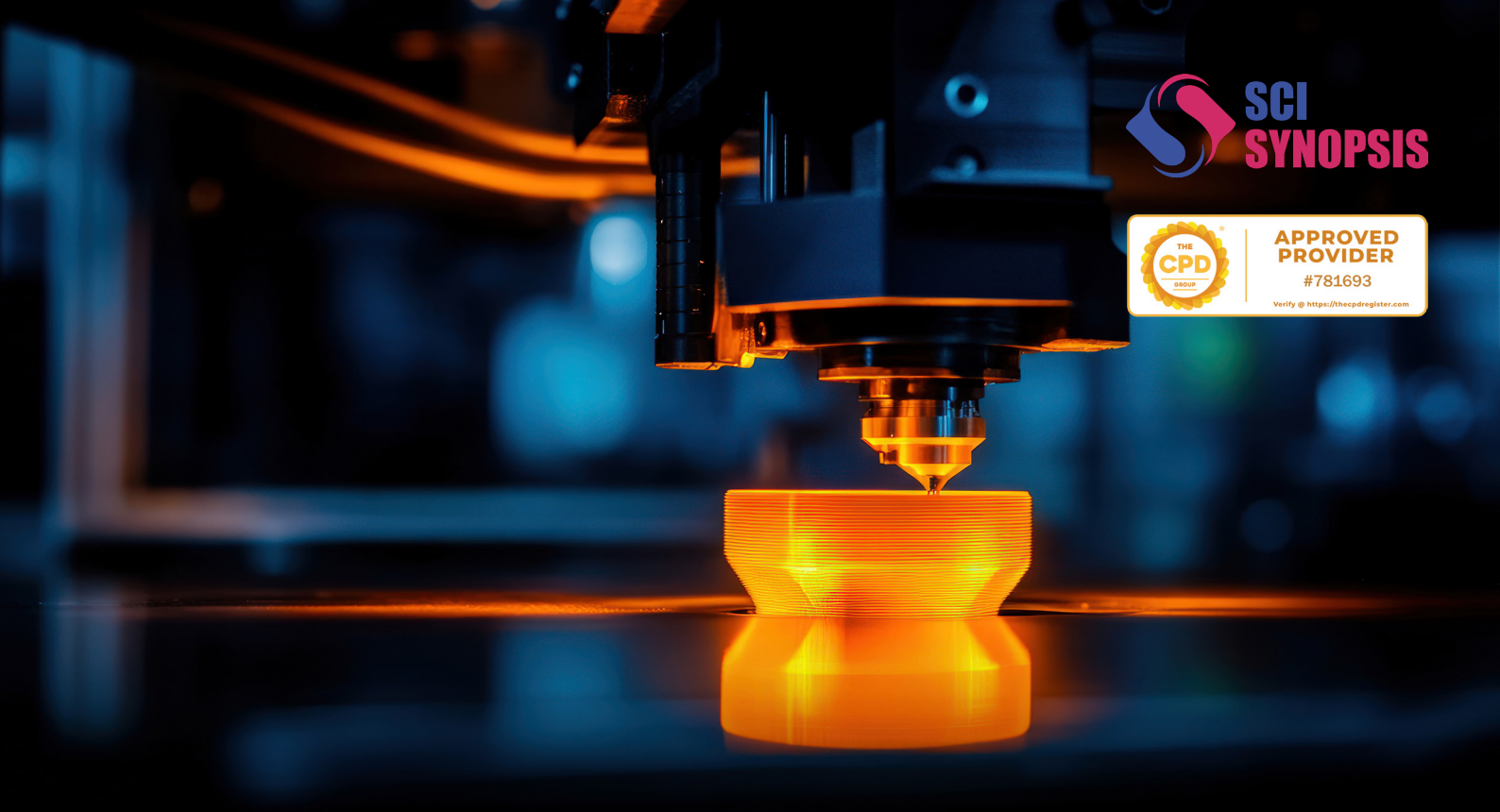


SCI SYNOPSIS

APPROVED PROVIDER #781693

5th International Conference on

3D Printing & Additive Manufacturing

September 17-19, 2026

Yıldız Technical University & Istanbul Fair Center, Türkiye

In Association with

YILDIZ TEKNİK ÜNİVERSİTESİ 1911

EXPO 3D ISTANBUL

Contact us:

Contact: +1-770-832-7291

Whatsapp: +1-770-884-4388

Scisynopsis LLC

Atlanta, GA 30326

USA

EXPO 3D ISTANBUL
ADDITIVE MANUFACTURING, DESIGN AND PRODUCTION TECHNOLOGIES FAIR

CONFERENCE PROGRAM

THURSDAY | 17 SEPTEMBER 2026

ISTANBUL EXPO CENTER

3D PRINTING 2026

5th International Conference on 3D Printing & Additive Manufacturing

OPENING & KEYNOTE PRESENTATIONS

SESSION I • Chair: Prof. Dr. Binnur Sağbaş

09:00-09:30 **Registration**

09:30-10:00 **Opening Speeches**

KEYNOTE

10:00-10:45 **Roman Perez**

Universitat Internacional de Catalunya (UIC Barcelona), Spain

Extrusion-Based Biomaterials as Angiogenic Inducers in Tissue Engineering

KEYNOTE

10:45-11:30 **Mahdi Bodaghi**

Nottingham Trent University, UK

Doing More with Less: 4D Materials & Printing for a Smarter Future

11:30-11:50 **Coffee Break**

BIOMATERIALS, BIOPRINTING & BIOMEDICAL APPLICATIONS

SESSION II • Chair: Mohammad Irshidat

11:50-12:10 **Mohammad Irshidat**

Qatar University, Qatar

3D-Printed Concrete with Fast-Setting Cement (FSC) and Recycled (CDW) Sand: Mix Design, Printability, and Performance Evaluation

12:10-12:30 **Farnaz Rezaei**

Uppsala University, Sweden

High-Conductivity MXene-Based 3D Microstructures for Biosensing Applications

12:30-12:50 **Elena Salvaterra**

Europa Uomo Schweiz, USA

Informed Consent for Organ Bioprinting and Transplantation: A Comparison Between Ethics and Patient Perspective

12:50-14:00 **Lunch**

INDUSTRY TALKS

INDUSTRY TALK

14:00-14:30 **Muhammed Enes Tahiroğlu**

Founder, METATECHTR

The Evolution of 3D Technologies in Türkiye and the Growth of the Industry

INDUSTRY TALK

14:30-15:00 **Ayşenur Altunbay**

Project Consultant, UPCORES

Additive Manufacturing and Generative Design

15:00-15:20 **Coffee Break**

METAL ADDITIVE MANUFACTURING & POST-PROCESSING

SESSION III • Chair: Dr. Azade Yelten Coşkun

15:20-15:40 **Azade Yelten Coşkun**

Istanbul University-Cerrahpaşa, Türkiye

Features of the Ti6Al7Nb Parts Produced via the Laser Powder Bed Fusion (LPBF) Method Using Different Laser Scanning Speeds

15:40-16:00 **Merve Gizem Özden**

Erzurum Technical University, Türkiye

Thermal-History Engineering of LPBF-Processed Fe-Based Soft Magnets through Sequential Laser Exposure

16:00-16:20 **Mustafa Sevimli**

Yıldız Technical University, Türkiye

Optimization of Laser Powder Bed Fusion Process Parameters for Improving the Wear Resistance of H13 Tool Steel

16:20-16:40 **Alperen Kaya**

Yıldız Technical University, Türkiye

Enhancement of Tribological and Corrosion Performance of SLM Additively Manufactured Ti6Al4V via Novel HIP Post-Processing

16:40-17:00 **Mehmet Erdi Korkmaz**

Yıldız Technical University, Türkiye

Analysis of Surface Roughness in Wire EDM Machining of Additive Manufacturing 316L Component

SCISYNOPSIS Synoptic Approch to Foster Research

YILDIZ TECHNICAL UNIVERSITY 1911

TAM FAIRS

EXPO 3D ISTANBUL
ADDITIVE MANUFACTURING, DESIGN AND PRODUCTION TECHNOLOGIES FAIR

CONFERENCE PROGRAM

FRIDAY | 18 SEPTEMBER 2026

ISTANBUL EXPO CENTER

3D PRINTING 2026

5th International Conference on 3D Printing & Additive Manufacturing

KEYNOTE PRESENTATIONS & INDUSTRY TALK

SESSION I • Chair: Aslı Günay Bulutsuz

KEYNOTE

09:30-10:10 **Anton Ficai**

National University of Science and Technology Politehnica Bucharest, Romania

Healing by Design: How STEM Shapes Personalized Medicine

KEYNOTE

10:10-10:50 **Boris Jalušić**

University North, Croatia

On the Validation of the Numerical Modeling of Thermo-Mechanical Manufacturing Processes

INDUSTRY TALK

10:50-11:15 **Yunus Eker**

YTÜ-ETP

Industrial Design and Prototyping Center: An Interphase Between Industry and Academia

11:15-11:30 **Coffee Break**

POLYMER ADDITIVE MANUFACTURING

SESSION II • Chair: Omer Egercioglu

INVITED

11:30-11:50 **Manoj Kumar Patel**

CSIR-Central Scientific Instruments Organisation, India

Convenience to Customized Nutrition: The Role of 3D Food Printing Technologies

11:50-12:10 **Omer Eyercioglu**

Gaziantep University, Türkiye

Influence of Raster Angle, Layer Thickness, and Abrasive Flow Machining on Surface Integrity of Carbon Fiber-Reinforced PLA Components

12:10-12:30 **Muslum Ozalp**

Gaziantep University, Türkiye

Influence of Post-Curing Duration on the Mechanical Performance of DLP-Printed Photopolymer Used in Rapid Tooling

12:30-12:50 **Musa Yilmaz**

Gaziantep University, Türkiye

ASTM D790 Flexural Evaluation of FFF-Printed Polycarbonate Parts with Different Infill Deposition Angles

12:50-14:00 **Lunch**

ROBOTICS PANEL & POSTER SESSION

PANEL

14:00-15:00 **The Transforming Role of Robotic Systems in Additive Manufacturing**

Moderator: Savaş Dilbal

15:00-15:20 **Poster Session**

15:20-15:30 **Coffee Break**

DESIGN OPTIMIZATION & STRUCTURAL APPLICATIONS

SESSION III • Chair: Saygın Sucuoğlu

15:30-15:50 **Ahmet Yağız Turpçu**

Eskişehir Technical University, Türkiye

Comparative Investigation of Additive and Subtractive Manufacturing Constraints in Topology Optimization of Aerospace Components

15:50-16:10 **Saygın Sucuoğlu**

Aydın Adnan Menderes University, Türkiye

Stress-Informed Functionally Graded TPMS Infill Design for a Monolithic Spar-Less UAV Wing

16:30-16:50 **Aysenur Aydin**

Yıldız Technical University, Türkiye

Redesign of Collapsible Steering Columns Used in Automotive Applications Based on Lattice Structures: Evaluation of Energy Absorption Performance Using Finite Element Analysis and Experimental Methods

16:40-17:00 **Hüseyin Can Aksa**

Karadeniz Technical University, Türkiye

Patient-Specific Corrective Implant Design for Post-Cranioplasty Aesthetic Contour Deformity Using a Hybrid Hard–Soft Tissue Phantom Model

EXPO 3D ISTANBUL
ADDITIVE MANUFACTURING, DESIGN AND PRODUCTION TECHNOLOGIES FAIR

CONFERENCE PROGRAM

SATURDAY | 19 SEPTEMBER 2026

ISTANBUL EXPO CENTER

3D PRINTING 2026

5th International Conference on 3D Printing & Additive Manufacturing

KEYNOTE PRESENTATIONS & INDUSTRY TALK

SESSION I • Chair: Boris Jalusic

KEYNOTE

09:30-10:10 **Cem Bülent Üstündağ**

Yıldız Technical University, Türkiye

Integrating Additive Manufacturing and Engineered Biomaterials for Personalized Microneedle-Mediated Drug Delivery

KEYNOTE

10:10-10:50 **Özgür Uyar**

GSI SLV-TR, Türkiye

Fundamentals of Sheet Lamination Additive Manufacturing

INDUSTRY TALK

10:50-11:15 **Cevdet Yalçıner & Ahmet Sever**

Marketing & Brand Executive / Additive Manufacturing Specialist, Ermaksan

The Manufacturing Technology of the Future: Global Developments in Additive Manufacturing, Türkiye, and Ermaksan Solutions

11:15-11:30 **Coffee Break**

LATTICE & TPMS STRUCTURES

SESSION II • Chair: Hamdi Kuleyin

11:30-11:50 **Hamdi Kuleyin**

Recep Tayyip Erdoğan University, Türkiye

Short-Term Recovery and Reloading of MSLA-Printed Schwarz Primitive TPMS

11:50-12:10 **Merve Koral**

Yıldız Technical University, Türkiye

Design and Optimization of Additively Manufactured Lattice Structures for Energy Absorption in Automotive Applications

12:10-12:30 **Sezin Selamoğlu**

Atılım University, Türkiye

Experimental Evaluation of TPMS-Filled Crash Boxes for Enhanced Energy Absorption in Automotive Applications

INDUSTRY TALK

12:30-12:50 **Mustafa Sevimli**

Sales Manager, digiMODE

From Powder to Final Part: End-to-End Solutions in Additive Manufacturing

12:50-14:00 **Lunch**

ADVANCED MATERIALS & PERFORMANCE

SESSION III • Chair: Enes Kalyoncu

14:00-14:20 **Yusuf Selim Bulut**

Yıldız Technical University, Türkiye

Compressive Mechanical Performance of Methacrylate-Functionalized TiO_2 Nanotube-Reinforced Polymer Composite Fabricated by Masked Stereolithography

14:20-14:40 **Yavuz Selim Gözüm**

Yıldız Technical University, Türkiye

Effect of Water Uptake on the Properties of 3D Parts

14:40-15:00 **Dilek Aygün**

Yıldız Technical University, Türkiye

Design and Characterization of Collagen-Containing IPN Hydrogel Bioinks for 3D-Printed Neural Tissue Scaffolds

15:00-15:20 **Enes Kalyoncu**

Istanbul Gelisim University, Türkiye

Machine Learning for Tensile Strength Prediction of FFF-Printed PLA: A Group-Wise Validation Approach

15:20-15:30 **Coffee Break**

EMERGING & INTERDISCIPLINARY APPLICATIONS

SESSION IV • Chair: Doruk Gürkan

15:30-15:50 **Hanife Bukre Koç Güneşsu**

Marmara University, Türkiye

Development and FDM Processing of PLA Composite Filaments Reinforced with Al, Al_2O_3, Ti, Nano-BN, and Spent Turkish Coffee Grounds for Functional 3D-Printed Products

15:50-16:10 **Doruk Gürkan**

İstanbul Gedik University, Türkiye

Tailoring Structure and Morphological Response of WAAM Superalloys via Mg-Modified ZnO Coatings Deposited by Advanced and Conventional EPD Routes

16:10-16:30 **Ismail Kaya**

İstanbul Technical University, Türkiye

A Parametric Study on the Design and Geometric Modification of 3D-Printed Radial Lip Seals

16:30-16:50 **Mohammad Hossein Sadeghi**

Tarbiat Modares University, Iran

Design and Fabrication of Functionally Graded Lattice Bone Scaffolds with Transversely Isotropic Behavior and Directional Reinforcement

16:50-17:10 **Yimin Huang**

National Heart, Lung, and Blood Institute, National Institutes of Health, USA

4D Bio-Printing Application in Physiologically Adaptable Cardiac Patch Fabrication

SCISYNOPSIS Synoptic Approch to Foster Research

YILDIZ TECHNICAL UNIVERSITY 1911

TAM FAIRS

EXPO 3D ISTANBUL

5th International Conference on 3D Printing & Additive Manufacturing

Poster Session

18 SEP 15.00 - 15.20

BARBORA KŘISTKOVÁ
VŠB-TUO, Czech Republic

Metal 3D Printing for Advanced Structural Components: From Microstructure to Architectural Applications

SAFA KAHRIMAN
Yildiz Technical University, Turkey

Topology Optimization and Generative Design of an Automotive Headlight Bracket for Additive Manufacturing: A Sustainability-Oriented Case Study

HARIKA YILDIZ
Yildiz Technical University, Turkey

Effect of Electron Beam Melting (EBM) Process Parameters on Density and Surface Roughness Of TI-6AL-4V PARTS

ABDURRAHMAN ÖZDEMIR
Yildiz Technical University, Turkey

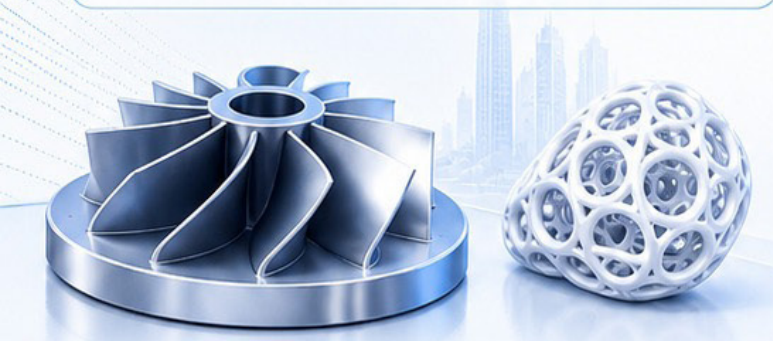
Development of a Lumbar Spine Anatomical Model Using Additive Manufacturing for Experimental Validation of Medical Devices

ENES BOĞAZKESEN
Yildiz Technical University, Turkey

Effect of drying conditions on the mechanical properties of PLA 3D parts

SASAN YAZDANI
Sahand University of Technology, Iran

Particle-Size-Driven Microstructural Evolution and Strengthening in SLM-Fabricated 316L/TiC Functionally Graded Composites



ELINA AKBARZADEH CHINIFOROUSH
Yildiz Technical University, Turkey

Cross-Alloy Effects of Reciprocating Deposition Paths in WAAM: Microstructure, Anisotropy, and CFD-Based Melt-Pool Analysis

17–19 SEPTEMBER 2026
ISTANBUL EXPO CENTER

İSTANBUL
FUAR MERKEZİ

Day 01

3D Printing & Additive Manufacturing

Keynote Presentations

EXTRUSION BASED BIOMATERIALS AS ANGIOGENIC INDUCERS IN TISSUE ENGINEERING

Roman A Perez
Bioengineering Institute of Technology and Bioengineering Department, Universitat Internacional de Catalunya (UIC Barcelona), Spain

Abstract:

Tissue engineering is an interdisciplinary field that combines principles from biology, materials science, and engineering to develop strategies capable of restoring, replacing, or regenerating damaged tissues. Rather than simply substituting lost tissue, tissue engineering aims to create biological environments that actively guide cell behavior and support the formation of functional new tissue. Biomaterials play a central role in this process by providing structural support while also delivering biochemical, mechanical, and physical signals that regulate cellular responses.

