance, with the smallest average elastic modulus (3018.51 MPa), maximum force (111.54 N), and maximum stress (31.87 MPa). However, maximum displacement values were similar among all materials, indicating comparable elongation before failure. The results demonstrated significant differences in the mechanical behavior of PETG materials prior to thermoforming. Iconic appears to be the most suitable material when high stiffness and strength are required, while Leone offers balanced mechanical properties. Erkodur may be suitable in cases where lower rigidity is acceptable. Further studies should evaluate the influence of thermoforming on these materials.

Keywords

PETG, Tensile properties, DIC, Orthodontic aligners, Mechanical testing.

Type of publication

Original Research Article.

CONTACTLESS STRAIN MEASUREMENT IN MECHANICAL TESTING OF DENTAL MATERIALS USING AN IN-HOUSE DEVELOPED VIDEO EXTENSOMETER

Milan Blagojevic[1*] [0000-0003-0710-5297], Nikola Zivkovic[2] [0009-0000-2739-073X], Milan Bojovic[3] [0009-0007-3522-3182], Rade Zivkovic[4] [0000-0002-8698-5810], Zivce Sarkocevic[1] [0000-0001-5110-6620]

[1]University of Pristina, Faculty of Technical Sciences, Department of Mechanics, Kosovska Mitrovica, Serbia

[2]University of Belgrade, Faculty of Dental Medicine, Department of Restorative Odontology and Endodontics, Belgrade, Serbia

[3]University University of Pristina, Faculty of Medicine, Department of Dentistry, Kosovska Mitrovica, Serbia

[4]University of Belgrade, Faculty of Dental Medicine, Department of Prosthodontics, Belgrade, Serbia

Corresponding author e-mail: milan.blagojevic@pr.ac.rs

Abstract

Dental materials are exposed to demanding mechanical conditions during clinical use, making accurate determination of their mechanical properties essential for material selection, quality control, and further development. Conventional mechanical testing often relies on machine crosshead displacement or contact extensometers for strain measurement. However, these approaches may be insufficient when testing small, brittle, heterogeneous, or surface-sensitive specimens, which are frequently encountered in dental material research. This paper presents the application of an in-house developed video extensometer for contactless strain measurement during mechanical testing of materials used in dentistry. The system is based on digital image acquisition and image processing algorithms that track selected markers or regions of interest on the specimen surface during loading. By determining their relative displacement over time, the system enables non-contact strain evaluation and supports the calculation of relevant mechanical parameters, including elastic modulus, strain at failure, and deformation behavior. The developed video extensometer was integrated with a universal testing machine and applied in experimental testing of selected dental materials. The measurement procedure included system calibration, specimen preparation, lighting adjustment, image acquisition, and synchronization of optical deformation data with force and displacement signals from the testing machine. Special attention was given to factors affecting measurement reliability, such as image resolution, marker visibility, camera positioning, and repeatability of the tracking procedure. The results indicate that the proposed video extensometer can be effectively used for contactless deformation measurement in dental material testing. Compared with displacement data obtained only from the testing machine, the image-based approach provides a more representative assessment of local specimen deformation. The developed system represents a flexible and cost-effective alternative to commercial optical extensometers and can be adapted for different specimen geometries, loading modes, and biomedical material testing applications.

Keywords

Video extensometer, Dental materials, Mechanical testing, Strain measurement, Image processing.

Acknowledgement

The part of this research is funded by Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Contract No. 451-03-65/2024-03/200155.

Type of publication

Original Research Article.

COMPRESSIVE AND DIAMETRAL TENSILE STRENGTH OF A NEW DENTAL BIOACTIVE DIRECT RESTORATIVE MATERIAL

Lalovic Marija[1*] [0000-0001-9576-7412], Kolak Veljko[1] [0000-0002-4178-410X], Melih Irena[1] [0000-0002-3254-9060], Nikitovic Ana[1] [0000-0001-8015-2458], Pesic Dragana[1] [0000-0003-2919-2985]

[1]University of Business Academy in Novi Sad, Faculty of Dentistry Pancevo, Department of Dental Pathology and Endodontics, 26000 Pancevo, Serbia

*Corresponding author e-mail: marija.lalovic@stomatoloski.rs

Abstract

The aim of this study was to evaluate the compressive strength (CS) and diametral tensile strength (DTS) of a dental restorative alkasite material polymerized using self-cure and light-cure modes, and to compare its properties with three commonly used bulk-fill restorative materials. A total of 150 specimens (n = 15 per group) of a light-cured (Cent LC) and self-cured (Cent self) alkasite material (Cention® Forte, Ivoclar Vivadent, Schaan, Liechtenstein), as well as three bulk-fill restorative materials for posterior use - GC Fuji IX Extra (Fuji) (GC, Tokyo, Japan), EQUIA Forte® HT (Equia) (GC, Tokyo, Japan), and Tetric® PowerFill (TPF) (Ivoclar Vivadent, Schaan, Liechtenstein), used as the control material - were prepared according to the manufacturers' instructions and standardized protocols for CS and DTS testing. The specimens were stored in distilled water at 37°C for 24 h, after which mechanical testing was performed using a universal testing machine at a crosshead speed of 0.75 mm/min. Strength values (MPa) were calculated and statistically analysed using one-way ANOVA followed by Tukey's post hoc test, with the level of significance set at $p < 0.05$. One-way ANOVA revealed significant differences among the tested materials for both CS and DTS ($p < 0.0001$). TPF showed the highest mean CS value (179.53 MPa), with no significant difference compared to Cent LC ($p > 0.05$). Cent LC showed the highest mean DTS value (48.98 MPa), with significantly higher values compared to TPF, Fuji, and Equia ($p < 0.05$). The results indicate that both dual-cured Cention® Forte and Tetric® PowerFill demonstrated superior mechanical performance among the tested materials, exhibiting the highest diametral tensile and compressive strength values, respectively.