One of the major challenges in translating tissue-engineered constructs into clinically effective therapies is the establishment of a functional vascular network. This limitation becomes particularly relevant in bone regeneration, where large or complex defects require rapid access to oxygen and nutrients to maintain cell viability and enable new tissue formation. Consequently, the design of biomaterials that simultaneously promote vascularization and bone formation has become a key objective in regenerative medicine.

This presentation will discuss different biomaterial-based approaches developed to address this challenge. Particular attention will be given to the incorporation and controlled release of bioactive inorganic ions, including cobalt, copper, and silicate species, which can stimulate pro-angiogenic pathways while contributing to osteogenic activity. These strategies provide an attractive alternative or complement to conventional growth-factor delivery and can be integrated into porous scaffolds, microparticles, bioactive glasses, and hydrogel-based systems.

The presentation will also explore how advanced biofabrication technologies, including 3D bioprinting, coaxial extrusion, and core-shell hydrogel systems, can be used to organize cells and materials into architectures that better reproduce the complexity of native tissues. In addition, the role of the host immune response will be considered, highlighting how biomaterial composition, surface properties, and ion release can influence macrophage behavior and create a regenerative microenvironment that supports vascular ingrowth.

Overall, the combination of smart biomaterials, controlled biological signaling, immunomodulation, and biofabrication offers a versatile framework for developing more effective tissue-engineering strategies. Bone regeneration will be used as a representative example to illustrate how these complementary approaches can be integrated toward clinically relevant, vascularized tissue constructs.

Biography

Roman A. Perez is Vice-Rector for Research, Innovation and Knowledge Transfer at Universitat Internacional de Catalunya (UIC Barcelona), where he is also Full Professor and senior researcher at the Bioengineering Institute of Technology. He holds a degree in Chemistry from the University of

Barcelona and a PhD in Materials Science from the Universitat Politecnica de Catalunya, including a doctoral research stay at Harvard University. His international academic experience includes research and faculty positions at Dankook University in South Korea, University College Dublin, and Toronto Metropolitan University in Canada.

His research focuses on bioengineering, advanced biomaterials, and regenerative medicine, with particular emphasis on the design of functional scaffolds, hydrogels, bioinks, and controlled delivery systems for hard and soft tissue regeneration. A major part of his work explores vascularization, immunomodulation, bioactive ions, and 3D/coaxial bioprinting as complementary tools to improve tissue regeneration. He has authored more than 100 peer-reviewed scientific publications, holds 10 patents, and has led competitive national and international research projects.

DOING MORE WITH LESS: 4D MATERIALS & PRINTING 4 A SMARTER FUTURE

Mahdi Bodaghi
Nottingham Trent University, UK

Abstract:

Four-dimensional (4D) printing combines additive manufacturing, smart materials and structural design to create components that change shape or mechanical behaviour after fabrication. This keynote presents a challenge-driven approach to designing 4D-printed thermo-mechanical metamaterials that deliver improved functionality with reduced material and energy use. The discussion first introduces hot and cold programming routes for shape-memory polymers and explains how material selection, geometry, stimulation and manufacturing method interact to determine performance. It then examines architected structures designed for quasi-constant-force response and quasi-zero stiffness, enabling controlled force transmission, vibration isolation and energy absorption. Representative applications include recoverable metamaterial boat fenders, bio-inspired meta-stabilisers with programmable multidirectional vibration isolation, and quasi-zero stiffness meta-structures developed for vehicle battery protection. The presentation also explores sustainable 3D/4D-printed meta-bio-composites containing bamboo charcoal and continuous natural fibres. These systems combine mechanical reinforcement, flame retardancy, thermomechanical stability, shape recovery and printability within a single material platform. Examples based on PLA, polyamide and fibre-reinforced composites demonstrate how constituent design and metamaterial architecture can work together to achieve multifunctionality. Practical translation remains a priority. The work establishes a practical design philosophy centred on selecting the right material, stimulus, architecture and manufacturing process for the intended application, supporting smarter and more resource-efficient engineering systems.

Biography

Mahdi Bodaghi is an Associate Professor of Smart Materials and Manufacturing in the Department of Engineering at Nottingham Trent University and Founding Director of the 4D Materials & Printing Lab. His research lies at the intersection of smart materials, metamaterials, bio-composites, and advanced 3D/4D printing. He develops programmable materials, architected structures, and sustainable composite systems for applications spanning healthcare, protective equipment, soft robotics, and engineering. He has published more than 360 peer-reviewed papers, and his work has received over 17,800 citations. Dr Bodaghi is a Chartered Engineer and Fellow of the Higher Education Academy. He is Founding Editor-in-Chief of the 4D Printing Journal, co-founder of the 4D Printing Society, and co-editor of the Elsevier book series Smart Materials in Additive Manufacturing. He works closely with academic, clinical, and industrial partners to translate fundamental research into practical technologies and has delivered invited and keynote lectures at major international conferences.

Day 01

3D Printing & Additive Manufacturing

Oral Presentations

3D-PRINTED CONCRETE WITH FAST-SETTING CEMENT (FSC) AND RECYCLED (CDW) SAND: MIX DESIGN, PRINTABILITY, AND PERFORMANCE EVALUATION

Mohammad Irshidat, Umar Amjad, Naeem Albeitjali and Muni R Maurya
Center for Advanced Materials, Qatar University, Qatar

Abstract:

Three-dimensional concrete printing (3DCP) has gained considerable attention in the construction industry in recent years. The technology offers real advantages in construction speed, design flexibility, and material efficiency. A central challenge in extrusion-based printing is balancing workability during pumping with rapid stiffening after deposition. Fast-Setting Cement (FSC) addresses this need by promoting early strength gain. Managing construction and demolition waste (CDW) responsibly has also become an industry priority. Incorporating recycled fine aggregate from CDW into printable construction material is a valuable step towards sustainable construction.

This study examines FSC combined with recycled CDW sand in extrusion-based 3D concrete printing. Five mortar mixtures were developed. Recycled sand replaced natural sand at levels from 0% to 100% substitution. The binder system included fly ash and silica fume alongside the FSC. A chemical accelerator, a superplasticizer, and a modest dosage of polypropylene fibres were incorporated. A constant, water-to-binder (W/B) ratio was maintained throughout mixing process.

Fresh-state performance was characterized through flow table testing and setting time measurements. Flow values declined progressively with increasing recycled sand content. This is attributed to the higher surface area and angular morphology of recycled particles. Setting times shortened with higher substitution yet stayed within an acceptable range/window for continuous extrusion. Buildability and dimensional accuracy were assessed by measuring layer height and width across all consecutively printed layers.

Compressive and flexural strengths were measured at three days and at twenty-eight days. At three days, a moderate substitution level produced the highest compressive and flexural strength, both exceeding the control. At twenty-eight days, a mid-range substitution level yielded peak compressive strength. A higher substitution level produced the greatest flexural strength. These trends suggest that recycled fine particles contribute to pore refinement and improved interfacial transition zone (ITZ) quality in the printed mortar.

This study confirms that FSC with recycled CDW sand are suitable for extrusion-based 3D concrete printing. Printability, buildability, and dimensional accuracy were maintained at substitution levels. Mechanical performance was preserved and, in several cases, improved relative to the control mixture. The findings offer practical mix design guidance for the additive construction community. They also support wider efforts to incorporate waste-derived materials into 3D concrete printing.

Biography

Mohammad R. Irshidat is the Director of the Center for Advanced Materials (CAM) and a Professor of Construction Materials at Qatar University (QU). He earned his Ph.D. in Civil Engineering from the University of Mississippi, USA, in 2010. Following his doctoral studies, he served as a Postdoctoral Research Associate with the Nano Infrastructure Research Group at the same institution. Before joining Qatar University in 2018, Dr. Irshidat was a faculty member in the Department of Civil Engineering at Jordan University of Science and Technology (JUST), where he held the position of Assistant Professor from 2011 to 2016 and Associate Professor from 2016 to 2018. During his tenure at JUST, he also served as the Assistant Dean for Research from 2014 to 2017. Dr. Irshidat' s research is primarily focused on applied projects in the areas of sustainable construction materials, 3D printable concrete, nanotechnology applications in structural engineering, and the strengthening and rehabilitation of reinforced concrete structures. He has published extensively in high-impact academic journals, peer-reviewed conference proceedings, and presented at numerous international conferences. He maintains an active research portfolio, collaborating with researchers at Qatar University and several international institutions. Dr. Irshidat has supervised a wide range of graduate students, postdoctoral fellows, visiting scholars, and undergraduate researchers. He is also an experienced educator, having taught multiple courses at both undergraduate and graduate levels.

HIGH-CONDUCTIVITY MXENE-BASED 3D MICROSTRUCTURES FOR BIOSENSING APPLICATIONS

Farnaz Rezaei, Cacie McDorman, Rickard Shen and Stefan Johansson
Uppsala University, Sweden

Abstract:

The development of next-generation biosensors relies on conductive materials that combine high electrical performance with large surface areas for efficient biomolecular interactions. While Ti_3C_2 MXene offers excellent electrical conductivity and favorable surface properties, the fabrication of high-resolution three-dimensional architectures for biosensing remains challenging. In this work, we demonstrate the use of near-collector electroprinting, a technique developed in our laboratory, for the fabrication of conductive 3D microstructures based on MXene-containing inks. Near-collector electroprinting was performed using a grounded syringe and a conductive substrate connected to a high-voltage source. A conductive ink composed of PEDOT:PSS, polyethylene oxide (PEO), and Ti_3C_2 MXene was deposited through an 80 µm glass nozzle at an applied voltage of 500 V and a nozzle-to-substrate distance of 10 µm. The process enabled the fabrication of well-defined multilayer architectures with fiber widths down to 3 µm and a pitch of 40 µm. The incorporation of Ti_3C_2 MXene resulted in an electrical conductivity of approximately 117 S cm^{-1}. To evaluate the biofunctional properties of the structures, dextran sulfate was incorporated into the printed architectures to promote protein binding. Functional performance was assessed using FITC-labeled bovine serum albumin (BSA). Attachment and release studies demonstrated reversible protein interactions, yielding a released BSA concentration of 198 ± 45 µg mL^{-1}, corresponding to a molar ratio of 107 ± 24% relative to dextran sulfate. These results demonstrate the combination of high-resolution fabrication, electrical conductivity, and biofunctional capability highlight near-collector electroprinting as a powerful enabling technology for advanced biosensors, biointerfaces, and future personalized diagnostic systems.

Biography

Farnaz Rezaei is a postdoctoral researcher specializing in advanced manufacturing, bioelectronics, and biosensor development. Her research focuses on the design and fabrication of high-resolution.

INFORMED CONSENT FOR ORGAN BIOPRINTING AND TRANSPLANTATION. A COMPARISON BETWEEN ETHICS AND PATIENT PERSPECTIVE

Elena Salvaterra[1] and Alice Vendramin Bandiera[2]
[1]Europa Uomo, Switzerland and National Coalition of Independent Scholars, USA
[2]Adoces Federation, Italy

Abstract:

Introduction: Since the first bioartificial organ transplant performed in 1999 by Atala and colleagues, bioprinting and regenerative surgery have made giant leaps forward. Recently, the clinical implementation of Lantidra (donislecel-jujn) has reached a pivotal stage, moving from a novel regulatory approval to an active medical procedure in the United States.

Though the widespread nature of this treatment is qualified by the complexity of the procedure and the specific patient population it serves, this is the first FDA-approved allogeneic islet cell therapy for Type 1 Diabetes (T1D). While its birthplace was Chicago (UI Health), this treatment was then performed in other specialized centers in the US. This recent advance in bioprinting and regenerative surgery raises attention to ethical, legal, and social issues that can no longer be delayed.

Methods and Results: According to the current literature, these technological progresses give rise to the urgent need to define pivotal ethical and legal principles and practices related to patients' informed consent and the exercise of their rights of autonomy throughout the complex process of constructing the biocomponent for transplantation. Ethical and legal issues, as well as social and anthropological ones of primary importance, come into play:

· The definition of the process itself aimed at treatment via bioartificial organ transplantation (uniquum technological process of human body part creation)

· The question of ownership: who owns the transplanted bioartificial organ (in the case of an allogeneic origin of the human cells used)?

· Data ownership: the rights over data acquired through digitalization.

·The right to patient autonomy: this translates into a specific form and process of informed consent covering every stage, from the initial tissue sample collection (to derive stem cells for the bioconstruct fabrication) to the digitalization of the anatomical body part, the development of bioink, the 3D/4D printing of the organ, and its incubation until the final transplant.

Discussion: For each of these phases, specific ethical-legal problems arise, centered on the common transversal issue of what information should be provided to the patients to ensure truly informed consent. In other words, the central emerging practical question is what type of informed consent should be employed for bioartificial organ development and transplantation.

Correspondingly, questions arise regarding the sufficiency of traditional ethical principles—given the peculiarity and complexity of this practice—or the need for their revision, if not the eventual introduction of new principles that contribute to the construction of a properly "digital bioethics."

Focusing on the most concrete and immediate aspect, this work intends to delve into the theme of informed consent for bioprinting organ transplantation, taking into account the importance of involving patients in expressing their opinions, feelings, and will. Regarding the latter, this abstract aims to present the most significant findings of a recent exploratory pilot study conducted by the authors, investigating patient knowledge, awareness, perceptions, and expectations concerning bioprinting and transplantation

Biography

Elena Salvaterra after the degree in Law and the PhD in Ethics of Science, Elena Salvaterra worked as researcher in several institutions in Italy and abroad. Since the 2014, she has been working as independent researcher. Her most recent studies are about the ethical and legal aspects of human biofabrication at the cross between biomedical science and AI. Author of books and papers, she cultivates the passion for the photography and the arts.

FEATURES OF THE TI6AL7NB PARTS PRODUCED VIA THE LASER POWDER BED FUSION (LPBF) METHOD BY USING DIFFERENT LASER SCANNING SPEEDS

Azade YELTEN COŞKUN
Istanbul University-Cerrahpaşa, Türkiye

Abstract:

Metallic biomaterials, as a class of biomaterials, are extensively used in orthopedic and dental applications. Ti6Al7Nb is a relatively new Ti alloy for biomedical studies compared with the more commonly preferred Ti6Al4V alloy. Concerns about the presence of V in Ti6Al4V have led researchers to work with alloys that exhibit not only higher corrosion resistance and mechanical durability but also other critical properties, such as safer alloying elements, e.g., Nb. Since Nb does not cause undesirable tissue reactions and the Ti6Al7Nb alloy is more ductile than the Ti6Al4V alloy, so that it can be formed into complex shapes more practically, Ti6Al7Nb becomes an advantageous candidate for hard tissue implants. In this context, Ti6Al7Nb samples were fabricated via additive manufacturing using the Laser Powder Bed Fusion (LPBF) method, which enables the production of parts one-to-one compatible with the sample's computer-aided design. In the manufacturing process, different laser scanning speeds were used to evaluate the effect of this fundamental process parameter on the physical, microstructural, and mechanical properties of the resulting Ti6Al7Nb parts by conducting density measurements, optical microscopy, scanning electron microscopy (SEM) observations, and hardness tests.

Acknowledgement: This work was supported by the Scientific and Technological Research Council of Türkiye under the project TÜBİTAK 3501 – Career Development Program, Project No. 125M877.

Biography

Azade Yelten Coşkun graduated as the valedictorian of the Department of Metallurgical and Materials Engineering at Istanbul University (IU) in 2008. She received her M.Sc. and Ph.D. degrees in the same department in 2011 and 2017, respectively. She conducted her postdoctoral research at Middle East Technical University (METU) under the TÜBİTAK BİDEB 2218 - National Postdoctoral Research Fellowship Program in 2021-2022. She has been working as an Assistant Professor in the Faculty of Engineering, Istanbul University-Cerrahpasa since 2024. Her research fields include bioceramic powder synthesis, surface modification of metallic biomaterials, and production of biomaterials via additive manufacturing.

THERMAL-HISTORY ENGINEERING OF LPBF-PROCESSED FE-BASED SOFT MAGNETS THROUGH SEQUENTIAL LASER EXPOSURE

Merve Gizem Özden[1] and Nicola A Morley[2]
[1]Department of Mechanical Engineering, Erzurum Technical University, Türkiye
[2]Department of Materials Science and Engineering, University of Sheffield, UK

Abstract:

The manufacture of geometrically complex soft-magnetic components by laser powder bed fusion (LPBF) remains challenging because the thermal conditions required to achieve high densification may simultaneously promote crystallization and microstructural coarsening, thereby deteriorating magnetic softness. This contribution examines how deliberate modification of the layer-scale thermal history through sequential laser exposure can be used to balance densification and magnetic performance in an Fe-Si-B-Cr-C soft-magnetic alloy. Cylindrical specimens were fabricated by LPBF using combinations of laser power, scanning velocity and hatch spacing selected to generate sufficient energy input for consolidation. Each layer was subsequently subjected to an additional low-energy laser exposure before deposition of the next powder layer. Rather than considering volumetric energy density alone, the results are interpreted in terms of the thermal sequence experienced by the previously consolidated material and its influence on melt-pool morphology, microstructural refinement and magnetic response. The sequential exposure strategy produced a pronounced change in the relationship between processing conditions and functional properties. Depending on the primary processing parameters, relative densities between approximately 94.6 and 99.3% were obtained, while saturation magnetization reached 226.8 $A \cdot m^2 \cdot kg^{-1}$. Most notably, coercivity was reduced to 130 $A \cdot m^{-1}$ under conditions combining relatively low primary laser power with subsequent low-energy rescanning. Microstructural observations indicate that these improvements cannot be attributed solely to increased densification. Changes in melt-pool fraction and refinement of the α-Fe(Si)-rich microstructure also strongly affect domain-wall motion and therefore the resulting soft-magnetic behavior. These findings highlight the importance of treating laser scanning history as an independent process-design variable when additively manufacturing soft-magnetic alloys. A sequential thermal-management strategy provides a route for partially decoupling the competing requirements of high consolidation and microstructural refinement and may therefore facilitate the production of complex magnetic components with improved functional performance.

Biography

Merve Gizem Özden is an Assistant Professor in the Department of Mechanical Engineering at Erzurum Technical University, Türkiye. She received her PhD from the University of Sheffield, where her research focused on the laser powder bed fusion of Fe-based nanocrystalline soft-magnetic alloys. Her work examines the relationships among additive-manufacturing parameters, thermal history, microstructure, densification, and magnetic performance. She currently leads a TÜBİTAK 3501 project on process optimization and microstructural control of additively manufactured Fe-based soft magnets, integrating experimental characterization with machine-learning-assisted predictive modelling. Her wider research interests include amorphous and nanocrystalline magnetic materials, functional metallic materials, magnetic characterization, and the development of complex components for electrical-machine and antenna applications. Through international collaborations, she also investigates extrusion-based additive manufacturing routes for sustainable, rare-earth-free soft-magnetic alloys. She has contributed to interdisciplinary research spanning materials processing, magnetic measurements, data-driven modelling, and engineering applications. Her research aims to translate process-structure-property understanding into practical manufacturing strategies for energy-efficient electromagnetic devices.

OPTIMIZATION OF LASER POWDER BED FUSION PROCESS PARAMETERS FOR IMPROVING THE WEAR RESISTANCE OF H13 TOOL STEEL

Mustafa Seviml[1,2] and Binnur Sagbas[1]
[1]Department of Mechanical Engineering, Yildiz Technical University, Türkiye
[2]Digimode Bilisim,Türkiye

Abstract:

Laser Powder Bed Fusion (L-PBF) enables the fabrication of H13 hot-work tool steel components with complex geometries and conformal cooling channels; however, their tribological performance is strongly affected by process-induced microstructural variations, defects, and service conditions. This study investigates the influence of laser power, scan speed, and build orientation on the sliding wear behavior of heat-treated H13 tool steel produced by L-PBF. Nine parameter combinations were designed using a Taguchi L9 orthogonal array. Laser power varied at 300, 330, and 360 W; scan speed at 850, 900, and 950 mm/s; and build orientation at 30°, 60°, and 90°. Specimens were manufactured on an EOS M290 system, heat treated by austenitizing at 1010 °C followed by controlled gas cooling and three tempering cycles, and machined into disks with a diameter of 15 mm and a thickness of 4 mm. Ball-on-disk wear tests were conducted under dry and lubricated conditions using a 6 mm Al_2O_3 counterbody, a normal load of 10 N, and a total sliding distance of 509 m. Specific wear rates were determined from mass loss and measured density. Taguchi signal-to-noise analysis and analysis of variance (ANOVA) were used to rank the effects of the investigated parameters, while optical microscopy was employed to evaluate the dominant wear mechanisms. Under dry sliding, the specific wear rate ranged from 7.78×10^{-6} to 5.70×10^{-5} $mm^3/(N{\cdot}m)$. The specimens produced at 300 W exhibited the highest wear rates, whereas several parameter sets produced at 330 and 360 W showed substantially improved wear resistance. Excluding one lubricated specimen that exhibited apparent mass gain, the mean lubricated specific wear rate was approximately 6.16×10^{-6} $mm^3/(N{\cdot}m)$. Taguchi analysis identified laser power as the dominant factor, followed by scan speed and build orientation. ANOVA confirmed that laser power was the only statistically significant parameter ($p = 0.005$). The predicted optimum condition for minimum wear was 330 W laser power, 900 mm/s scan speed, and 30° build orientation. Optical microscopy revealed abrasion-dominated mixed wear under dry sliding and a milder film-controlled wear regime under lubrication. These results demonstrate that the tribological performance of L-PBF H13 tool steel can be improved through appropriate process-parameter selection and lubrication.

Acknowledgment: This study was supported by the Scientific Research Projects Coordination Unit of Yildiz Technical University under Project No. FYL-2024-6246.

Biography

Mustafa Sevimli is a metallurgical and materials engineer and a mechanical engineer working in the field of metal additive manufacturing. He received his bachelor's degree in metallurgical and materials engineering from Eskisehir Osmangazi University and his master's degree in mechanical engineering from Yildiz Technical University, Türkiye. His research focuses on laser powder bed fusion of tool steels, process-parameter optimization, heat treatment, mechanical characterization, and tribological performance. In his recent work, he investigated the influence of laser power, scan speed, and build orientation on the wear behavior of H13 hot-work tool steel using Taguchi experimental design and analysis of variance. He is also affiliated with Digimode Bilisim, where he works on the industrial implementation of additive manufacturing technologies, including technical evaluation, application development, and collaboration with manufacturing companies. His professional interests include metal additive manufacturing systems, design for additive manufacturing, process qualification, post-processing, and the transfer of laboratory-scale research into industrial applications. He aims to contribute to the development of reliable and application oriented.

ENHANCEMENT OF TRIBOLOGICAL AND CORROSION PERFORMANCE OF SLM ADDITIVELY MANUFACTURED TI6AL4V VIA NOVEL HIP POST-PROCESSING

Alperen Kaya[1,2], Faiz MUHAFFEL[3], Hüseyin AYDIN TÜBİTAK[4], Özkan GÖKÇEKAYA[5], Takayoshi NAKANO[5] and Hakan YILMAZER[6]

[1]Graduate School of Natural and Applied Sciences, Yıldız Technical University, Türkiye
[2]Department of Metallurgical and Materials Engineering, Ankara Yildirim Beyazit University, Türkiye
[3]Department of Metallurgical and Materials Engineering, Istanbul Technical University, Türkiye
4Marmara Research Center (MAM), Materials Institute, Materials and Process Technologies Research Group, Türkiye
[5]Graduate School of Engineering, Department of Materials and Manufacturing Science, Anisotropic Design and Additive Manufacturing Research Center, Osaka University, Türkiye
[6]Faculty of Chemical and Metallurgical Engineering, Department of Metallurgical and Materials Engineering, Yıldız Technical University, Türkiye

Abstract:

Ti6Al4V (Ti64) alloys are widely used in biomedical and aerospace applications due to their high specific strength and excellent corrosion resistance. However, increasing demands for high-performance parts with complex geometries limit the use of conventional manufacturing methods. In this context, additive manufacturing (AM) enables fabrication of Ti64 components with reduced material waste and high design flexibility. Among powder bed fusion (PBF) techniques, Selective Laser Melting (SLM) and Electron Beam Melting (EBM) are the most commonly used processes. EBMTi64 typically shows higher internal defects such as gas porosity and lack-of-fusion, while SLM parts generally exhibit higher strength and better surface quality. However, achieving fully dense SLMTi64 is not always possible. Rapid solidification and high thermal gradients lead to a dominant α' martensitic microstructure and promote anisotropic columnar grains. Therefore, post-processing treatments are widely applied to improve SLMTi64 performance. Although heat treatments have been extensively studied for strength–ductility optimization, their effects on wear and corrosion behavior remain limited.

In this study, a novel two-step HIP-tempering process was applied to SLMTi64 samples produced at 37.5 J/mm³ energy density to enhance the mechanical and tribological properties of as-built material, which exhibited the highest relative density and mechanical performance in our previous work. First, samples were β-annealed and water quenched. Then, HIP tempering was performed at pressures between 0 and 100 MPa. Microstructural evolution was analyzed using OM, SEM, and XRD. Density, hardness, wear, and corrosion properties were evaluated using Archimedes method, Vickers microhardness, ball-on-disk wear tests, and potentiodynamic polarization in 3.5 wt.% NaCl solution, respectively.

Results showed that increasing energy density reduced internal defects and improved density and mechanical properties, especially for SLMTi64 samples. XRD and microstructural results confirmed that the as-built and quenched states were dominated by α' martensite, while HIP treatment transformed the structure into α+β basket-weave and lamellar Widmanstätten morphologies. Increasing HIP pressure further decreased porosity and enhanced densification. Although, hardness generally decreased with increasing HIP pressure, the HIP100 condition showed the highest hardness among tempered specimens due to reduced porosities and a higher fraction of α colonies. The HIP100 sample exhibited the best wear resistance, which correlated with hardness, density, and surface morphology. In addition, HIP treatments at 100 MPa and below better corrosion behaviour compared to the as-built condition, attributed to a more stable TiO_2 passive layer and reduced galvanic activity. Overall, the proposed two-step HIP-tempering strategy significantly improves the tribological and corrosion performance of SLMTi64 alloys.

Keywords: Ti6Al4V, Additive Manufacturing, Selective Laser Melting, Hot Isostatic Pressing, Heat Treatment, Wear Properties, Corrosion Behaviour.

Acknowledgment: The authors gratefully acknowledge TÜBİTAK-BİDEB for the scholarship support provided under the 2210-C Priority Areas Domestic Master's Scholarship Program.

Biography

Research Assistant Alperen Kaya was born in Ankara, Türkiye. He obtained his bachelor's degree in metallurgical and Materials Engineering from Yıldız Technical University in 2024. He is currently pursuing a thesis-based Master's degree in Materials Science at the same university. He is also working as a Research Assistant in the Department of Metallurgical and Materials Engineering at Ankara Yıldırım Beyazıt University. His academic interests are driven by a strong motivation to understand the fundamental nature of materials. His current research focuses on the additive manufacturing of titanium alloys and the control of microstructure and phase transformations through heat treatment processes. He is also involved in experimental studies on advanced manufacturing methods and post-processing of metallic materials. He has experience in microstructural characterization techniques such as optical microscopy (OM), scanning electron microscopy (SEM), and X-ray diffraction (XRD). His long-term goals include specializing in physical metallurgy, thermomechanical processing, and advanced post-processing techniques; gaining expertise in advanced characterization methods such as TEM and EBSD; publishing in high-impact international journals; and contributing to commercially applicable R&D projects.

ANALYSIS OF SURFACE ROUGHNESS IN WIRE EDM MACHINING OF ADDITIVE MANUFACTURING 316L COMPONENT

Mehmet Erdi Korkmaz[1], Salih Güvercin[2] and Mustafa Günay[3]
[1]Department of Mechanical Engineering, Yildiz Technical University, Istanbul, Türkiye
[2]Vocational School of Technical Sciences, Amasya University, Amasya, Türkiye
[3]Department of Mechanical Engineering, Karabük University, Karabük, Türkiye

Abstract:

To ensure the desired quality criteria in terms of dimensional accuracy and surface integrity of parts produced by metal additive manufacturing methods, or to remove support structures, post-processing methods are required. For this purpose, conventional and unconventional machining methods are frequently used. In this study, the variation of surface roughness in wire electrical discharge machining (WEDM) of a 316L stainless steel part produced by selective laser melting (SLM) technique was analyzed according to machining parameters. WEDM experiments were performed in a deionized water environment using three different pulse durations (Ton), table feed rates (f), and wire speeds (Wf). The average surface roughness (Ra) measured as a result of the experiments conducted according to the L9 experimental design was analyzed. In general, it was observed that Ra results increased with increasing pulse duration and table feed rate, and decreased with increasing wire speed. Within the scope of the current machining parameters, Ra values were obtained in the range of 8.3-10 µm. When the cut surfaces were examined, it was understood that the disruption of the discharge balance due to the microporous structure of the SLM part negatively affected the surface quality. According to the variance analysis results, the most influential parameter on surface roughness was found to be the Ton parameter with 66.94%. It was determined that for the lowest Ra value, the shortest pulse duration and table feed rate, and the highest wire speed should be used. Furthermore, it is predicted that surface quality can be improved by applying a multi-cutting strategy in WEDM technology.

Keywords: Additive manufacturing, SLM, 316 L, surface roughness, WEDM.

Biography

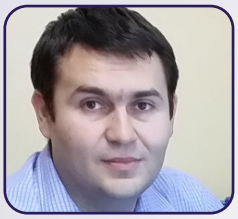
Mehmet Erdi Korkmaz is an Associate Professor in the Department of Mechanical Engineering at Yıldız Technical University in Istanbul.

Day 02

3D Printing & Additive Manufacturing

Keynote Presentations

HEALING BY DESIGN: HOW STEM SHAPES PERSONALIZED MEDICINE



Anton FICAI[1,3], Andreea-Isabela LAZAR[1], Denisa FICAI[2,3], Sorin HARIGA[4], Oguzhan GUNDUZ[5], Cem Bulent USTUNDAG[6], Zehra Betül AHI[7], Erwann GUÉNIN[8] and Christophe EGLES[9]

[1]Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Chemical Engineering and Biotechnology, National University of Science and Technology Politehnica Bucharest, Bucharest, Romania

[2]Department of Inorganic Chemistry, Physical Chemistry and Electrochemistry, Faculty of Applied Chemistry and Materials Science, National University of Science and Technology Politehnica Bucharest, Bucharest, Romania

[3]Academy of Romanian Scientists, Bucharest, Romania

[4]University of Medicine and Pharmacy Carol Davila, Bucharest, Romania

[5]Center for Nanotechnology & Biomaterials Application and Research (NBUAM); Department of Metallurgical and Materials Engineering, Faculty of Technology, Marmara University, Turkey

[6]Health Biotechnology Joint Research and Application Center of Excellence; Department of Bioengineering, Faculty of Chemistry and Metallurgy, Yildiz Technical University, Davutpasa Istanbul, Turkey

[7]Kazlı Çeşme Deri Ürünleri Ar-Ge San. Tic. Ltd. Şti.; İstanbul Deri OSB, Turkey

[8]Université de Technologie de Compiègne, France

[9]Univ Rouen Normandie, INSA Rouen Normandie, CNRS, Normandie Univ, Polymères Biopolymères Surfaces (PBS) France

Abstract:

In this presentation, we will focus our attention to the technological tools used to develop new or enhanced materials for biomedical applications. The study case will be mainly focussed on the tissue engineering of bone and nerve tissue considering the natural tissue compositions and functions. Based on the biomimicry approach, composite materials based on polymers and graphene-related materials will be used for nerve regeneration while Collagen / Hydroxyapatite composite materials will be considered for bone regeneration. Looking into the literature, graphene-related materials are increasingly used in many medical and non-medical applications, alone or associated with specific polymers including collagen, gelatine, chitosan, silk fibroin, etc. Their use is justified especially considering the special biological, chemical, mechanical and electric properties, including several studies to get nerve grafts, acting not only as a support for the cells but also to take some of the functionalities of the nerves. In nerve regeneration, all these properties are essential and, especially graphene oxide can fulfil all the requested characteristics, including the electric stimulation for the regeneration purpose or the electric triggering capacity for controlling the release rate of the biological active agents loaded into these grafts; the tuneable hydrophil/ hydrophobe ratio, which is especially important in the delivery but also in the biocompatibility; etc. For bone grafting, a wide range of materials are used, some of them being bioinert while other are resorbable, from metals and alloys to tissue engineered nanocomposite materials.