Keywords

Mechanical properties; Compressive strength; Diametral tensile strength; Alkasite material; Polymerization mode.

Type of publication

Original Research Article.

EFFECT OF ZIRCONIA SURFACE TREATMENTS ON THE BOND STRENGTH OF COMPOSITE RESIN IN CERAMIC REPAIR

Danica Popovic Antic[1] [0000-0002-2322-810X], Minja Milicic Lazic[1] [0009-0009-0348-4702], Nenad Mitrovic[2] [0000-0001-9296-2669], Aleksandra Mitrovic[3] [0000-0002-5183-6276], Milan Travica[2] [0000-0003-1156-6563], Luka Zupac[1*] [0009-0007-4113-4864], Ana Djurdjevic[1] [0009-0005-7783-0621]

[1]University of Belgrade, School of Dental Medicine, Department of Prosthodontics,11000 Belgrade, Serbia

[2]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

[3]University of Criminal Investigation and Police Studies, Department of Forensic Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: lukazupac95@gmail.com

Abstract

The chipping of veneering ceramics from a zirconia core is a common cause of prosthetic rehabilitation failure, which is why various composite restoration protocols have been developed to establish morphological and functional integrity of the restoration. To examine the bond strength between zirconia and composite resin used for repair applying different zirconia surface preparation protocols. Plate-shaped specimens (1×5×10 mm) were fabricated from monolithic zirconia (Honchon Smile, Changsha Honchon Technology Co., Ltd., China) using the CAD/CAM method and divided into three groups according to the surface preparation protocol. The first group of specimens was sandblasted with Al_2O_3 particles (50 μm; 1–2 bar; 10 mm; 45°), followed by cleaning with isopropanol and application of MDP primer (Z- Prime Plus). The second group was mechanically treated with a diamond bur, followed by the application of a universal primer containing MDP (Monobond Plus). The third group was treated by tribochemical silcatization (SiO_2), and the application of a universal primer containing MDP (Monobond Plus). A composite resin for repair (Tetric EvoCeram, Ivoclar Vivadent) was applied to all samples using a layered technique. The bond strength was tested on a universal testing machine (Shimadzu AGS-X) at a speed of 1 mm/min until fracture occurred at the interface of zirconia and composite. The first group showed significantly higher values of fracture force (332.47 ± 172.81 N) and bond strength (8.31 ± 4.32 MPa) compared to the second group (153.79 ± 77.74 N; 3.84 ± 1.94 MPa), ($p<0.01$). The third group also showed higher values (310.00 ± 150.00 N; 7.89 ± 4.85 MPa) compared to the second ($p<0.01$), but without significant difference compared to the first group ($p>0.05$). The samples of the first and third groups showed higher deformation, absorbed energy and displacement at failure compared to the second group, which indicates higher joint resistance. Treatment with Al_2O_3 particles and tribochemical silcatization showed higher fracture resistance, with higher material durability (absorbed energy, displacement and percent of deformation), indicating the importance of micromechanical retention and chemical adhesion.

Keywords:

Fracture force, Sandblasting Al_2O_3, Diamond bur, Tribochemical silcatization, Deformation.

Type of publication

Original Research Article.

RESTORATION OF MOLAR TEETH WITH TRUSS ACCESS CAVITY: POLYMERIZATION AND FRACTURE RESISTANCE

Neda Ninkovic[1*] [0009-0008-3081-9398], Vanja Opacic-Galic[1] [0000-0001-9680-4529], Vesna Miletic[2] [0000-0001-9892-1323], Danica Bajuk-Bogdanovic[3] [0000-0003-2443-376X], Milos Milosevic[4] [0000-0002-2418-1032], Isaak Trajkovic[4] [0000-0001-6671-4733]

[1] University of Belgrade, School of Dental Medicine, Department for Restorative Dentistry and Endodontics, Serbia

[2] The University of Sydney, Faculty of Medicine and Health, Sydney Dental School, Australia

[3] University of Belgrade, Faculty of Physical Chemistry, 11221 Belgrade, Serbia

[4] Innovation Center of the Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

*Corresponding author e-mail: neda.ninkovic@stomf.bg.ac.rs

Abstract

This study evaluated the quality of polymerization and effect of restorative materials on fracture resistance of molars with different types of access cavities in a simulated full pulpotomy case. Plastic molar teeth with truss (TREC) and traditional endodontic access cavity (TEC) were restored with nanofilled composite (Filtek Supreme), glass-ionomer Fuji IX and Filtek (Fuji+Filtek) or fiber-reinforced everX Posterior and Filtek (everX+Filtek). The degree of conversion (DC) of resin-based materals was determined using micro-Raman spectroscopy. Human molars prepared and restored in the same way were used for fracture resistance testing at baseline and after thermocycling. Data were analysed using analyses of variance, Mann-Whitney test and multilinear regression (α=0.05). Results DC were significantly higher in Filtek than everX (mean range 55.0-66.0, p<0.001) but no differences in DC existed at different locations in the cavity and between access cavities (factor interaction p=0.101). TREC had significantly higher fracture resistance than TEC but more unrestorable fractures (p<0.05). Significantly higher fracture resistance was found in TEC restored with everX+Filtek than Filtek and Fuji+Filtek (p<0.05). Immediately loaded samples showed significantly higher fracture resistance than thermocycled (p<0.05). In conclusion, the conservative access cavity design (TREC) had no significant effect on composite polymerization and resulted in higher fracture resistance of restored molars compared to the TEC but was also associated with a higher incidence of unrestorable fractures. Clinical relevance Fiber-reinforced composite everX posterior can be recommended for restoring molars with TEC cavity design but not TREC. Glass-ionomer Fuji IX appears to be a better choice for restoring TREC as a base material than fiber-reinforced everX posterior and nanofilled composite Filtek.