Biography

Anton FICAI (born 1981) is full professor and PhD advisor in the Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest being actively involved in both academic and scientific life of the university. His major academic interests are related to Composite Materials for Medicine, NanoBioMaterials for Tissue Engineering, Coatings and Chemical Surface Modification, and Drug Delivery Systems. Till now, over 400 scientific papers, from which over 350 ISI papers and 24 books or chapters (including 3 edited books) were published along with 14 issued patents. The international recognition of the R&D activity can be highlighted by the multiple invitations for participate as speaker at international conferences, the positions of guest editors, member of the editorial boards of different national and international journals as well as Section Editor in Chief of Coatings. Valedictorian of UPB, former participant and laureate of the National Chemistry Olympiads he was awarded with over 150 Gold Medals, Special Awards or Best Paper Awards and included in the most relevant rakings such as Top 2% Scientists, Stanford, AD Scientific Index, Research.com, etc.. He is also full member of The Academy of Romanian Scientists and several professional societies.

ON THE VALIDATION OF THE NUMERICAL MODELING OF THERMO-MECHANICAL MANUFACTURING PROCESSES

Boris Jalušić[1], Sanja Šolić[1], Marin Vukovojac[2], Tomislav Lesičar[2], Zdenko Tonković[2], Karlo Murković[1] and Vlado Tropša[1]
[1]University North, Department of Mechanical Enginnering, Croatia
[2]Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia

Abstract:

Manufacturing processes involving intense localized heating and cooling, for example, fusion welding and Additive Manufacturing (AM) have thermal and mechanical behaviour. Non-uniform temperature fields associated with these processes cause thermal expansion, plastic deformation, residual stress and geometrical distortion in the manufactured components. An understanding of how temperature and stresses interact is required to optimize process efficiency, component quality and structural performance. Fusion welding remains one of the most widely used joining processes due to its cost effectiveness and high productivity, while at the same AM offers tremendous design flexibilities through fabrication of complex parts by using a layer-by-layer methodology from a 3D digital model. There is a continuous demand on the development of AM and welding for advanced engineered application, hence a reliable tool is greatly required to predict the results of these processes for optimization and defect prevention.

Finite element analysis (FEA) has quickly become a very valuable tool for analyzing coupled thermo-mechanical responses of manufacturing processes. Herein, the commercial simulation environments Ansys and Abaqus are used to model welding and additive manufacturing with focus on determination of residuals stresses, strains and distortions. The numerical simulation approach consists of firstly solving the transient thermal analysis, and subsequently the mechanical analysis. Thus, thermal solution history with temperature dependent material properties has to be sequentially transferred as load to the mechanical analysis. This approach provides a good compromise between the accuracy of the numerical results and simulation performance. Predictions of temperatures, residual stresses, distortions and thermal gradients formed during manufacturing processes are obtained through simulations. Therein, the technique of layer activation is employed in the case of AM, enabling the layer-by-layer deposition which directly affects the formation of stresses. Hence, the models deliver in-depth information about process induced effects and provide an effective tool to improve quality, lowering defects and optimizing manufacturing settings.

Validation is an important aspect for the development of the thermo-mechanical finite element models for manufacturing processes. Numerical predictions have to be compared with experimental results taken during welding or AM processes. Validation within Ansys and Abaqus is undertaken by comparing the simulated thermal histories at certain locations within the component with thermocouple measurements. Predicted distortion values are compared to the ones obtained using digital image correlation (DIC) techniques. In addition, the obtained residual stress fields are verified by using experimental measurements from the scientific litera-

ture. With good agreement of the numerical results with the experimental measurements, it can then be shown that the material properties, coupled with the heat source parameters and boundary conditions, as well as the chosen coupling strategy are suitable to model the manufacturing process.

Biography

Boris Jalušić is an Assistant Professor at the Department of Mechanical Engineering, University North, Varaždin University Center, Croatia. He obtained his PhD at the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia. His research activities are primarily focused on the development and application of advanced numerical methods for structural and material modeling. These include models and algorithms based on the finite element method (FEM) and meshless methods for numerical simulation of welding processes in thick-walled structures, as well as phase-field approaches for damage modeling in pre-welded components. He has also developed mixed Meshless Local Petrov–Galerkin (MLPG) collocation algorithms for the analysis of classical and gradient elasticity with particular emphasis on heterogeneous materials. More recently, his scientific contributions extend to the field of additive manufacturing, where he develops and applies numerical simulation techniques to predict and optimize process–structure–property relationships.

Day 02

3D Printing & Additive Manufacturing

Invited Talk

CONVENIENCE TO CUSTOMIZED NUTRITION: THE ROLE OF 3D FOOD PRINTING TECHNOLOGIES

Manoj Kumar Patel, Neha Sharma and Sakshi Sukhija
CSIR-Central Scientific Instruments Organisation, India

Abstract:

The growing demand for convenience food has driven researchers to explore advanced manufacturing technologies, leading to the development of personalized food with inherited functional and nutritional requirements of the consumer. 3D food printing has emerged as a transformative approach which is capable of redefining the development of next-generation, customized-convenience foods. Moringa leaves are recognized for their exceptional nutritional composition, being rich in high-quality proteins, dietary fibre, essential amino acids, vitamins and bioactive components with antioxidant potential. The nutritional benefits of moringa leaves can be combined with the flexibility of 3D food printing to tailor functional pasta that supports nutritional security, dietary diversification, and improved consumer engagement. However, advancements in formulation strategies and technological expertise related to rheological behaviour, extrusion stability, print fidelity, texture optimization, and sensory acceptability are required for the development of 3D printed moringa leaves powder-enriched pasta. It also emphasises the influence of ingredient interactions on printability, structural integrity, cooking quality, and nutritional retention. The discussion further explores how digital food manufacturing enables customization of shape, portion size, nutrient composition, and functional attributes according to age, lifestyle, metabolic needs, and health conditions. This approach aligns with the evolving concept of precision nutrition and industrial challenges in the rapidly expanding domain of consumer-centric food design.

Biography

Manoj K. Patel started his research career in charged particulate technology, electro-hydrodynamics of liquid sprays, and the aerodynamics of charged particulate matter. His research interests include food safety and nutrition, 3D Food printing, green energy, electrostatic liquid atomization, airborne charged particulate technology, and surface decontamination. Dr. Patel has received several awards; the most prominent are the Young Achiever Alumnus Award 2024, BRICS Young Scientist Award 2022, CSIR Young Scientist Award 2020, IETE-Hari Ramji Toshniwal Award 2020, IEI Young Engineers Award 2019, NRDC National Societal Innovation Award 2017, and Gandhian Young Technological Innovation (GYTI) Award 2016.

Day 02

3D Printing & Additive Manufacturing

Oral Presentations

INFLUENCE OF RASTER ANGLE, LAYER THICKNESS, AND ABRASIVE FLOW MACHINING ON SURFACE INTEGRITY OF CARBON FIBER REINFORCED PLA COMPONENTS

Omer EYERCIOGLU and Mehmet Ali AKELOGLU
Department of Mechanical Engineering, Gaziantep University, Türkiye

Abstract:

Carbon fiber reinforced polymer filaments are increasingly used in fused deposition modeling (FDM) to improve the mechanical performance of additively manufactured components. The incorporation of carbon fibers into polylactic acid (PLA) enhances stiffness and strength, making these materials attractive for engineering applications. However, fiber reinforcement also introduces challenges related to surface integrity, particularly in parts containing internal channels where conventional finishing methods have limited accessibility. Abrasive flow machining (AFM) offers a promising solution for improving internal surface quality, yet the interaction between fiber-reinforced material behavior, printing parameters, and AFM conditions remains insufficiently explored.

This study investigates the combined effects of raster angle (0°, 45°, and 90°), layer thickness (0.20, 0.28, and 0.36 mm), and AFM process parameters, including abrasive mesh size and abrasive concentration, on the surface integrity of FDM-manufactured PLA+CF cylindrical specimens with internal channels. Surface roughness parameters (Ra and Rz), material removal rate (MRR), and surface morphology were systematically evaluated before and after AFM processing to assess finishing performance under different manufacturing and post-processing conditions.

The results indicate that layer thickness plays a critical role in determining both the initial surface condition and the effectiveness of AFM. Larger layer thicknesses produced more pronounced stair-stepping effects and increased fiber exposure, which altered the interaction between the abrasive media and the composite surface. Although AFM significantly reduced surface roughness in all specimens, different material removal mechanisms were observed depending on abrasive conditions. Fiber pull-out, matrix smearing, micro-cutting, and localized abrasion were identified as the dominant mechanisms governing surface modification.

Compared with neat PLA structures reported in previous studies, PLA+CF specimens exhibited more complex and nonlinear responses to AFM due to their heterogeneous microstructure. Raster angle further influenced the orientation and exposure of fibers, contributing to variations in polishing efficiency and material removal behavior. These findings highlight the importance of simultaneously considering additive manufacturing and post-processing parameters when producing fiber-reinforced polymer components and provide valuable insights for developing optimized hybrid manufacturing strategies for high-performance composite parts.

Keywords: Additive manufacturing, PLA+CF, abrasive flow machining, layer thickness, composite materials, surface integrity, hybrid manufacturing.

Biography

Omer Eyercioglu is a distinguished academic and researcher in the fields of mechanical engineering, manufacturing technologies, materials science, and surface engineering. His expertise encompasses metal forming, advanced manufacturing methods, and surface modification technologies. He serves as a faculty member in the Department of Mechanical Engineering at Gaziantep University and as the Head of the Construction and Manufacturing Division in same department. He has extensive experience in research, teaching, postgraduate supervision, and engineering project management. He has actively participated in numerous university–industry collaboration projects, particularly within the framework of TÜBİTAK 1505 programs, facilitating the transfer of scientific knowledge into industrial practice. His multidisciplinary approach integrates engineering fundamentals with industrial applications, contributing to innovation, process optimization, and the development of advanced manufacturing and material technologies. Through his sustained academic and industrial engagement, he continues to make significant contributions to manufacturing and surface engineering research.

INFLUENCE OF POST-CURING DURATION ON THE MECHANICAL PERFORMANCE OF DLP-PRINTED PHOTOPOLYMER USED IN RAPID TOOLING

Müslüm Ozalp, Omer EYERCIOGLU and Hakan Candar
Gaziantep University, Türkiye

Abstract:

Rapid tooling produced by vat photopolymerization has emerged as an efficient alternative to conventional metal tooling for prototype and low-volume injection molding applications. Among various additive manufacturing technologies, Digital Light Processing (DLP) enables the fabrication of high-resolution mold inserts with relatively short production times and low manufacturing costs. However, the mechanical performance of photopolymer-based tooling is highly dependent on post-processing conditions, particularly ultraviolet (UV) post-curing, which directly influences the degree of polymer cross-linking and consequently the structural integrity of the printed components. Despite its importance, limited studies have systematically investigated the effect of post-curing duration on the flexural behavior of DLP-printed photopolymers intended for rapid tooling applications.

In this study, the influence of UV post-curing time on the flexural properties of DLP-printed TM300 photopolymer resin is experimentally investigated. Flexural specimens were fabricated under identical printing conditions while varying only the post-curing duration. Three-point bending tests were conducted in accordance with ASTM D790 to determine the flexural strength, flexural modulus, maximum deflection, and fracture behavior of the specimens. The obtained results are comparatively evaluated to identify the post-curing condition providing the most favorable balance between stiffness, strength, and fracture resistance.

The findings of this study are expected to establish a practical guideline for selecting appropriate post-curing conditions in the manufacture of DLP-printed rapid tooling inserts. Furthermore, the proposed experimental methodology provides a fundamental framework for future investigations involving printing orientation, wall thickness, thermo-mechanical durability, and mold life assessment of photopolymer tooling used in low-pressure injection molding applications.

Keywords: Additive manufacturing, rapid tooling, post curing, flexural bending.

ASTM D790 FLEXURAL EVALUATION OF FFF-PRINTED POLYCARBONATE PARTS WITH DIFFERENT INFILL DEPOSITION ANGLES

Musa Yilmaz[1] and Necip Fazil Yilmaz[2,3]
[1]Naci Topcuoglu Vocational School, Gaziantep University, Türkiye
[2]Gaziantep University, Department of Mechanical Engineering, Türkiye
[3]Hasan Kalyoncu University, Board of Trustees, Türkiye

Abstract:

Additive manufacturing technologies have been widely used in engineering applications in recent years due to their ability to produce complex geometries with high design freedom. Particularly, the Fused Filament Fabrication (FFF) method is one of the most commonly used additive manufacturing methods for layer-by-layer production of thermoplastic materials. However, the mechanical performance of FFF-printed parts is strongly influenced by several printing parameters, including layer orientation, infill pattern, and filament deposition angle. In this study, the flexural behaviour of polycarbonate (PC) specimens with different line-type infill deposition angles was investigated. Test specimens were designed according to the ASTM D790 standard and fabricated using the FFF method with deposition angles of 0°, 30°, 60°, and 90°. Three-point bending tests were then carried out to evaluate the effect of deposition angle on flexural strength. The obtained results showed that the filament deposition angle has a significant effect on flexural strength. The highest flexural strength was obtained in specimens where the filaments were aligned perpendicular to the load application direction, while mechanical strength was observed to decrease at certain angles due to weakening of interlayer bonding. Additionally, the fracture surfaces of post-failure specimens were examined by scanning electron microscopy (SEM); interlayer bonding, void formation, and fracture mechanisms were evaluated. SEM analyses revealed that layer separation and weak interfacial bonding were more pronounced in specimens exhibiting low strength. The obtained findings demonstrate that filament deposition angle is a critical parameter on the flexural performance and fracture behaviour of PC parts produced by the FFF method.

COMPARATIVE INVESTIGATION OF ADDITIVE AND SUBTRACTIVE MANUFACTURING CONSTRAINTS IN TOPOLOGY OPTIMIZATION OF AEROSPACE COMPONENTS

Ahmet Yağız TURPÇU, Özgür POYRAZ and Ahmet Furkan DEMİR
Department of Mechanical Engineering, Eskişehir Technical, University (ESTU), Türkiye

Abstract:

Lightweight design is essential in aerospace and automotive applications, where mass reduction improves material efficiency, structural performance, fuel economy, and operating costs. Topology optimization (TO) provides a computational framework for maximizing stiffness while minimizing mass by redistributing material according to prescribed loads and boundary conditions. However, unconstrained TO frequently produces complex, organic geometries that are difficult to manufacture. Therefore, manufacturing-specific constraints must be incorporated into the optimization process to balance structural efficiency with manufacturability.

This study presents a comparative investigation of an Inconel 718 aerospace bracket under three optimization conditions: unconstrained, additive manufacturing (AM)-constrained, and subtractive manufacturing (SM)-constrained. A baseline CAD model was defined by separating design and nondesign regions and applying vertical and horizontal loads of approximately 15.5 kN and 18.8 kN. The optimization cases were carried out in Altair Inspire using the Solid Isotropic Material with Penalization (SIMP) method under equivalent loading, boundary conditions, and design-domain definitions. Manufacturing requirements related to self-supporting geometry for AM and tool accessibility for SM were considered. The SM-constrained geometry was further reconstructed using PolyNURBS to obtain a smooth CAD geometry and improve machining accessibility, and the final geometries were reanalyzed by finite element analysis. CAM-based toolpath evaluations were also conducted in HyperMILL. The results show differences in both geometry and structural response among the final designs. The AM-constrained final geometry achieved approximately 63% material reduction, while the SMconstrained final geometry achieved approximately 52.8%. The SM-constrained design showed lower maximum stress, while both designs had similar deformation levels. Based on the final masses and the density of Inconel 718, the calculated material volumes were approximately 32,725 mm^3 for the AM-constrained design and 42,616 mm^3 for the SM-constrained design. LPBF processing times were estimated using a volumetric build rate of 4.2 mm^3/s for Inconel 718 on an EOS M290 system with a 40 μm layer thickness. The estimated LPBF times were 2.16 h and 2.82 h, respectively. Therefore, the estimated LPBF processing time of the SM-constrained geometry was approximately 30% longer because of its larger material volume. In contrast, CAM results showed that the milling post-processing time of the SM-constrained design was approximately 80% shorter because of improved tool accessibility. These results show that the AM-constrained design has an advantage during LPBF, while the SM-constrained design has an advantage during milling postprocessing. Therefore, material reduction, structural response, LPBF processing time, tool accessibility, and post-processing requirements should be evaluated together when selecting a manufacturing-oriented topology optimization approach.

Biography

Ahmet Yağız Turpçu is a fourth-year Mechanical Engineering student at Eskişehir Technical University (ESTU). His academic research, conducted under the supervision of Dr. Özgür Poyraz, focuses on topology optimization, additive and subtractive manufacturing constraints, and the structural analysis of aerospace components. He participated in the 19th Eskişehir Technical University Project Fair and separately received funding support through the TÜBİTAK 2209-A Undergraduate Research Projects Support Program. He gained practical knowledge of precision manufacturing and defense-industry production processes through internships at TEI – TUSAŞ Engine Industries, Inc. and Samsun Yurt Savunma (SYS). He is currently working as a long-term intern at Turkish Technic within the Components Workshops Directorate, where he actively participates in aerospace component manufacturing operations. His research interests include computational design optimization and aerospace manufacturing processes. His work combines numerical methods, manufacturability considerations, and engineering evaluation to support the development of lightweight, production-oriented aerospace structures. He aims to further develop his expertise in advanced manufacturing, finite element analysis, and design for manufacturing.

STRESS-INFORMED FUNCTIONALLY GRADED TPMS INFILL DESIGN FOR A MONOLITHIC SPAR-LESS UAV WING

Hilmi Saygın SUCUOĞLU, Kerem TAN, Pinar DEMIRCIOGLU and Ismail BOGREKCI
Department of Mechanical Engineering, Faculty of Engineering, Aydın Adnan Menderes University, Aydın, Türkiye

Abstract:

Reducing structural mass while maintaining sufficient stiffness is an important objective in the design of small unmanned aerial vehicle (UAV) wings, since structural weight directly affects payload capacity and endurance. Conventional wings generally use discrete spars and ribs to transfer aerodynamic loads. Additive manufacturing, however, permits continuous internal geometries whose material distribution can be varied according to local structural demand. This study investigates a monolithic spar-less UAV wing concept in which the outer skin and a functionally graded Triply Periodic Minimal Surface (TPMS) core jointly carry the applied loads. A computational workflow combining finite element analysis and implicit volumetric modeling was developed for the proposed design. The wing was evaluated under representative static bending and distributed aerodynamic lift loads. Von Mises stress and principal stress distributions from the initial analysis were used to identify load-critical regions and define a spatial grading field. Gyroid and Schwarz Diamond topologies were examined as internal core alternatives. Their relative density, wall thickness, and unit-cell dimensions were varied across the wing volume, with comparatively dense regions placed near the wing root and more porous regions toward the wingtip. The resulting functionally graded configurations were compared with uniform TPMS infills and a conventional rib-spar model under equivalent material definitions, loading conditions, and boundary constraints. Structural performance was assessed using mass, stress distribution, deformation response, and specific bending stiffness. Within the investigated numerical cases, the functionally graded TPMS configurations produced mass reductions of up to 28% relative to the reference models while providing a more uniform stress distribution and favorable specific bending stiffness. The results indicate that stress-informed grading can improve material utilization without relying on discrete internal spars. Nevertheless, the findings are limited to the selected geometry, material model, and static loading conditions. Experimental testing is required to verify stiffness, strength, and failure behavior under representative service conditions. The continuous TPMS core may also reduce internal support requirements during additive manufacturing, although print orientation, minimum wall thickness, process-induced anisotropy, dimensional accuracy, and post-processing access must be considered for the selected manufacturing process. Overall, the study presents a feasible numerical design route for lightweight, additively manufactured UAV wing structures.

Keywords: UAV wing, functionally graded TPMS, finite element analysis, implicit modeling, additive manufacturing, lightweight design.

Biography

Hilmi Saygın Sucuoğlu is an Associate Professor in the Department of Mechanical Engineering at Aydın Adnan Menderes University, Türkiye. His academic and professional work focuses on mechanical design, product development, finite element analysis, topology optimization, additive manufacturing, and artificial intelligence-assisted engineering. He has experience developing parametric CAD models, conducting structural simulations, and translating design concepts into prototype-ready engineering solutions. His research includes lightweight structures, robotic systems, UAV components, industrial equipment, and machine learning-based surrogate models for mechanical performance prediction. In addition to academic research and teaching, he has contributed to a broad range of product development projects involving manufacturability, material selection, assembly design, and design for additive manufacturing. He uses integrated digital workflows that combine CAD, simulation, optimization, and prototyping to evaluate engineering concepts systematically. He also participates in academic peer review and supervises engineering research and student projects. His current work also examines lightweight internal structures for additive manufacturing.

REDESIGN OF COLLAPSIBLE STEERING COLUMNS USED IN AUTOMOTIVE APPLICATIONS BASED ON LATTICE STRUCTURES: EVALUATION OF ENERGY ABSORPTION PERFORMANCE USING FINITE ELEMENT ANALYSIS AND EXPERIMENTAL METHODS

Aysenur Aydin and Mehmet Ali Bayrak
Yıldız Technical University, Türkiye

Abstract:

Collapsible steering columns play a critical role in protecting the driver during frontal collisions by absorbing impact energy while maintaining sufficient stiffness under normal operating conditions. In this study, a conventional energy-absorbing component of an automotive collapsible steering column is redesigned using lattice structures to improve its energy absorption capability while maintaining a lightweight design [1]. Different lattice geometries are investigated based on their mechanical response and energy absorption performance. Lattice unit cells are generated using nTop and subsequently evaluated in ANSYS Material Designer through representative volume element (RVE)-based homogenization to obtain their effective mechanical properties. The resulting properties are implemented in finite element models to evaluate the deformation behavior, stress distribution, and energy absorption characteristics of the proposed lattice designs. For experimental validation, different lattice configurations are additively manufactured using polylactic acid (PLA) and subjected to compression tests to experimentally characterize their energy absorption performance and deformation behavior. The experimental results are compared with the numerical predictions to assess the accuracy of the finite element models and identify the most promising lattice configuration for collapsible steering column applications. In addition to their structural and energy absorption advantages, the digitally defined lattice geometries offer potential benefits for spare-part supply, enabling components to be manufactured on demand and potentially reducing inventory requirements, lead times, and logistical constraints. The proposed approach therefore provides a potential pathway toward lightweight, energy efficient, and more flexible manufacturing of safety-critical automotive components.

Biography

I am Ayşenur Aydın, a Mechanical Engineering student at Yıldız Technical University. I am interested in additive manufacturing and its applications across different fields, including space, automotive, aerospace, and dental technologies. I work on projects that bring these areas together, focusing on innovative designs, advanced materials, and multidisciplinary engineering solutions.

PATIENT-SPECIFIC CORRECTIVE IMPLANT DESIGN FOR POST-CRANIOPLASTY AESTHETIC CONTOUR DEFORMITY USING A HYBRID HARD–SOFT TISSUE PHANTOM MODEL

Hüseyin Can AKSA[1,2], Kutay ÇAVA[1], Altuğ UŞUN[1] and Muhammet URALOĞLU[3]
[1]Karadeniz Technical University, Medical Device Design and Production Application and Research Center, Trabzon, Türkiye
[2]Karadeniz Technical University, Trabzon Vocational School, Department of Electronics and Automation, Biomedical Device Technology Program, Trabzon, Türkiye
[3]Karadeniz Technical University, Faculty of Medicine, Department of Surgical Medical Sciences Department Of Plastic and Reconstructive and Aesthetic Surgery, Trabzon, Türkiye

Abstract:

A patient who had previously undergone cranioplasty presented with a postoperative aesthetic contour deformity on the right side of the skull, caused by partial displacement of the existing cranioplasty material and the formation of a visible depression and soft tissue gap. To correct this secondary deformity and improve cranial symmetry, a patient-specific corrective implant was planned in collaboration with the plastic surgery team. Computed tomography (CT) data were used to evaluate the displaced cranioplasty area, the residual contour irregularity, and the surrounding cranial anatomy. Based on these data, several alternative corrective implant designs were created to fill the aesthetic defect and restore the external cranial contour without replacing the entire previous cranioplasty reconstruction. The designed implants were manufactured using Selective Laser Melting (SLM) three-dimensional printing technology. In order to assess the implant alternatives before surgery, a patient-specific hybrid hard–soft phantom model was developed. The cranial bone and existing reconstructed region were segmented from CT images and fabricated as a rigid skull phantom using Digital Light Processing (DLP) 3D printing. The patient's external soft tissue contour was also reconstructed from CT data, and a mold was produced to simulate the soft tissue envelope. The printed skull phantom was positioned inside the mold, and Shore 5 silicone was cast around it to mimic the patient's soft tissues. The manufactured corrective implant alternatives were then tested on this hybrid model through simulated surgical incisions, allowing the surgeon to evaluate accessibility, implant insertion, positioning, fit, contour restoration, and expected aesthetic outcome under realistic soft tissue conditions. Following this preoperative simulation, the most appropriate corrective implant design was selected and subsequently implanted in the patient. This case demonstrates that patient-specific corrective implants, combined with hybrid hard–soft tissue phantom modeling, may provide a useful approach for managing secondary aesthetic deformities after cranioplasty. The proposed workflow can support surgical decision-making, enable comparison of different implant designs, reduce intraoperative uncertainty, and improve planning for aesthetic revision procedures.

Keywords: Post-cranioplasty deformity; corrective implant; patient-specific implant; 3D printing; selective laser melting; digital light processing; soft tissue phantom; surgical simulation; aesthetic reconstruction; preoperative planning.

Day 02

3D Printing & Additive Manufacturing

Poster Presentations

METAL 3D PRINTING FOR ADVANCED STRUCTURAL COMPONENTS: FROM MICROSTRUCTURE TO ARCHITECTURAL APPLICATIONS

Barbora Křistková, Miroslav Vacek and Vít Křivý
VSB - Technical University of Ostrava, Czech Republic

Abstract:

The implementation of metal additive manufacturing in structural applications is no longer limited by the ability to produce complex geometries, but rather by the need to understand and control the relationship between process parameters, microstructural evolution and mechanical performance. In laser-based powder bed fusion processes, such as Selective Laser Melting, rapid melting and solidification generate specific material characteristics that differ significantly from conventionally manufactured metals. These include anisotropic mechanical behaviour, residual stresses, surface roughness, porosity, lack-of-fusion defects and locally heterogeneous microstructures. For load-bearing components, these features cannot be considered only as technological imperfections, but as parameters that directly affect stiffness, strength, ductility, fatigue resistance and reliability.

This contribution discusses metal 3D printing as a tool for the development of advanced structural components, with emphasis on the transition from material-scale phenomena to architectural applications. Particular attention is given to stainless steel 316L, which is relevant for structural and architectural use due to its corrosion resistance, ductility and processing stability. However, its application in construction requires a more systematic evaluation of print orientation, layer-dependent behaviour, post-processing requirements and performance under normal and elevated temperatures.

The paper is conceived as a review-oriented contribution supported by an ongoing case study focused on additively manufactured stainless steel components for architectural glass structures. The case study illustrates how the design of architecturally expressive structural fittings must be integrated with material characterization and numerical modelling. Test specimens manufactured in different orientations relative to the build platform are considered as a basis for evaluating tensile properties, deformation behaviour and microstructural imperfections. The resulting data are intended to support finite element modelling of structural components and to improve the reliability of future design procedures.

The broader objective is to identify the main technological and scientific barriers that currently limit the use of metal 3D printing in construction. These include insufficient experimental data, limited design guidance, uncertainties related to anisotropy and elevated temperature behaviour, and the absence of validated models for complex printed components. By connecting microstructural aspects with structural performance and architectural design requirements, the contribution highlights the potential of metal additive manufacturing as a future-oriented approach for creating efficient, customized and mechanically reliable structural components.

Biography

Barbora Křistková is an architect and PhD researcher focusing on the application of metal additive manufacturing in architectural and structural engineering. Her research is primarily oriented towards the design of structural glass systems with stainless steel components produced by 3D printing technologies. She is particularly interested in the relationship between architectural form, material behaviour and structural reliability.

Her doctoral work investigates the potential of metal 3D printing for the development of advanced fittings and connection details for glass structures. The research combines architectural design, material characterization, experimental testing and numerical modelling. Special attention is given to stainless steel 316L, print orientation, microstructural imperfections, mechanical performance and the behaviour of additively manufactured components under normal and elevated temperatures. Through her work, she aims to contribute to the wider implementation of metal additive manufacturing in construction and to support the development of innovative, reliable and architecturally expressive structural components for contemporary glass architecture.

EFFECT OF ELECTRON BEAM MELTING (EBM) PROCESS PARAMETERS ON DENSITY AND SURFACE ROUGHNESS OF TI-6AL-4V PARTS

Harika Yildiz[1], Hakan YILMAZER[2], Özkan GÖKÇEKAYA[3] and Takayoshi NAKANO[4]

[1]Department of Metallurgical and Materials Engineering, PhD Program, Yıldız Technical University, Türkiye
[2]Yıldız Technical University, Faculty of Chemical and Metallurgical Engineering, Department of Metallurgical and Materials Engineering, Yıldız Technical University, Türkiye
[3]Graduate School of Engineering, Department of Materials and Manufacturing Science, Anisotropic Design and Additive Manufacturing Research Center, Osaka University, Japan
[4]Graduate School of Engineering, Department of Materials and Manufacturing Science, Anisotropic Design and Additive Manufacturing Research Center, Osaka University, Japan

Abstract:

Electron Beam Melting (EBM) is an additive manufacturing technology based on powder bed fusion (PBF) that enables the production of complex metallic components and is particularly suitable for Ti-6Al-4V alloy due to its processing environment and high-temperature processing conditions. In the EBM process, the thermal history and melt pool behavior are largely influenced by process parameters such as beam current, scan speed, and focus offset. Variations in these parameters can affect the amount and distribution of energy transferred to the powder bed and, consequently, the surface morphology, surface roughness, porosity, and density of the produced parts. Therefore, understanding the relationship between EBM process parameters and the resulting material properties is important for improving process stability and product quality.

In this study, the effects of different EBM process parameters on the surface roughness and density of additively manufactured Ti-6Al-4V samples were investigated. The experimental design involved different combinations of beam current, scan speed, and focus offset. Surface properties were investigated using the roughness parameters Ra, Rz, and Wa. To improve the reliability and representativeness of the experimental data, ten repeated measurements were performed for each sample using a surface roughness measuring device with metrological traceability. In addition, the density of the samples was determined using the Archimedes method, allowing the effect of processing conditions on material consolidation to be evaluated.

The experimental findings showed that the effects of the process parameters on surface roughness and density were not uniform across the entire parameter range investigated. In general, increasing scan speed and focus offset tended to result in higher surface roughness values, while lower density values were observed under various high-speed processing conditions. However, the magnitude of these changes depended on the interaction between beam current, scan speed, and focus offset.

These variations can be attributed to changes in energy input, melt pool stability, powder melting behavior, and

the formation of internal defects such as lack-of-fusion porosity.

Keywords: Powder Bed Fusion, Electron Beam Melting, Ti-6Al-4V, Surface Roughness, Focus Offset, Porosity, Archimedes, Density.

Biography

Harika YILDIZ is a Metallurgical and Materials Engineer. She received her Bachelor's and Master's degrees in Metallurgical and Materials Engineering from Yıldız Technical University in 2005 and 2010, respectively, and is currently pursuing her doctorate in the same field. She has professional experience in materials testing, laboratory management, metrology, and quality and accreditation systems. Throughout her career, she has worked in various technical positions in materials testing laboratories and participated in laboratory accreditation activities under TS EN ISO/IEC 17025. She also serves as a technical expert and auditor for TÜRKAK (Turkish Accreditation Agency) and as a reviewer and evaluator for TÜBİTAK (Turkish Scientific and Technological Research Council). Her academic interests include titanium alloys, surface engineering, materials characterization, and additive manufacturing. Her previous research focused on the surface modification, wear behavior, and *in vitro* bioactivity of Ti-6Al-4V alloys. The current doctoral research investigates Ti-6Al-4V components produced by Electron Beam Melting (EBM), focusing particularly on the effects of process parameters on surface roughness, density, and material properties. Research interests also include characterization techniques for metallic materials and process-property relationships.

EFFECT OF DRYING CONDITIONS ON THE MECHANICAL PROPERTIES OF PLA 3D PARTS

Enes Boğazkesen, Mehmet Safa Bodur and Ali Avcı
Yıldız Technical University, Türkiye

Abstract:

This study investigates the influence of pre-processing drying conditions on the mechanical performance of poly(lactic acid) (PLA)-based composites manufactured via fused deposition modeling (FDM). Four material formulations were considered: neat PLA, PLA reinforced with cellulose nanofibers (PLA/CNF), PLA/CNF containing a coupling agent (PLA/CNF/CA), and a flame-retardant PLA composite (PLA/FR). To evaluate the effect of moisture content prior to processing, all formulations were dried at 60 °C for 2, 4, and 7 h, resulting in twelve experimental groups. The dried granules were converted into 1.75 mm filaments using a 3Devo desktop filament extruder and subsequently processed into standardized tensile (ASTM D638), three-point flexural (ASTM D790), and notched Izod impact (ASTM D256) specimens using a Creality K1C FDM printer. Mechanical characterization was performed using universal testing equipment. The investigation was conducted in two sequential phases. In the first phase, the mechanical performance of all twelve groups was evaluated to identify the optimum drying duration for each formulation. The optimum drying times were determined as 2 h for neat PLA, 4 h for PLA/CNF, 2 h for PLA/CNF/CA, and 4 h for PLA/FR. Under dry conditions, the PLA/CNF/CA composite exhibited the highest tensile strength (41.09 MPa), whereas the PLA/CNF composite achieved the highest flexural strength (66.10 MPa), highlighting the beneficial effects of cellulose nanofiber reinforcement and interfacial modification. In contrast, the flame-retardant PLA/FR formulation displayed the lowest overall mechanical performance and presented additional challenges in processability and specimen fabrication.