Keywords

Access cavity, Resin composites, Glass ionomer, Fracture resistance, Degree of conversion.

Acknowledgement

This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia by Contract No. 451-03-47/2023-01/ 200213.

Type of publication

Original Research Article.

MACHINE LEARNING-BASED DENTAL AGE ESTIMATION FOR REDUCING OBSERVER VARIABILITY IN FORENSIC ODONTOLOGY

Aleksandra Mitrovic[1*] [0000-0002-5183-6276], Ksenija Zelic Mihajlovic[2] [0000-0002-3582-2878], Luka Zupac[2] [0009-0007-4113-4864]

[1]University of Criminal Investigation and Police Studies, Department of Forensic Engineering, 11000 Belgrade, Serbia

[2]University of Belgrade, School of Dental Medicine, 11000 Belgrade, Serbia

*Corresponding author e-mail: aleksandra.mitrovic@kpu.edu.rs

Abstract

Accurate estimation of biological age plays a crucial role in forensic identification, particularly in cases involving unknown individuals, undocumented migrants, and legal age disputes. Age estimation based on radiographic dental methods remains one of the most reliable approaches. Recent advances in artificial intelligence (AI), particularly in image analysis, offer promising avenues for improving the accuracy and reproducibility of dental age estimation. By leveraging machine learning algorithms applied to dental radiographs, such as panoramic and periapical x-rays, it becomes possible to automatically extract features related to tooth formation and maturation. These data-driven approaches can reduce human bias and provide consistent estimations across large datasets. This paper provides an overview of current trends in AI-assisted dental age estimation, with a focus on practical applicability in forensic contexts. Emphasis is placed on the balance between model accuracy and interpretability, as well as the challenges related to dataset quality, ethical considerations, and generalization across different populations. From an engineering perspective, the integration of AI tools into forensic workflows requires robust validation, standardized protocols, and user-friendly software interfaces. The aim of this work is to offer a clear and accessible entry point into this emerging field, highlighting both its potential and its current limitations. By bridging traditional forensic methods with modern computational tools, AI-driven dental analysis has the capacity to significantly enhance the reliability and efficiency of forensic age estimation.

Keywords

Dental Age Estimation, Forensic Odontology, Machine Learning, Radiographic Analysis, Observer Variability.

Type of publication

Review Article.

EFFECT OF THERMOCYCLING ON THE WETTABILITY OF PMMA DENTURE BASE MATERIALS

Mirjana Peric[1] [0000-0003-3667-4253], Aleksandra Cairovic[1] [0000-0001-8807-5426], Ivica Stancic[1] [0000-0001-8836-6506] Danica Popovic Antic[1*] [0000-0002-2322-810X], Milena Radunovic[2] [0000-0003-3507-1186], Sanja Petrovic[2] [0000-0002-4847-0891], Radmila Panjotovic[3] [0000-0002-2174-0062]

[1]University of Belgrade, School of Dental Medicine, Department for Prosthodontics, 11000 Belgrade, Serbia

[2]University of Belgrade, School of Dental Medicine, Department for Microbiology and Immunology, 11000 Belgrade, Serbia

[3]University of Belgrade, Faculty of Physics, Institute of Physics, 11000 Belgrade, Serbia

Corresponding author e-mail: danica.popovic@stomf.bg.ac.rs

Abstract

The surface wettability of polymethyl methacrylate (PMMA) denture base materials is important for the longevity of removable prosthetic restorations. The aim of this study was to evaluate the influence of hydrothermal ageing on the water contact angle (WCA) of denture base resins fabricated using different manufacturing techniques. Four groups of denture base resins were investigated: cold-polymerized (CP), heat-polymerized (HP), CAD-CAM milled (CADm), and 3D-printed (3D) PMMA based materials. Samples were subjected to hydrothermal ageing through thermocycling (5000 cycles between 5°C and 55°C). Surface wettability was assessed by measuring the water contact angle using a contact angle goniometer before and after ageing. Before ageing, all tested materials demonstrated hydrophilic surface characteristics, with the lowest contact angle observed in the 3D-printed group. After hydrothermal ageing, an increase in contact angle values was observed in all groups, indicating a move toward more hydrophobic surface behavior. A statistically significant increase in WCA was detected in the 3D-printed resin group ($p = 0.018$). After ageing, all tested materials exhibited relatively hydrophobic properties. Hydrothermal ageing significantly modified the wettability of denture base materials. The transition from hydrophilic to hydrophobic surface characteristics may affect longevity of removable prosthetic restorations.

Keywords

Denture base resin, Water contact angle, Hydrothermal ageing, PMMA.

Type of publication

Original Research Article.