Biography

Enes Boğazkesen is a graduate of the Department of Mechanical Engineering at Yıldız Technical University. During his undergraduate studies, he developed a particular interest in mechanical design, additive manufacturing, product development, and computer-aided engineering. Throughout his university education, he gained practical experience in mechanical design through two separate internship periods at Baykar Technologies. During these internships, he worked with teams involved in shock absorption systems and aircraft control surfaces. He has experience using engineering software such as CATIA V5, SolidWorks, Fusion 360, ANSYS, and AutoCAD. For his undergraduate graduation project, he investigated the effects of drying conditions and moisture content on the mechanical properties of PLA and PLA-based composite materials manufactured using FDM. The study involved filament production, FDM printing, tensile testing, flexural testing, and impact testing. He aims to pursue a career in mechanical design, additive manufacturing, and product development while continuing to expand his knowledge and practical experience in these fields.

TOPOLOGY OPTIMIZATION AND GENERATIVE DESIGN OF AN AUTOMOTIVE HEADLIGHT BRACKET FOR ADDITIVE MANUFACTURING: A SUSTAINABILITY-ORIENTED CASE STUDY

Safa KAHRİMAN[1], Hafize ÇELİK[2] and Binnur SAĞBAŞ[1]
[1]Department of Mechanical Engineering, Yıldız Technical University, Istanbul, Türkiye
[2]Turkish Automobile Factory R&D Center, Türkiye

Abstract:

Weight reduction of non-structural automotive components is an effective strategy for improving fuel efficiency and reducing the carbon footprint of vehicles, yet parts produced by conventional injection molding are constrained by mold cost and geometric complexity. In the presented study, topology optimization (TO) and generative design (GD) were applied for the first time to a series-production headlight-mounting bracket of a passenger vehicle (Fiat Egea), originally manufactured from polypropylene (PP 130.50) by plastic injection molding, in order to evaluate the feasibility of redesigning and re-manufacturing the part with additive manufacturing (AM). The bracket geometry was optimized in Fusion 360 under the applied load and boundary conditions, and the resulting GD output was verified by static structural analysis in SolidWorks before being fabricated as a polypropylene prototype using the fused deposition modeling (FDM) method. The results showed that the generative design reduced the part weight by 12% while providing a considerably more favorable stress and displacement distribution than the original CAD geometry, with the maximum von Mises stress decreasing from 13.80 MPa to 2.68 MPa and the maximum displacement decreasing from 6.60 mm to 0.084 mm under the same static load case. These findings indicate that combining TO/GD-based redesign with FDM-based additive manufacturing can simultaneously reduce material consumption and improve structural performance, supporting more sustainable production of automotive trim and bracket components. Future work will include physical load testing of the printed prototype and a quantitative sustainability assessment of the AM-based production route relative to conventional injection molding. As additive manufacturing matures with higher-strength engineering-grade polymers, this approach is expected to extend to structural, series-production automotive components beyond non-structural trim parts.

This study was supported by TÜBİTAK (The Scientific and Technological Research Council of Türkiye) under the 2209/B University Students Industry-Oriented Research Projects Support Programme (Project No: 1139B412202160). The authors would like to thank TOFAS Turkish Automobile Factory R&D Center for its industrial guidance and support throughout the project.

Biography

Safa Kahriman is a mechanical engineer who graduated from the Department of Mechanical Engineering at Yıldız Technical University and is currently pursuing his master's degree. His academic and professional work focuses on additive manufacturing, mechanical design, structural analysis, topology optimization, and generative design. Throughout his undergraduate education and subsequent professional studies, he has gained experience in the manufacturing, design, and post-processing of both metal and polymer-based parts produced using additive manufacturing technologies. His research interests particularly include improving the mechanical and surface properties of additively manufactured components, designing lightweight structures, and optimizing manufacturing processes. As part of his undergraduate graduation project, he investigated the

production and surface treatment of AlSi10Mg parts. He has also contributed to a TÜBİTAK-funded project focusing on the application of topology optimization and generative design methods in conjunction with additive manufacturing. Kahriman currently works as a Mechanical Design Engineer in the defense industry, where he is involved in the design and development of mechanical systems, mechanisms, actuators, and structural components. His academic and industrial work focuses on advancing the applications of additive manufacturing technologies in the aerospace and defense industries.

EFFECTS OF POWDER REUSE IN METAL ADDITIVE MANUFACTURING: A SYSTEMATIC REVIEW

Abdurrahman Özdemir and Aslı Günay Bulutsuz
Yıldız Technical University, Türkiye

Abstract:

Metal additive manufacturing (MAM) has been increasingly used in various industrial sectors, including healthcare, aerospace, automotive, and energy. During MAM processes, a considerable amount of powder remains unfused and can be collected, sieved, and reused in subsequent production cycles. Powder reuse reduces material costs and waste generation and therefore contributes to the economic and environmental sustainability of additive manufacturing. However, repeated exposure of metallic powders to the processing environment may gradually alter their characteristics, and the number of reuse cycles that can be applied without affecting the final product remains unclear. In this review, the effect of repeated powder reuse on feedstock properties and the properties of components manufactured by MAM is systematically reviewed. Titanium, aluminum, stainless steel, cobalt-chromium alloys, pure copper , and selected high-performance alloys including Inconel and Nitinol, are considered. The literature search and selection procedure follows the PRISMA methodology. An initial search of Scopus and Web of Science identified approximately sixtyfive relevant studies published between 2015 and 2026. Changes associated with successive reuse cycles are assessed in terms of particle size distribution, particle sphericity, powder flowability, morphology, elemental composition, and contamination, together with their effects on microstructure, porosity, tensile properties, and, where reported, biocompatibility of the manufactured parts. Particular attention is given to the relationship between the number of reuse cycles, changes in powder condition, and resulting part performance. By comparing the reported findings across different alloy systems and MAM processing conditions, this review aims to identify common degradation trends, material dependent responses, and current limitations in defining reliable powder reuse criteria. The findings are expected to provide a systematic framework to evaluate limitations for powder reuse to promote more sustainable use of metallic feedstock for additive manufacturing.

Biography

Abdurrahman Özdemir is a Mechanical Engineering student with a strong passion for learning and practical application in metal additive manufacturing and mechanical design. His TÜBİTAK 2209-B research leads his knowledge on the material characterizations and metallic powder evaluation, combining theoretical knowledge with direct laboratory testing. For him, the true engineer is someone who understands what is real and theoretical, so he actively engages in student-led engineering projects, where he enjoys both expanding his technical skills and sharing practical knowledge with his friends. Through his academic coursework, research, and collaborative projects experience, he aims to further develop his expertise in advanced.

5th International Conference on
3D Printing & Additive Manufacturing
September 17-19, 2026 | Yıldız Technical University & Istanbul Fair Center, Türkiye
SCI SYNOPSIS

PARTICLE-SIZE-DRIVEN MICROSTRUCTURAL EVOLUTION AND STRENGTHENING IN SLM-FABRICATED 316L/TIC FUNCTIONALLY GRADED COMPOSITES

Sasan Yazdani[1], Elina Akbarzadeh Chiniforoush[2], Mohammad Reza Jandaghi[3,4] and Johan Moverare[3,4]

[1]Faculty of Materials Engineering, Sahand University of Technology, Iran
[2]Department of Mechanical Engineering, Yildiz Technical University, Türkiye
[3]Division of Engineering Materials, Department of Management and Engineering (IEI), Linköping University, Sweden
[4]Wallenberg Initiative Materials Science for Sustainability, Department of Management and Engineering (IEI), Linköping University, Sweden

Abstract:

Selective laser melting (SLM) provides a versatile route for producing metal–matrix composites with spatially tailored microstructures and properties. In the present work, a functionally graded 316L stainless steel/TiC composite was designed to investigate how the initial size of ceramic reinforcement influences solidification behavior, microstructural development, and mechanical response under identical processing conditions. A three-layer architecture was fabricated by SLM, consisting of unreinforced 316L stainless steel, 316L containing 10 wt% fine TiC particles (<10 μm), and 316L containing 10 wt% coarse TiC particles (10–20 μm). This configuration enabled a direct comparison of particle-size effects while maintaining the TiC content and laser-processing parameters constant. The fabricated material exhibited high consolidation, with a relative density of approximately 98% across the different regions. Microstructural characterization by scanning electron microscopy, X-ray diffraction, and electron backscatter diffraction revealed pronounced changes in grain morphology and crystallographic characteristics with TiC particle size. The addition of TiC promoted heterogeneous nucleation and restricted grain growth, resulting in a transition from relatively coarse columnar grains in the unreinforced 316L region to a predominantly equiaxed and refined structure in the TiC-containing layers. The finest TiC reinforcement produced the strongest grain-refinement effect and a substantially higher fraction of high-angle grain boundaries. Microstructural observations further indicated that part of the TiC reinforcement underwent fragmentation and partial dissolution during laser melting, followed by the formation of nanoscale secondary TiC precipitates during solidification. These microstructural modifications were accompanied by significant improvements in mechanical strength. The fine-TiC region exhibited a yield strength of about 847 MPa and an ultimate tensile strength of approximately 1042 MPa, while the strengthening effect was associated with the combined contributions of grain refinement, Orowan strengthening, and load transfer. Coarser TiC particles produced a different balance between particle strengthening and microstructural refinement. The results demonstrate that controlling reinforcement particle size, rather than simply increasing ceramic content, can provide an effective strategy for tailoring the local properties of SLM-fabricated 316L/TiC functionally graded materials. The findings provide useful guidance for the design of additively manufactured metal–ceramic composites requiring a combination of strength, microstructural control, and spatially varying performance.

CROSS-ALLOY EFFECTS OF RECIPROCATING DEPOSITION PATHS IN WAAM: MICROSTRUCTURE, ANISOTROPY, AND CFD-BASED MELT-POOL ANALYSIS

Elina Akbarzadeh Chiniforoush[1], Mohammad Reza Jandaghi[2], Habib Hamed Zargari[3], Sasan Yazdani[3], Johan Moverare[4] and C Hakan Gür[5]

[1]Department of Mechanical Engineering, Yildiz Technical University, Türkiye
[2]Department of Building Engineering, Energy Systems and Sustainability Science, Faculty of Engineering and Sustainable Development, University of Gävle, Sweden
[3]Faculty of Materials Engineering, Sahand University of Technology, Iran
[4]Division of Engineering Materials, Department of Management and Engineering (IEI), Linköping University, Sweden
[5]Department of Metallurgical and Materials Engineering, Middle East Technical University, Türkiye

Abstract:

Wire Arc Additive Manufacturing (WAAM) offers high deposition rates for large metallic structures, but its repeated thermal cycles commonly produce directional heat flow, columnar grain growth, and pronounced mechanical anisotropy. The present work establishes a cross-alloy perspective on the role of deposition strategy by comparing reciprocating torch-path approaches applied to austenitic 316L and duplex stainless steel (DSS) 2209. In both materials, the conventional linear deposition path was compared with a modified forward–backward or switch-back trajectory designed to alter molten-pool dynamics without changing the fundamental WAAM configuration. For 316L, the forward–backward (FB) path generated stronger melt-pool agitation and promoted a transition from elongated columnar grains toward a more equiaxed and randomly oriented microstructure. Electron backscatter diffraction (EBSD) revealed substantial reductions in texture intensity of 42.3%, 65.5%, and 78.2% along the build, transverse, and normal directions, respectively. The modified path also changed the grain-boundary network toward a higher fraction of high-angle boundaries and produced nearly orientation-independent tensile and impact properties, with ultimate tensile strength above 549 MPa, elongation exceeding 43%, and impact energy above 96 J. A similar response was obtained for WAAMed DSS 2209 using the switch-back (SB) strategy. The SB path markedly reduced columnar grain formation and crystallographic alignment, with reductions of 83% for δ-ferrite and 70% for γ-austenite. The fraction of high-angle grain boundaries increased from 35% in the conventional condition to 91% after switch-back deposition. Mechanical testing showed improved strength and toughness, with the SB horizontal specimens reaching 816 MPa ultimate tensile strength and 74.7 J impact energy, compared with 760 MPa and 51.7 J, respectively, for the conventional condition. To clarify the common physical basis of these improvements, computational fluid-flow and thermal analyses were considered together with the experimental observations. The numerical results for DSS showed that the reciprocating path increased peak temperature, broadened the molten pool, and intensified melt turbulence, while reducing the thermal-gradient-to-solidification-rate (G/R) ratio. These conditions enhance convective transport and dendrite fragmentation, providing additional nucleation sites and

disrupting directional solidification. The combined experimental evidence from 316L and DSS demonstrates that deposition-path engineering is a material-independent process lever for controlling melt-pool dynamics, solidification structure, and mechanical anisotropy in WAAM. The findings highlight the potential of simple torch-path modification as a scalable strategy for producing more homogeneous and mechanically isotropic stainless-steel components without additional post-processing equipment.

Day 03

3D Printing & Additive Manufacturing

Keynote Presentations

INTEGRATING ADDITIVE MANUFACTURING AND ENGINEERED BIOMATERIALS FOR PERSONALIZED MICRONEEDLE-MEDIATED DRUG DELIVERY

Cem Bulent Ustundag[1,2]
[1]*Department of Bioengineering, Faculty of Chemical and Metallurgical Engineering, Yildiz Technical University, Türkiye*
[2]*Health Biotechnology Joint Research and Application Center of Excellence, Türkiye*

Abstract:

This study presents an innovative approach to personalized medicine by integrating additive manufacturing-particularly Digital Light Processing (DLP) 3D printing-with engineered biomaterials to develop advanced microneedle (MN) systems. Mechanically robust MN arrays with highly customizable geometries were developed using photocrosslinkable hydrogel composites, enabling the design of personalized transdermal delivery profiles tailored to specific patient and therapeutic requirements. To facilitate multifunctional therapeutic applications, including tissue repair, these biomaterial platforms were functionalized with nanoparticle-based coatings to enable the precise delivery of antibiotics and growth factors. The resulting integrated MN systems demonstrated excellent structural integrity, combining high flexibility with the mechanical strength required for effective skin penetration. Functional evaluations confirmed the controlled release of therapeutic agents and demonstrated potent antimicrobial activity against a range of pathogenic microorganisms. Furthermore, comprehensive biological assessments revealed excellent biocompatibility of the developed materials and their ability to support cell proliferation. Overall, these nanoparticle-functionalized microneedles, which integrate additive manufacturing with advanced biomaterials engineering, provide a highly customizable and multifunctional platform with significant potential to advance the future of personalized MN-mediated drug delivery and regenerative medicine.

Keywords: 3D Printing; Microneedles; Photocrosslinkable Hydrogels; Nanoparticle Functionalization; Personalized Drug Delivery.

FUNDAMENTALS OF SHEET LAMINATION ADDITIVE MANUFACTURING CORRESPONDING

Özgür Uyar
GSI SLV-TR, Turkey

Abstract:

Sheet lamination is among the earliest additive manufacturing (AM) technologies, enabling the production of near-net-shape components through the successive bonding of thin material layers. Over the years, several sheet lamination variants have been developed, including Ultrasonic Additive Manufacturing (UAM), Very High Power Ultrasonic Additive Manufacturing (VHP-UAM), Laminated Object Manufacturing (LOM), and Friction Stir Additive Manufacturing (FSAM). Each of these techniques employs a distinct bonding mechanism, such as ultrasonic vibration, adhesive bonding, or frictional heat, yet they share the common goal of creating fully dense and mechanically robust parts. One of the major advantages of sheet lamination processes is their capacity to fabricate geometrically complex structures that incorporate internal channels or cavities. This characteristic makes the technique particularly suitable for embedding functional elements such as electronics, sensors, and wiring directly into the part during fabrication. Additionally, sheet lamination enables the joining of dissimilar materials-such as metals, polymers, and composites-without significantly compromising the mechanical integrity of the base materials. Unlike powder-based additive processes such as Laser Powder Bed Fusion (LPBF) or Direct Energy Deposition (DED), sheet lamination does not involve melting and solidification. Consequently, it avoids common metallurgical defects including porosity, shrinkage cavities, and oxidation that result from rapid solidification. However, despite its advantages, the process has notable limitations. The most significant drawback is the need for extensive post-processing, such as machining or surface finishing, to achieve the desired dimensional accuracy and surface quality. This paper provides a comprehensive overview of the main sheet lamination processes, comparing their operational principles, materials compatibility, and performance characteristics. Furthermore, it highlights the technological challenges that remain, particularly in improving bonding quality, material diversity, and automation. Finally, potential research directions are identified, including hybrid process integration, enhanced process monitoring, and the development of multi-material lamination systems. These advancements are expected to expand the industrial applicability of sheet lamination in sectors such as aerospace, electronics, and tooling, establishing it as a competitive alternative to other additive manufacturing technologies.

Biography

Özgür Uyar, Metallurgical and Materials Engineer graduated from Middle East Technical University (METU). Specialized in additive manufacturing of lattice structures during master's studies. Completed the International Metal Additive Manufacturing Coordinator training within the European Welding Federation's (EWF) pilot project in 2023. Currently working as a Welding Engineer at GSI SLV-TR since 2019.

Day 03

3D Printing & Additive Manufacturing

Oral Presentations

SHORT-TERM RECOVERY AND RELOADING OF MSLA-PRINTED SCHWARZ PRIMITIVE TPMS

Hamdi Kuleyin, Kutay Çava and Altuğ Uşun
Department of Mechanical Engineering, Faculty of Engineering and Architecture, Recep Tayyip Erdoğan University, Rize, Türkiye

Abstract:

Digital light processing (DLP) enables the fabrication of complex cellular architectures with high geometric resolution and repeatability. Although deformation recovery under cyclic compression has been investigated for compliant thermoplastic TPMS lattices, the short-term post-compression recovery and subsequent reloading behavior of tough photopolymer TPMS structures remain less characterized. This study experimentally investigated the dimensional recovery and reloading response of DLP-printed Schwarz Primitive triply periodic minimal surface (TPMS) structures fabricated from a commercial tough photopolymer resin (Tough Resin 2.0). Quasi-static compression tests were conducted at engineering strain levels of 10%, 20%, and 30%, with three specimens tested at each strain level. Following the initial compression, the specimens were unloaded and maintained under zero external load at room temperature. Specimen height was measured at 1 min and 4 h after unloading to quantify short-term dimensional recovery. A common initial height of 50.97 mm, obtained from the mean of three undeformed height measurements, was used as the reference for recovery calculations. After the 4 h recovery period, each specimen was compressed again to the same prescribed strain level, and the resulting stress-strain response was compared with that obtained during the initial loading. Rapid dimensional recovery occurred immediately after unloading, with approximately 67-69% of the imposed deformation recovered within the first minute. After 4 h, the recovery ratios reached 96.27 ± 0.86%, 96.11 ± 0.91%, and 97.58 ± 0.20% following compression to 10%, 20%, and 30% strain, respectively. The corresponding residual height losses relative to the initial reference were 0.37 ± 0.09%, 0.78 ± 0.18%, and 0.73 ± 0.06%. Despite this near-complete dimensional recovery, the second compression curves did not fully reproduce the initial stress-strain responses, with the divergence being most apparent at the highest investigated strain level of 30%. This result indicates that recovery of the external dimensions does not necessarily correspond to complete restoration of the preceding mechanical response. These findings reveal a distinction between dimensional recovery and reloading behavior in tough-photopolymer Schwarz Primitive TPMS structures and demonstrate the influence of prior deformation history on subsequent compression. The underlying material-level mechanisms were not directly characterized in the present study. Future work will combine dynamic mechanical analysis (DMA) and Fourier-transform infrared spectroscopy (FTIR) to investigate thermomechanical relaxation and curing-related chemical characteristics associated with the observed recovery behavior.

Biography

Hamdi Kuleyin works as an Assistant Professor in the Department of Mechanical Engineering at the Faculty of Engineering and Architecture, Recep Tayyip Erdoğan University, Rize, Turkey. He obtained his undergraduate, M.Sc., and Ph.D. degrees in Mechanical Engineering from Karadeniz Technical University. His research focuses on the mechanical behavior of materials, polymer blends, fatigue, and crashworthiness. Dr. Kuleyin's expertise encompasses both experimental characterization and computational methods, with particular emphasis on finite element analysis, me-

chanical testing, and material characterization.

DESIGN AND OPTIMIZATION OF ADDITIVELY MANUFACTURED LATTICE STRUCTURES FOR ENERGY ABSORPTION IN AUTOMOTIVE APPLICATIONS

Merve Koral and Binnur Sağbaş
Department of Mechanical Engineering, Yildiz Technical University, Istanbul, Türkiye

Abstract:

In the automotive industry, lightweighting, energy efficiency, and passenger safety are critical drivers of global competitiveness. Achieving sustainable mobility requires reducing vehicle weight to lower fuel consumption and carbon emissions, while simultaneously maintaining crashworthiness. However, conventional manufacturing methods impose severe geometric and production-related restrictions. These limitations are successfully overcome by the unique design freedom and structural versatility offered by advanced additive manufacturing technologies. This study focuses on the design, optimization, and development of lightweight, highly producible lattice structures with superior energy absorption performance for automotive applications. The research targets critical impact-absorbing components, including bumpers, crash-boxes, and side-collision beams, aiming to maximize specific energy absorption (SEA) and crashworthiness at minimum structural weight by systematically optimizing cell topology, relative density, and spatial material distribution parameters. Numerical simulations were executed using ANSYS and LS-DYNA to evaluate their axial crushing behavior and mechanical response. To validate the finite element analysis (FEA) methodology, a benchmark axial compression analysis was performed on a reference lattice structure from the literature. This validation yielded an exceptionally low error rate of 5,9% with 9,86 J of simulated energy absorption compared to the 10,48 J experimental value at 15 mm displacement. Following this, axial compression analysis of the study's primary lattice design was conducted using a plastic kinematic material model. The primary design exhibited outstanding crashworthiness, absorbing 202 J of energy under a deformation of 11,4 mm. Its progressive crushing demonstrated a highly desirable force-displacement profile, characterized by a stable plateau of force oscillations up to 11,4 mm, followed by a rapid force ramp that prevents sudden densification failures. In the on going studies, this research will involve comprehensive static and dynamic compression analyses of the developed designs, parameter optimization, and experimental validation of physical specimens fabricated via FDM. Ultimately, this study aims to contribute both novel design parameters to the literature and practical optimization approaches directly applicable to the automotive sector.

Biography

Merve Koral is a PhD candidate and researcher in the Department of Mechanical Engineering at Yildiz Technical University, Istanbul, Turkey, working under the supervision of Prof. Dr. Binnur Sağbaş. She specializes in additive manufacturing technologies, design optimization, and finite element analysis (FEA) with a strong focus on advanced structural engineering. Her doctoral research centers on the design and optimization of nature-inspired biomimetic and hybrid lattice structures to enhance energy absorption and lightweighting in critical automotive components. With a background in mechanical design and manufacturing, she aims to develop innovative structural solutions that bridge the gap between academic research and industrial applications. Her work contributes to sustainable mobility by combining advanced computational methods, such as drop-weight and compression simulations on ANSYS, with state-of-the-art additive manufacturing techniques like FDM (Fused Deposition Modelling). Her upcoming academic milestones include publishing peer-reviewed articles and establishing inter-institutional collaborations to facilitate physical sample manufacturing and experimental validation. Through these comprehensive research efforts, she seeks to improve passenger safety and vehicular energy efficiency.

EXPERIMENTAL EVALUATION OF TPMS-FILLED CRASH BOXES FOR ENHANCED ENERGY ABSORPTION IN AUTOMOTIVE APPLICATIONS

Sezin Selamoğlu, Arda Ölmez, Onur Kılıç and Ali Fallah
Atılım University, Türkiye

Abstract:

Reducing vehicle weight while maintaining crashworthiness remains a major challenge in modern automotive engineering. Triply Periodic Minimal Surface (TPMS) metamaterials have recently emerged as promising lightweight architectures capable of improving energy absorption through geometry-driven deformation mechanisms. This study investigates the crashworthiness performance of TPMS-filled crash boxes fabricated by additive manufacturing. Three TPMS architectures, namely Gyroid, Schwarz, and Diamond, were integrated into thin-walled crash box structures and experimentally compared with a conventional hollow crash box under quasi-static axial compression. The mechanical response of each configuration was evaluated using force-displacement curves, from which key crashworthiness indicators, including Energy Absorption (EA), Specific Energy Absorption (SEA), Initial Peak Crushing Force (IPCF), Mean Crushing Force (MCF), and Energy Absorption Efficiency (EAE), were determined. The incorporation of TPMS cores fundamentally changed the collapse mechanism from unstable localized buckling to stable progressive deformation, resulting in substantially improved energy absorption performance. Among the investigated geometries, the Diamond TPMS exhibited the best overall crashworthiness, achieving the highest specific energy absorption (approximately 11.2 J/g) while maintaining a relatively low initial peak crushing force (approximately 7.8 kN). The Schwarz topology provided the highest energy absorption efficiency, whereas all TPMS-filled structures demonstrated approximately fourfold higher energy absorption capability than the conventional hollow crash box. The results demonstrate that TPMS-based mechanical metamaterials significantly enhance the crashworthiness of lightweight automotive energy absorbers and highlight the Diamond architecture as a promising candidate for next-generation additively manufactured crash management systems.

Biography

Sezin Selamoğlu received her B.Sc. degree in Automotive Engineering from Atılım University, Ankara, Türkiye, where she conducted undergraduate research under the supervision of Dr. Ali Fallah. She has been admitted to the M.Sc. program in Mechanical Engineering at Hacettepe University and will begin her graduate studies in the upcoming semester. During her undergraduate education, she actively participated in research projects related to additive manufacturing, mechanical metamaterials, smart materials, and 4D printing. Her work involved the design, fabrication, and experimental characterization of lightweight structures for automotive applications using additive manufacturing technologies. She has co-authored several conference papers and contributed to research on energy-absorbing metamaterials and shape memory materials. Her current research interests include additive manufacturing, mechanical metamaterials, lightweight structures, energy absorption, and advanced materials for automotive engineering.

COMPRESSIVE MECHANICAL PERFORMANCE OF METHACRYLATE-FUNCTIONALIZED TIO2 NANOTUBE-REINFORCED POLYMER COMPOSITE FABRICATED BY MASKED STEREOLITHOGRAPHY

Yusuf Selim Bulut[1,2], Nehir Yalçın[1,2], Harun Metin[1-3], Metehan Demirkol[1,2] and Bedri Onur Küçükyıldırım[1,2]

[1]Yıldız Technical University, Department of Mechanical Engineering, Turkey
[2]Yıldız Technical University, Advanced Materials Research Group (AMRG), Turkey
[3]Beykent University, Department of Mechanical Engineering, Turkey

Abstract:

Vat photopolymerization, specifically Mask Stereolithography (MSLA), employs projected light to selectively cure a liquid resin layer by layer. This additive manufacturing technique enables the fabrication of intricate polymeric components, garnering significant interest across the medical, automotive and consumer sectors. Nevertheless, neat photopolymerized resins frequently exhibit limited compressive strength, restricting their applicability in load-bearing structural contexts. To overcome this limitation, embedding different fillers into the 3D-printable resins has been investigated in the literature. As there are several filler materials, methacrylate-functionalized titanium dioxide nanotubes (MA-TiO2-NT) are one of the promising candidates, as pristine TiO2 promotes favorable ultraviolet (UV) curing behavior, due to its optical properties, when compared to other traditional opaque ceramic fillers, and superior matrix-reinforcement interface due to the methacrylate functional groups attached to the nanotube surface, that has chemical affinity to acrylic-based matrix. Accordingly, the present study systematically examines the incorporation of TiO2 with varying filler ratios into photopolymerizable resin to enhance both mechanical properties under compression and processability in MSLA printing, to broaden their functional scope in engineering applications, as MA-TiO2-NT reinforced composites and their 3D-printing have been newly studied in the literature. MA-TiO2-NT are incorporated into an acrylic-based resin matrix at solid loadings of 0, 0.05, 0.1 and 0.15 wt%. Standard compression test specimens are fabricated via MSLA at two build orientations: 0° and 90° respectively. Following the fabrication of the specimens, uniaxial quasi-static compression tests are performed in accordance with ASTM D695 and fracture surfaces of the specimens have been imaged by scanning electron microscopy. Key mechanical properties, including the compressive modulus, ultimate compressive strength and fracture characteristics have been evaluated, according to the influence of both MA-TiO2-NT content and printing orientation and underlying mechanisms have been discussed.

This study is expected to provide critical insights for establishing optimal filler fractions and printing orientations for acrylic-based resins with MA-TiO2-NT fillers. The resulting framework will facilitate cost-effective and reliable prototyping of high-strength, dark-antibacterial photopolymer components for load-bearing engineering applications.

Biography

Yusuf Selim Bulut is an undergraduate student in the Department of Mechanical Engineering at Yıldız Technical University and an active researcher within the Advanced Materials Research Group (AMRG). For the past two years, he has been engaged in the synthesis, functionalization, and characterization of nanomaterials. He has also contributed as a team member to a project focused on the additive manufacturing of MXene-reinforced hydroxyapatite (HA) biocomposite bone scaffolds. His recent research focuses on advanced nanomaterials, such as TiO2 nanotubes, into photocurable polymer matrices via vat photopolymerization. He investigates layer-by-layer printability, photocuring dynamics, and mechanical performance under standardized testings. Yusuf aims to adopt advanced computational tools, including molecular dynamics (MD) simulations and density functional theory (DFT), to establish a multi-scale understanding of material behavior. He is fluent in Turkish and English. Combining classical mechanical engineering principles with advanced computational.

EFFECT OF WATER UPTAKE ON THE PROPERTIES OF 3D PARTS

Yavuz Selim Gözüm, Mehmet Safa Bodur and Ali Avcı
Yıldız Technical University, Türkiye

Abstract:

This study investigates the effects of hydrothermal aging on the mechanical performance of poly(lactic acid) (PLA)-based composites manufactured via fused deposition modeling (FDM). Four material formulations were considered: neat PLA, PLA reinforced with cellulose nanofibers (PLA/CNF), PLA/CNF containing a coupling agent (PLA/CNF/CA), and a flame-retardant PLA composite (PLA/FR). Prior to filament production, the polymer granules were subjected to controlled drying conditions, and the resulting dried materials were converted into 1.75 mm diameter filaments using a 3Devo desktop filament extruder. The produced filaments were subsequently processed into standardized tensile, three-point flexural, and notched Izod impact specimens using a Creality K1C FDM printer, in accordance with ASTM D638, ASTM D790, and ASTM D256 standards, respectively. Mechanical characterization was performed using a universal testing machine. Specimens were subjected to water immersion aging and compared with their corresponding unaged counterparts. The effects of hydrothermal exposure on water uptake and mechanical performance were evaluated for all investigated formulations. Water exposure resulted in a general reduction in strength and stiffness, accompanied by an increase in ductility, indicating a moisture-induced plasticization effect within the polymer matrix. Water uptake increased rapidly during the initial stages of immersion and approached an equilibrium condition after approximately 120 h. The extent of moisture-induced degradation, however, varied considerably depending on the composite formulation. Among the investigated materials, the PLA/CNF composite exhibited the lowest water absorption and the highest resistance to moisture-induced mechanical degradation, demonstrating comparatively superior retention of its mechanical properties following hydrothermal aging. In contrast, the PLA/FR formulation exhibited the highest water uptake and the most pronounced deterioration in mechanical performance. These differences are attributed to the distinct moisture sensitivity and interfacial characteristics associated with the incorporated additives and their interactions with the PLA matrix.Overall, the findings demonstrate that both drying conditions and additive selection play critical roles in determining the mechanical integrity, moisture resistance, and durability of FDM-manufactured PLA composites. The results provide practical insights into the processing and material parameters governing the long-term performance of additively manufactured PLA-based composites and offer guidance for the development of more reliable composite structures intended for applications involving humid or aqueous environments.

Biography

Yusuf Selim Bulut is an undergraduate student in the Department of Mechanical Engineering at Yıldız Technical University and an active researcher within the Advanced Materials Research Group (AMRG). For the past two years, he has been engaged in the synthesis, functionalization, and characterization of nanomaterials. He has also contributed as a team member to a project focused on the additive manufacturing of MXene-reinforced hydroxyapatite (HA) biocomposite bone scaffolds. His recent research focuses on advanced nanomaterials, such as TiO2 nanotubes, into Yavuz Selim Gözüm is a mechanical engineer based in Istanbul, Türkiye, specializing in additive manufacturing and sustainable energy systems. He earned his B.Sc. in Mechanical Engineering from Yıldız Technical University (2026) with a CGPA of 3.47/4.00, completing a distinguished capstone project graded AA (100/100). The project examined the effect of pre-heat treatment and environmental aging on the tensile, flexural, and impact behavior of FDM-printed PLA composites reinforced with cellulose nanofiber, compatibilizer, and flame-retardant additives. During his final year, Yavuz worked part-time as an Engine Mechanical Design Engineer at BAYKAR, contributing to turbofan engine technologies design—a role that built on

an earlier long-term internship with the same team. His research credentials include leading a TÜBİTAK 2209-A national undergraduate research grant as project manager and lead researcher, where he investigated support-structure strategies for cobalt–chromium alloy components produced by metal additive manufacturing. Yavuz also brings a strong record in engineering competition: as a member of the Alternative Energy Systems Club's simulation team, he helped his university win first place at the TEKNOFEST 2023 Robotaxi-Passenger Autonomous Vehicle Competition. His technical toolkit spans CATIA, SolidWorks, Fusion 360, AutoCAD, nTopology, ANSYS, and MATLAB, complemented by hands-on additive manufacturing and 3D-printing expertise cultivated since high school. Driven by a passion for advanced manufacturing and sustainable technology, Yavuz aims to contribute to research and development in the defense and aerospace industry. He combines rigorous engineering analysis with a maker's practical mindset, and continues to explore how additive manufacturing can push the boundaries of lightweight, high-performance mechanical design.