EFFECT OF HYDROTHERMAL AGEING ON SURFACE ROUGHNESS OF PMMA DENTURE BASE MATERIALS

Aleksandra Cairovic[1] [0000-0001-8807-5426], Mirjana Peric[1] [0000-0003-3667-4253], Ivica Stancic[1] [0000-0001-8836-6506], Aleksandra Mitrovic[2][0000-0002-5183-6276], Milena Radunovic[3] [0000-0003-3507-1186], Sanja Petrovic[3] [0000-0002-4847-0891], Radmila Panjotovic[4] [0000-0002-2174-0062]

[1]University of Belgrade, School of Dental Medicine, Department for Prosthodontics, 11000 Belgrade, Serbia

[2] University of Criminal Investigation and Police Studies, Department of Forensic Engineering, 11000 Belgrade, Serbia

[3] University of Belgrade, School of Dental Medicine, Department for Microbiology and Immunology, 11000 Belgrade, Serbia

[4] University of Belgrade, Faculty of Physics, Institute of Physics, 11000 Belgrade, Serbia

*Corresponding author e-mail: aleksandramspringercnn@gmail.com

Abstract

Surface roughness of denture base materials is important for clinical performance and longevity of removable prosthetic restorations. The aim of this study was to evaluate the influence of hydrothermal ageing on the surface roughness of denture base resins fabricated using different manufacturing techniques.
Materials and Methods: Four groups of polymethyl methacrylate (PMMA) denture base materials were analysed: cold-polymerized (CP), heat-polymerized (HP), CAD-CAM milled (CADm), and 3D-printed (3D) resins. Hydrothermal ageing was performed using thermocycling (5000 cycles between 5°C and 55°C). Surface roughness and topography were evaluated using atomic force microscopy (AFM). Hydrothermal ageing significantly influenced the surface roughness of tested denture base materials (p = 0.002). The highest roughness values before and after ageing were observed in the 3D-printed resin group, while heat-polymerized samples exhibited the smoothest surfaces. A statistically significant increase in roughness after ageing was detected in cold-polymerized and heat-polymerized resins. CAD-CAM milled and 3D-printed materials didn't show significant changes. Hydrothermal ageing changed the surface characteristics of denture base materials. Increased surface roughness may raise microbial adhesion and biofilm accumulation, particularly in materials with initially rougher surfaces.

Keywords

Denture base resin, Surface roughness, AFM; Hydrothermal ageing, PMMA.

Type of publication

Original Research Article.

ASSESSMENT OF BOND STRENGTH BETWEEN PMMA TEETH AND DENTURE BASE UNDER DIFFERENT SURFACE TREATMENTS AND LOADING ANGLES USING DIGITAL IMAGE CORRELATION

Aleksandra Cairovic[1] [0000-0001-8807-5426], Mirjana Peric[1] [0000-0003-3667-4253], Igor Djordjevic[1] [0000-0003-2695-4577], Danica Popovic Antic[1] [0000-0002-2322-810X], Nenad Mitrovic[2] [0000-0001-9296-2669], Milan Travica[2] [0000-0003-1156-6563], Luka Zupac[1*] [0009-0007-4113-4864]

[1]University of Belgrade, School of Dental Medicine, Department for Prosthodontics, 11000 Belgrade, Serbia

[2]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: lukazupac95@gmail.com

Abstract

The bond strength between polymethyl methacrylate (PMMA) artificial teeth and denture base materials is important for clinical longevity of removable dentures. This study aimed to evaluate the bond strength at the interface between PMMA teeth and denture base under different loading angles using Digital Image Correlation (DIC) method. Real-time measurements of force, strain, and displacement were performed during loading on Universal Testing Machine (Shimadzu AGS-X) at a loading speed of 1 mm/min. Specimens were divided into three groups based on surface preparation: untreated tooth base surface, sandblasted tooth base surface, and tooth base surface with mechanical retention. All groups were tested under loading angles of 45° and 90°. These are clinically relevant angles corresponding to mandibular movements during mastication. Half of the specimens were subjected to artificial thermal ageing to assess its potential influence on bond strength. The results demonstrated variations in force, strain, and displacement among the tested groups, depending on surface treatment and loading angle. DIC showed that deformation was predominantly concentrated in the incisal region, while higher strain values were observed in the lower regions of the specimens. Artificial thermal ageing did not show a consistent influence on fracture resistance. Specimens with mechanical retention exhibited higher resistance to fracture. The application of DIC enabled detailed, localized analysis of strain and deformations fields, providing additional insight into the mechanical behavior of the tooth–denture base interface.

Keywords

Digital Image Correlation (DIC), PMMA teeth, Denture base, Bond strength, Strain analysis.

Acknowledgement

The authors gratefully acknowledge Ivoclar Vivadent AG (Schaan, Liechtenstein) for the donation of SR Vivodent Double Cross Linked PMMA artificial teeth used in the experimental part of this research.

Type of publication

Original Research Article.

EVALUATION OF FLEXURAL PROPERTIES AND STRAIN DISTRIBUTION IN HEAT AND COLD POLYMERIZED ACRYLIC RESINS USING DIGITAL IMAGE CORRELATION METHOD

Luka Zupac[1*] [0009-0007-4113-4864], Igor Djordjevic[1] [0000-0003-2695-4577], Aleksandra Cairovic[1] [0000-0001-8807-5426], Nenad Mitrovic[2][0000-0001-9296-2669], Aleksandra Mitrovic[3] [0000-0002-8302-0853], Milan Travica[2] [0000-0003-1156-6563], Momcilo Colic[1] [0009-0006-2437-7082]

[1]University of Belgrade, School of Dental Medicine, Department for Prosthodontics, 11000 Belgrade, Serbia

[2] University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

[3] University of Criminal Investigation and Police Studies, Department of Forensic Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: lukazupac95@gmail.com

Abstract

The mechanical performance of acrylic resins used in prosthodontics is important for the durability and clinical longevity of removable partial and complete dentures. This study aimed to evaluate and compare the mechanical performance of heat-polymerized and cold-polymerized acrylic resins using a three-point bending test combined with Digital Image Correlation (DIC) method. Two groups of samples were prepared with dimensions 100 x 5 x 5 mm. The first group was fabricated using the conventional dental flasking technique with heat-polymerized acrylic resin (Ivoclar Triplex Hot, Liechtenstein). The second group was fabricated using 3D printed mold (Bambu Lab X-1 Carbon, China) by PETG material with cold-polymerized acrylic resin for denture relining. Mechanical testing was performed using a universal testing machine (Shimadzu AGS-X) at a loading speed of 1 mm/min. One camera (Basler, Germany) with 5 MP resolution and GOM Correlate software (GOM, Germany) was used for 2D DIC method. The heat-polymerized acrylic resin demonstrated greater mechanical performance, with higher mean values of maximum force (155.87 N), maximum stress (59.86 MPa), and elastic modulus (1855.89 MPa), compared to the cold-polymerized resin (36.83 N, 14.14 MPa, and 274.58 MPa, respectively). The cold-polymerized material showed greater deformation capacity, with higher displacement (10.19 mm vs. 5.68 mm) and strain values (7.46 % vs. 4.16 %). DIC analysis revealed that the first group showed more localized strain concentration prior to fracture, while second group showed more distributed strain fields. Heat-polymerized acrylic resin provides higher strength and rigidity, while cold-polymerized resin provides greater deformation but have lower supporting capacity.

Keywords

Heat-polymerized acrylic resin, Cold-polymerized acrylic resin, Digital Image Correlation (DIC) Method, Flexural properties, Strain distribution.

Type of publication

Original Research Article.

Artificial intelligence

Invited lecture

FROM DATA TO EQUATIONS: SYMBOLIC REGRESSION IN SCIENCE AND ENGINEERING

Aleksandar Kartelj[1*] [0000-0001-9839-6039]

[1]University of Belgrade, Faculty of Mathematics, 11000 Belgrade, Serbia

**Corresponding author e-mail: aleksandar.kartelj@matf.bg.ac.rs*

Abstract

Symbolic regression (SR) is a data-driven methodology for discovering explicit analytical expressions that describe relationships among variables. Unlike traditional regression techniques that assume a predefined model structure, SR simultaneously searches over the space of mathematical expressions and estimates their parameters, producing interpretable closed-form equations. The objective of this work is to present and analyze the RILS-ROLS framework, which formulates symbolic regression as a structured optimization problem. The approach combines iterated local search for exploring expression structures with regularized ordinary least squares for efficient parameter estimation. A composite fitness function balances predictive accuracy and model complexity, guiding the search toward compact and robust solutions. The proposed framework is particularly relevant for materials science and engineering, where complex nonlinear dependencies between process parameters, microstructure, and material properties are often difficult to model explicitly. In such settings, symbolic regression enables the discovery of empirical relationships, scaling laws, and surrogate models directly from experimental and simulation data while preserving interpretability and consistency with physical principles. The method was evaluated on standard symbolic regression benchmarks, including the Feynman benchmark of analytical physics equations and the Strogatz benchmark of nonlinear dynamical systems. Experimental results demonstrated state-of-the-art predictive accuracy together with compact and interpretable analytical expressions across diverse scientific modelling tasks. The resulting models are computationally efficient and directly applicable in simulation, optimization, and engineering design workflows. Overall, symbolic regression provides a principled framework for transforming data into analytical knowledge and supporting scientific insight through explicit and structurally meaningful equations.

Keywords

Symbolic regression, Equation discovery, Interpretable modelling, Metaheuristic optimization.

Type of publication

Original Research Article.

STRATIFYHF PROJECT: ARTIFICIAL INTELLIGENCE-BASED DECISION SUPPORT SYSTEM FOR RISK STRATIFICATION AND EARLY DETECTION OF HEART FAILURE

Nenad Filipovic[1,2*] [0000-0001-9964-5615] Djordje Jakovljevic[3] [0000-0003-2686-6542], Zoran Bosnic[4] [0000-0003-0501-7146], Dimitrios Fotiadis[5] [0000-0002-7362-5082], Milos Kojic[1,2] [0000-0003-2199-5847]

[1]BioIRC doo Kragujevac, Andre Marinkovica 26, 34000 Kragujevac, Serbia

[2] Faculty of Engineering, University of Kragujevac, Sestre Janjic 6, 34000 Kragujevac, Serbia

[3]University Hospitals Coventry and Warwickshire NHS Trust, Coventry, UK

[4]University of Ljubljana, Faculty of Computer and Information Science, Ljubljana, Slovenia

[5]Department of Biomedical Research, Foundation for Research and Technology Hellas, Greece

Corresponding author e-mail: fica@kg.ac.rs

Abstract

Heart failure (HF) affects up to 15 million people in Europe and remains a leading cause of hospitalization, mortality and healthcare expenditure. As a complex and heterogeneous clinical syndrome, HF requires improved tools for early detection, risk prediction and personalized management. The STRATIFYHF aims to develop, validate and implement the first artificial intelligence (AI)-based, Decision Support System (DSS) integrated with multiscale computational modeling with big data for assessing and predicting the risk of HF, its early diagnosis and progression. STRATIFYHF project integrates 1) patient-specific data i.e. demographic, clinical, genetic, lifestyle and socio-economic, 2) an AI-based digital patient library and algorithms for risk stratification, early diagnosis, and disease progression and 3) a highly innovative multifunctional AI-based and computational modelling DSS, big data and mobile app for informing a patient-centred, personalised, prevention and treatment strategies. During the retrospective phase, data from 5.624 confirmed HF patients and 4.465 suspected cases were collected, alongside access to over 11 million primary care records and 680.000 confirmed HF cases through national data repositories. These datasets supported the development of predictive, diagnostic, and prognostic models, including multimorbidity analyses. The platform architecture includes a Workflow Manager Module for orchestrating high-computation tasks such as 3D biomechanical heart simulations, risk and early diagnosis modules powered by machine learning, and intuitive visual analytics dashboards integrated into clinical workflows. By enabling earlier intervention and personalized treatment strategies, STRATIFYHF aims to reduce hospital admissions, prevent disease progression and contribute to more efficient and sustainable healthcare systems.

Keywords

Heart failure, Decision Support System, Computational modeling, Risk stratification, Early diagnosis.

Acknowledgement

This research is funded by the project that has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement No 101080905 (STRATIFYHF). This research is also supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, contract numbers [451-03-136/2025-03/200107 (Faculty of Engineering, University of Kragujevac)] and [451-03-136/2025-03/200378 (Institute for Information Technologies)].

Type of publication

Original Research Article.

ARTIFICIAL INTELLIGENCE AND THE EVOLUTION OF INNOVATION ECOSYSTEMS: A MULTI-LEVEL PROCESS MODEL

Snezana Kirin[1*] [0000-0002-2176-3969], Milos Milosevic[1] [0000-0002-2418-1032],

Irina Gabriela Radulescu[2] [0000-0002-2551-1363]

[1]Innovation Centre of Faculty of Mechanical Engineering, 11000 Belgrade, Serbia

[2]Petroleum-Gas University of Ploiesti, Ploiesti, Romania

*Corresponding author e-mail: skirin@mas.bg.ac.rs

Abstract

The rapid advancement of artificial intelligence (AI) is reshaping the structure, coordination, and value creation dynamics of innovation ecosystems. Despite a growing body of research on AI-enabled innovation, existing studies largely adopt static or firm-centric perspectives, offering limited insight into how innovation ecosystems evolve over time and across levels of analysis. This paper addresses this gap by developing a multi-level process model that explains the evolution of innovation ecosystems in the AI era. Drawing on the literature on innovation ecosystems, open innovation, and socio-technical systems, the paper conceptualizes ecosystem transformation as a staged and dynamic process, progressing from digital and data-driven configurations toward AI-augmented and AI-native ecosystems. Within this evolutionary trajectory, the model identifies a set of interrelated mechanisms of change, including cognitive augmentation, transformation of work and skills, relational reconfiguration among ecosystem actors, organizational adaptation, and institutional alignment. By integrating micro-, meso-, and macro-level dynamics into a unified framework, the study advances existing research beyond descriptive accounts and offers a mechanism-based explanation of ecosystem transformation. The proposed model contributes to theory by clarifying how AI acts as both an enabling infrastructure and an active agent in innovation processes. The paper also outlines implications for managers and policymakers, emphasizing the need for adaptive organizational capabilities, collaborative innovation infrastructures, and governance frameworks that can support sustainable and inclusive AI-driven ecosystems.

Keywords

Artificial intelligence, Innovation ecosystems, Process mode, Ecosystem transformation.

Type of publication

Original Research Article.

ADVANTAGES OF AI IN PREDICTIVE SUSTAINABILITY FOR RES

Aleksandra Tomic[1*] [0000-0001-6557-9576]

[1]Innovation Centre of Faculty of Mechanical Engineering, Belgrade, Serbia

11000 Belgrade, Serbia

*Corresponding author e-mail: atomic@mas.bg.ac.rs

Abstract

This paper discusses the application of artificial intelligence in the integrated modeling of renewable energy sources (RES) systems, with the aim of improving the reliability, efficiency and sustainability of energy system. A special focus is placed on predictive maintance as a key strategy to reduce downtime, extend equipment life and optimize operating costs in wind farms, solar farms and other RES plants. The increasing penetration of renewable energy sources introduces operational challenges related to generation variability, equipment reliability, and maintenance planning. To address these issues, machine learning techniques are employed to analyze operational, meteorological, and environmental data in order to detect anomalies, forecast component degradation, and support timely maintenance actions. The proposed approach combines data-driven AI methods with environmental modeling to evaluate the influence of climate variability and resource fluctuations on the performance of renewable energy installations. By integrating historical measurements, weather indicators, and system-level operational data, the model enables more accurate prediction of failures and more efficient scheduling of maintenance interventions. This framework contributes to improved system reliability, reduced downtime, lower operating costs, and extended equipment lifespan. In addition, the study highlights the relevance of AI-assisted environmental modeling for the sustainable integration of renewable energy sources into modern power systems. The results suggest that the synergy between artificial intelligence and environmental modeling can provide a robust methodological basis for enhancing both technical performance and environmental sustainability in renewable energy applications.

Keywords

Advantages AI, Integrated modeling of RES systems, Predictive maintance, Environmental modeling, Synergy.

Acknowledgement

The results shown here are the results of research supported by the Ministry of Science, Technological Development and Innovation of the RS under Contract 451-03-33/2026-03/200213 dated 05.02.2026.

Type of publication

Original Research Article.

PRINCIPLES OF INTERPRETING MACHINE LEARNING MODELS IN BIOMEDICINE

Marina Popovic Krneta[1*] [0000-0002-7627-453X]

[1] Institute for Oncology and Radiology of Serbia, Department of Nuclear Medicine, 11000 Belgrade, Serbia

*Corresponding author e-mail: marina.popovic1989@gmail.com

Abstract

Machine learning (ML) models are increasingly used in biomedicine, often evaluated using global performance metrics such as the area under the ROC curve (AUC). However, although these metrics provide valuable information, they do not offer clear guidance on how model outputs should be used in real-world clinical practice. The aim of this work is to present key principles for interpreting ML models in a biomedical context, with a focus on bridging the gap between model performance and practical clinical use. Special attention is given to metrics derived from the confusion matrix and their interpretation in the context of clinical practice, including the impact of prevalence and threshold selection. For example, in oncology-related applications, minimizing false negative results may be prioritized in order to avoid classifying patients with aggressive disease as low-risk and consequently exposing them to insufficient treatment. The lecture emphasizes that no single metric can adequately capture model usefulness, and that different clinical scenarios such as screening versus treatment require different evaluation priorities. Furthermore, ML models are presented as decision-support tools rather than replacements for clinical judgment. By reframing model evaluation through the lens of clinical consequences, this work aims to provide a practical framework for more meaningful interpretation and responsible use of ML models in biomedicine. In addition, the lecture seeks to bridge engineering and clinical perspectives by clarifying what type of information is required for appropriate use in clinical practice.

Keywords

Machine Learning, Model Interpretation, Clinical decision-making.

Type of publication

Review Article.

PRINCIPLES AND PITFALLS OF DEVELOPING MACHINE LEARNING MODELS IN BIOMEDICINE

Miljana Tanic[1*] [0000-0003-3102-776X]

[1] Experimental Oncology Department, Institute for Oncology and Radiology of Serbia, Belgrade, Serbia

*Corresponding author e-mail: tanic.miljana@ncrc.ac.rs

Abstract

With the increase in computational power over the past decades allowing processing of big data and the development of novel algorithms for machine learning (ML) such as deep learning, often (mis)labelled as artificial intelligence (AI), there has been a surge of ML models developed for biomedical applications as decision support tools or classifiers. Unfortunately, many are being developed as “a model for the sake of a model” without due consideration for the intended application, data quality, context, confounding factors, potential biases, limitations or interpretation. Here I aimed to address the guiding principles and common pitfalls in relation to the development of effective and responsible ML models in healthcare, covering the entire data cycle. Data acquisition challenges will be discussed considering biases, insufficient data, multiple data types and data sharing and privacy. Regarding ML model development, particular focus will be placed on model selection depending on intended purpose and use of appropriate metrics and standards in the biomedical field for model evaluation in the trade-off between ML model explainability and model accuracy will be discussed, introducing the advantages and limitations of post-hoc explanations. The ethical challenges and the current regulatory framework for AI in medicine will be reviewed. Finally, current applications of ML in oncology will be showcased.

Keywords,

Machine learning, Biomedicine, Oncology.

Acknowledgement

Ministry of Science, Technology and Innovation of Republic of Serbia 451-03-33/2026-03/ 200043.

Type of publication

Review Article.

Student session

WIND ENERGY – OPERATING PRINCIPLES, AERODYNAMICS, AND ENERGY CONVERSION

Mihajlo Sreckovic[1], Nemanja Stanojevic[1], Petar Jovanovic[1], Stefan Soldatovic[1], Luka Reznic[1], Dimitrije Stanojevic[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents the fundamental principles of wind energy utilization as one of the most significant renewable energy sources. The operating principle of a wind turbine is explained, including its key components – the rotor, blades, nacelle, and tower – as well as the process of converting the kinetic energy of wind into electrical energy. Special emphasis is placed on the aerodynamic characteristics of wind turbines, the influence of wind speed on system power output, and the importance of Betz's law in determining the maximum achievable efficiency of wind energy conversion. The paper also highlights the differences between onshore and offshore wind farms and provides examples of countries with a high share of wind energy in total electricity production. In addition, the main advantages of wind energy, such as low CO_2 emissions and sustainability, are analysed, along with challenges related to high initial investment costs, wind variability, and material fatigue.

Keywords

Wind energy, Wind turbine, Aerodynamics, Betz's law, Renewable energy.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

ENERGY OF THE EARTH-GEOTHERMAL ENERGY AND ITS APPLICATION

Matija Novakovic[1], Sofija Pavlica[1], Luka Panic[1], Boza Panic Perovic[1], Andrija Pantelic[1], Vera Pesic[1], Mina Pribanovic[1], Kosta Rajcic[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents the fundamental characteristics of geothermal energy as an important renewable energy source. The origin of geothermal energy is explained as a consequence of heat generated within the Earth due to the decay of radioactive elements and the extremely high temperatures in the Earth's core. Special emphasis is placed on geothermal energy sources such as hot springs, geysers, groundwater reservoirs, and volcanic regions, as well as on the operating principles of geothermal power plants. Different forms of geothermal energy are presented, with hydrogeothermal energy identified as the most suitable for practical application due to its availability, renewability, and low environmental impact. The paper also analyzes the potential for geothermal energy utilization worldwide and in Serbia, with particular focus on the hydrogeothermal resources of the South Morava balneothermal region, Macva, and Posavina. The most significant application areas are presented, including electricity generation, heating, agriculture, industry, and balneotherapy, together with the main advantages and disadvantages of this energy source.

Keywords

Geothermal energy, Hydrogeothermal resources, Renewable energy sources, Geothermal power plants, Sustainable development.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

WATER ENERGY – THE POWER OF NATURE AND A SUSTAINABLE FUTURE

Filip Starcevic[1], Sasa Stefanovic[1], Marko Tomanic[1], Aleksa Tomic[1], Nemanja Tomic[1], Nikola Cocic[1], Nevena Urosevic[1], Tatjana Todan[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents the fundamental characteristics of geothermal energy as an important renewable energy source. The origin of geothermal energy is explained as a consequence of heat generated within the Earth due to the decay of radioactive elements and the extremely high temperatures in the Earth's core. Special emphasis is placed on geothermal energy sources such as hot springs, geysers, groundwater reservoirs, and volcanic regions, as well as on the operating principles of geothermal power plants. Different forms of geothermal energy are presented, with hydrogeothermal energy identified as the most suitable for practical application due to its availability, renewability, and low environmental impact. The paper also analyzes the potential for geothermal energy utilization worldwide and in Serbia, with particular focus on the hydrogeothermal resources of the South Morava balneothermal region, Macva, and Posavina. The most significant application areas are presented, including electricity generation, heating, agriculture, industry, and balneotherapy, together with the main advantages and disadvantages of this energy source.

Keywords

Geothermal energy, Hydrogeothermal resources, Renewable energy sources, Geothermal power plants, Sustainable development.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

SOLAR ENERGY – AGRIVOLTAIC SYSTEMS AND SUSTAINABLE AGRICULTURE

Matija Klen[1], Lazar Kovacevic[1], Lazar Kiproski[1], Djordje Koman[1], Filip Jovanovski[1], Srdjan Korolija[1], Mateja Kokovic[1], Mihajlo Jevtovic[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents agrivoltaic systems as a modern approach to integrating solar energy production and agriculture on the same land area. The principle of installing solar panels above agricultural crops is explained, enabling the simultaneous generation of electrical energy and cultivation of plants. Special emphasis is placed on the advantages of utilizing solar energy as a renewable and environmentally friendly energy source, as well as on the positive effects of solar panels in protecting crops from excessive heat, intense solar radiation, and reducing water evaporation from the soil. The paper analyzes the environmental and economic benefits of agrivoltaic systems, including the reduction of fossil fuel consumption, improvement of energy efficiency, and contribution to sustainable agriculture. Challenges related to the initial investment costs and technical implementation of these systems are also highlighted.

Keywords

Solar energy, Agrivoltaic systems, Solar panels, Renewable energy sources, Sustainable agriculture.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

BIOGAS PRODUCTION – ENERGY FROM NATURE FOR A SUSTAINABLE FUTURE

Marko Kocic[1], Matija Krasic[1], Nikola Luzajic[1], Petar Malovic[1], Aleksa Maricic[1], Ivan Markovic[1], Stefan Matejic[1], Bojan Matic[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

*Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents the biogas production process as an important renewable energy source obtained through the anaerobic digestion of organic materials. The principle of organic waste decomposition in hermetically sealed digesters is explained, where microorganisms produce biogas rich in methane and carbon dioxide in the absence of oxygen. Special emphasis is placed on the types of feedstocks used in the process, including manure, plant residues, food waste, and municipal waste, as well as on the stages of biogas production – feedstock preparation, anaerobic digestion, biogas storage, and purification. The paper presents the possibilities of biogas application for the production of electrical and thermal energy, as well as for the production of biomethane that can be used as vehicle fuel. In addition, the environmental and economic advantages of biogas production are analysed, including the reduction of greenhouse gas emissions, organic waste management, and the production of organic fertilizer.

Keywords

Biogas, Anaerobic digestion, Renewable energy sources, Organic waste, Biomethane.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

ENERGY GENERATED FROM BIOMASS – A RENEWABLE ENERGY SOURCE AND SUSTAINABLE DEVELOPMENT

Lazar Milenkovic[1], Andjela Nikolic[1], Miljana Milosevic[1], Vuk Nikolic[1], Vukasin Mitrovic[1], Sanja Mitrovic[1], Filip Mitrovic[1], Vukasin Nikodijevic[1], Ivan Zlatanovic[1] [0000-0002-6949-7305]

[1]University of Belgrade, Faculty of Mechanical Engineering, Department of Process Engineering, 11000 Belgrade, Serbia

Corresponding author e-mail: ivan.zlatanovic@gmail.com

Abstract

This paper presents the fundamental characteristics of biomass as an important renewable energy source. Biomass includes living or recently living plant and animal matter that can be used to produce thermal and electrical energy, as well as for the production of biofuels. The paper presents the classification of biomass according to its origin, including woody biomass, agricultural residues, animal waste, and biomass derived from municipal waste. Special emphasis is placed on the methods of energy production from biomass and the application of biofuels such as bioethanol, biodiesel, and biogas, which represent a more environmentally friendly alternative to fossil fuels. Environmental aspects of biomass utilization are also analysed, highlighting its carbon neutrality and importance for sustainable development and the reduction of negative environmental impacts.

Keywords

Biomass, Renewable energy sources, Biofuels, Bioethanol, Biodiesel.

Acknowledgement

This student paper was prepared and presented in the form of a poster as part of a group project assignment within the course Renewable and Secondary Resources (Undergraduate Academic Studies) at the Faculty of Mechanical Engineering, University of Belgrade.

Type of publication

Review Article.

CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

621(048)(0.034.2)
62:519.6(048)(0.034.2)

INTERNATIONAL conference of experimental and numerical investigations and new technologies (2026; Beograd)
Programme [Elektronski izvor] ; and The Book of Abstracts / International Conference of Experimental and Numerical Investigations and New Technologies - CNN TECH 2026, 26-28 May 2026, Belgrade ; organized by Innovation Center of Faculty of Mechanical Engineering [and] University of Belgrade, Faculty of Mechanical Engineering, Center for Business Trainings ; [editors Aleksandra Mitrovic, Isaak Trajkovic, Milan Travica]. - Belgrade : University, Faculty of Mechanical Engineering, 2026 (Belgrade : University, Faculty of Mechanical Engineering). - 1 USB fleš memorija ; 1 x 2 x 5 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 150.

ISBN 978-86-6060-246-8

a) Машинство -- Апстракти b) Техника -- Нумерички методи -- Апстракти

COBISS.SR-ID 194095113