5th International Conference on
3D Printing & Additive Manufacturing

September 17-19, 2026 | Yıldız Technical University & Istanbul Fair Center, Türkiye

DESIGN AND CHARACTERIZATION OF COLLAGEN CONTAINING IPN HYDROGEL BIOINKS FOR 3D PRINTED NEURAL TISSUE SCAFFOLDS

Dilek AYGÜN[1], Selin ELİTAŞ[1,2], Aleyna ÇAVDAR[1,3], Hale BERBER[4], Yasemin YILMAZER[5], Oğuzhan GÜNDÜZ[6], Hasan SADIKOĞLU[2] and Hakan YILMAZER[4]

[1]Department of Bioengineering, Faculty of Chemical and Metallurgical Engineering, Yildiz Technical University, Istanbul, Türkiye

[2] Department of Chemical Engineering, Yıldız Technical University, Türkiye

[3]Department of Biochemistry, Faculty of Pharmacy, İstanbul Kent University, Istanbul, Türkiye

[4]Department of Metallurgical and Materials Engineering, Yıldız Technical University, Türkiye

[5]Department of Molecular Biology and Genetics, Sabahattin Zaim University, Istanbul, Türkiye

[6]Department of Metallurgical and Materials Engineering, Faculty of Technology, Marmara University, Istanbul, Türkiye

Abstract:

Spinal cord injuries (SCI) remain one of the most challenging neurological disorders due to the limited regenerative capacity of neural tissue and the formation of an unfavorable microenvironment following injury. In recent years, hydrogel based biomaterials have attracted increasing attention in neural tissue engineering because of their high water content, extracellular matrix (ECM) like structure, and ability to support cellular interactions [1]. Among these materials, interpenetrating polymer network (IPN) hydrogels offer improved structural stability, tunable physicochemical properties, and enhanced printability, making them attractive candidates for three dimensional (3D) printing applications [2]. In this study, an ECM inspired IPN hydrogel bioink composed of methyl cellulose (MC), hyaluronic acid (HA), collagen (Col), and acrylamide (AAm) was developed for the fabrication of neural tissue scaffolds using extrusion based 3D printing [3,4,5]. The bioink was designed to combine the biological advantages of natural polymers with the structural support provided by the IPN architecture [1,6]. Utilizing this formulation, 3D porous scaffolds with interconnected structures were successfully fabricated and evaluated in terms of morphology, printability, swelling behavior, biodegradation, physicochemical properties, and cytocompatibility. The influence of Col incorporation on scaffold properties was systematically investigated. Morphological analyses performed by scanning electron microscopy (SEM) revealed porous structures suitable for cell material interactions, while fourier transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC) analyses confirmed the successful formation and stability of the hydrogel network. In addition, swelling and degradation studies were carried out under physiological conditions to assess the functional behavior of the scaffolds. *In vitro* cell culture studies demonstrated favorable cytocompatibility of the developed scaffolds. The developed IPN hydrogel scaffolds combine biomimetic composition, structural integrity, and biological compatibility, highlighting their potential as scaffold platforms for future neural tissue engineering applications.

Keywords: IPN hydrogel, collagen, 3D printing, biomimetic scaffold, cytocompatibility.

Acknowledgement: This study was supported by TÜBİTAK under the 2209-B Industry Oriented Undergraduate Research Projects Support Program.

Biography

Dilek Aygün received her B.Sc. degree in Bioengineering from Yıldız Technical University, Türkiye, and is currently pursuing her M.Sc. degree in Bioengineering at the same institution. Her research interests focus on biomaterials, tissue engineering, hydrogel systems, and additive manufacturing technologies for biomedical applications. Throughout her academic and research career, she has been involved in the development and characterization of advanced biomaterials, including hydrogel based scaffolds, nanofibers wound dressings, and 3D printed tissue engineering constructs. Her work primarily focuses on designing biomimetic materials that support tissue regeneration and improve biological performance. She is currently involved in research activities at the Biomaterials and Additive Manufacturing (BiomatAM) Laboratory focusing on biomaterials, tissue engineering, and additive manufacturing technologies. She has also participated in several research and innovation projects, including TÜBİTAK supported studies and multidisciplinary product development initiatives. Her long term research goal is to contribute to the development of biomaterials and biofabrication strategies for tissue engineering and biomedical applications.

MACHINE LEARNING FOR TENSILE STRENGTH PREDICTION OF FFF-PRINTED PLA: A GROUP-WISE VALIDATION APPROACH

Enes Kalyoncu, Besim Ali Alpaslan, Birgul Ascioglu Temiztas and Berna Alpan
Department of Aeronautical Engineering, Istanbul Gelisim University, Istanbul, Türkiye

Abstract:

Machine learning is increasingly used to reduce the experimental burden of characterizing fused filament fabrication (FFF)-printed parts, since mapping the full space of printing parameters experimentally is costly and time-consuming. However, small, replicated datasets typical of thesis-scale experimental campaigns are prone to overly optimistic validation when specimens from the same production condition are randomly split between training and test sets, allowing a model to be effectively evaluated on conditions it has already seen. This study investigates whether the maximum tensile strength of FFF-printed PLA specimens can be reliably predicted from raster angle and infill ratio when validation is instead performed group-wise. Using 60 specimens from 12 production conditions (3 raster angles × 4 infill ratios, 5 repetitions each) obtained from a doctoral thesis, three regression models-a dummy baseline, a linear model, and a second-degree polynomial model with Ridge regularization-were compared under Leave-One-Group-Out (LOGO) cross-validation, in which all specimens belonging to one production condition are held out together. The polynomial model achieved the best performance (MAE = 3.26 MPa, RMSE = 3.97 MPa, R^2 = 0.826), clearly outperforming the linear (R^2 = 0.623) and dummy (R^2 = −0.185) models, confirming that raster angle and infill ratio are informative predictors and that their combined effect on strength is not purely linear. Condition-wise analysis showed that prediction accuracy was not uniform across the parameter space: the model tracked the regular strength increase in the 0° and 90° raster series closely, whereas the largest errors were concentrated in the 45° series, reaching 7.07 MPa at 45°/75% infill and 5.78 MPa at 45°/100% infill. These findings suggest that, for small and structured FFF datasets, validation strategy may be at least as important as model complexity, and that reporting condition-specific error, rather than only global metrics, is necessary to identify where a data-driven model can and cannot be trusted. Within the studied parameter range, the proposed model is best understood as a preliminary estimation tool for narrowing the experimental search space, rather than as a substitute for physical testing or as an optimization method; no parameter combination is claimed as optimal. Confirming the high-infill behaviour observed in the 45° series, and testing whether it generalizes beyond the present dataset, would require additional experimental validation.

Biography

Enes Kalyoncu is a faculty member in the Department of Aeronautical Engineering at Istanbul Gelisim University, Türkiye. He holds a background in Mechanical Engineering, with doctoral research focused on fused filament fabrication FFF-based 3D printing and the mechanical characterization of additively manufactured parts. His current research interests center on the mechanical performance of FFF-printed polymers under varying process parameters such as raster angle and infill ratio, and on applying data-driven and machine learning approaches to predict material behaviour from small, structured experimental datasets rather than relying solely on large-scale testing campaigns. He is particularly interested in validation strategies that produce realistic performance estimates for such datasets, and in translating thesis-scale experimental work into broader, reusable predictive tools for additive manufacturing. Beyond his research and teaching activities, he also contributes to institutional governance through roles in quality management and currently serves as Dean of Students at Istanbul Gelisim University. Through this combination of experimental research, academic administration, and computational modelling, his aim is to bridge additive manufacturing research with practical and reproducible approaches that remain useful even when only limited experimental data is available.

DEVELOPMENT AND FDM PROCESSING OF PLA COMPOSITE FILAMENTS REINFORCED WITH AL, AL_2O_3, TI, NANO-BN, AND SPENT TURKISH COFFEE GROUNDS FOR FUNCTIONAL 3D PRINTED PRODUCTS

Hanife Bukre KOÇ GÜNEŞSU, Gürcan ATAKÖK, Menderes KAM and Binnur SAĞBAŞ
Marmara University, Pure and Applied Science, Mechanical Engineering, Türkiye

Abstract:

Polylactic acid (PLA) has become one of the most widely used biopolymers in additive manufacturing (AM) due to its biodegradability, renewable origin, and compatibility with fused deposition modeling (FDM) based 3D printing technologies. Nevertheless, its inherent brittleness, limited thermal resistance, and low impact strength restrict its use in engineering applications. Various fillers have therefore been incorporated into PLA to improve its mechanical, thermal, and functional properties. This study investigates the development of PLA composite filaments reinforced with aluminum (Al) and titanium (Ti) as metallic fillers, alumina (Al_2O_3) and nanoscale boron nitride (BN) as ceramic fillers and spent Turkish coffee grounds (STCG) as a filler from organic waste. The produced filaments were evaluated in terms of FDM processability and printability optimization, and the optimum performing for each composite composition were subsequently utilized for the fabrication of functional 3D-printed components. Mechanical characterization was subsequently conducted on specimens fabricated under the selected conditions. The results indicated that filament FDM processability and mechanical performance depended on filler type and content, particle sizes, dispersion quality, and matrix-filler interfacial adhesion. Distinct differences in printability and mechanical response were observed among the metallic, ceramic, and biogenic fillers. Owing to its satisfactory printability, distinctive aesthetic characteristics, and potential for waste valorization, the PLA/STCG composition containing 1 wt.% STCG was selected for validation through 3D printed product fabrication. A planter inspired by the form of a coffee bean and a matching water tray were 3D printed using this filament. The 3D printed components maintained the intended geometry and exhibited satisfactory dimensional accuracy and surface quality. The incorporation of STCG also imparted a natural brown color and distinctive surface patterns without additional colorants, creating an appearance resembling wood. The results indicate the potential of reinforced PLA composites to produce functional FDM components and highlight the importance of optimizing material composition and processing parameters for targeted engineering applications. Future investigations will evaluate the environmental degradation behavior and mechanical durability of these 3D printed composite structures under prolonged environmental exposure and sustained service loads.

Biography

Hanife Bukre KOÇ GÜNEŞSU is a PhD candidate in mechanical engineering at Marmara University, Istanbul, where she also earned her M. Sc degree. She received her bachelor's degree in mechanical engineering from the Faculty of Engineering at Düzce University. (GPA: 3.19/4.00). Her research interests include additive manufacturing (AM), 3D Printing, PLA recycling, biomaterials, sustainable composites, and composite filament characterization. Her doctoral work involves sustainable PLA biocomposite filaments within Marmara University's Scientific Research Project Unit

(BAPKO), (FDK-2024-11396). Her research has been published in journals indexed in SCIE. These publications address the mechanical and thermal behavior of PLA and recycled PLA, statistical evaluation of 3D printed components, manufacturing parameter optimization, PLA composites, and circular approaches to polymer waste. Professionally, she served as an expert design engineer at Marmara University's Product Development Center (MÜRGEMER), providing CAD/3D printing training, and as a mechanical engineer at the Istanbul Chamber of Industry. She also contributed to R&D and 2D piping (P&ID) design at Marrin Makina and Gizil. Furthermore, her five years of operating a personal 3D printer provide practical expertise that directly supports her experimental research.

TAILORING STRUCTURE AND MORPHOLOGICAL RESPONSE OF WAAM SUPERALLOYS VIA MG-MODIFIED ZNO COATINGS DEPOSITED BY ADVANCED AND CONVENTIONAL EPD ROUTES

Doruk Gürkan[1], Özgür Yurtsever[2], Egemen Sulukan[1] and Utku Canci Matur[1]
[1]*İstanbul Gedik University, Türkiye*
[2]*İstanbul Nişantaşı University, Türkiye*

Abstract:

Wire Arc Additive Manufacturing (WAAM) superalloys are characterized by heterogeneous microstructures, surface waviness and the presence of oxide layers, all of which critically influence coating nucleation, growth mechanisms and interfacial bonding. These inherent surface irregularities, arising from the layer-by-layer deposition nature of WAAM, can lead to non-uniform coating coverage and localized defects if not properly addressed. In this context, tailoring the chemistry and deposition strategy of functional coatings becomes essential for achieving stable structural performance and reliable surface functionality. In the present study, Mg-doped ZnO (ZnO:Mg) coatings were deposited onto WAAM-fabricated superalloy substrates using two different electrophoretic deposition (EPD) approaches: conventional EPD and sol-gel-assisted EPD. The deposition process was carried out at 10 V for 1 min, followed by post-deposition heat treatment at 600°C for 1 h to enhance crystallinity, phase stability and interfacial integrity. The structural evolution, morphology, and chemical composition of the coatings were systematically analyzed using scanning electron microscopy (SEM) and energy-dispersive spectroscopy (EDS). In addition, surface wettability, mechanical integrity, and adhesion behavior were evaluated to better understand the functional performance of the coatings under different deposition conditions. The incorporation of Mg into the ZnO lattice contributed to reduced defect density, crack formation and modified crystal structure which in turn affected coating stability compared to undoped ZnO systems. Furthermore, coatings obtained via sol-gel-assisted EPD exhibited enhanced uniformity, lower porosity and improved adhesion due to better particle dispersion, controlled suspension chemistry and more stable deposition kinetics. The findings highlight that the combined effect of Mg doping and deposition route plays a critical role in governing coating compactness, interfacial quality and overall functional performance. These ZnO:Mg coatings demonstrate strong potential for use as protective and electrically tunable surface layers in advanced engineering applications where controlled electrical behavior, surface stability and coating reliability are required, particularly in aerospace and high-performance environments.

Biography

Doruk Gürkan was born in Istanbul. After completing his undergraduate studies in mechanical engineering at Trakya University, he earned his master's and doctoral degrees in the same field at Yıldız Technical University. Following a career in the communications sector, he began his academic career. He currently works in the Department of Mechanical Engineering at Istanbul Gedik University. His work focuses primarily on additive manufacturing, coatings and materials science. His research also includes energy efficiency studies and the development of collaborative projects with private sector companies in this field.

5th International Conference on
3D Printing & Additive Manufacturing
September 17-19, 2026 | Yıldız Technical University & Istanbul Fair Center, Türkiye
SCI SYNOPSIS

A PARAMETRIC STUDY ON THE DESIGN AND GEOMETRIC MODIFICATION OF 3D-PRINTED RADIAL LIP SEALS

Ismail Kaya, Hamza Toklu and Zeynep Parlar
İstanbul Technical University, Türkiye

Abstract:

Sealing elements are among the most critical components in mechanical engineering. Sealing performance directly dictates the operational lifespan of machinery and systems; furthermore, in the event of a failure, these components cause disproportionately severe damage compared to their inherent unit cost. Notably, lip seals account for a substantial proportion of sealing component applications. When evaluating the manufacturing procedure of lip seals, it becomes evident that the primary expenses stem from mold preparation and product performance testing, rather than the raw materials. In this context, it is postulated that conducting research and development (R&D) studies via 3D printing to attain an optimum geometry-and subsequently correlating this geometry with conventional manufacturing methods-will yield significant time and cost efficiencies. Consequently, a widely utilized radial lip seal geometry was modelled, and an endeavour was initiated to manufacture the component using a 3D printer. Several challenges are encountered during the 3D printing of sealing elements, the foremost being material selection. Commercially available lip seals, typically manufactured from elastomers such as NBR and FKM, exhibit a hardness of approximately 70 Shore A. TPU has a hardness of 90 Shore A to 95 Shore A. This material discrepancy necessitates the modification of standard seal geometries in 3D-printed counterparts to achieve a comparable interference fit (shaft tightness). To equalize this tightness, specific geometric parameters were modified, including the neck region of the sealing element, the distance between the garter spring and the lip, the length of the bending beam, and the overall inside diameter. Establishing the physical constraints of both the sealing element and the 3D printer as lower limits, a two-level parametric study was conducted based on the standard seal geometry to thoroughly examine the resulting interference fit of these elements. Neck region is sized %0 (baseline geometry) to -24%, garter spring to lip distance is sized 0% to -29%, beam length is sized 0% to +14%, inside diameter is sized 0% to +2%. Following the design phase, print optimization was executed to ensure the sealing element accurately met these desired geometrical specifications during the additive manufacturing process. In the present study, 3D printing capabilities were leveraged during the fabrication process to achieve the desired design geometry of the sealing elements. Subsequently, these design parameters were optimized based on the required interference fit of the seal.

Keywords: Radial lip seals, 3D printer parameters, geometric optimisations.

Day 03

3D Printing & Additive Manufacturing

Video Presentations

DESIGN AND FABRICATION OF FUNCTIONALLY GRADED LATTICE BONE SCAFFOLDS WITH TRANSVERSELY ISOTROPIC BEHAVIOR AND DIRECTIONAL REINFORCEMENT

Mohammad Hossein Sadeghi[1], Amirhosein Yarahmadi[1], Golbarg Nikaein[1] and Binnur Sagbas[2]
[1]Tarbiat Modares University
[2]Yıldız Technical University, Türkiye

Abstract:

Bone scaffolds for load-bearing applications must provide sufficient compressive strength while maintaining stiffness compatibility with the host bone. In this study, three functionally graded lattice bone scaffolds based on an anisotropic octet-truss/cross-strut (OT-C) unit cell were designed, fabricated via DLP additive manufacturing, and experimentally evaluated under compression. The unit cell was defined using an expansion ratio of 1.4 and an average porosity of approximately 60%, selected to reproduce the anisotropic mechanical response of cortical bone in the diaphyseal region. The primary objective was to investigate whether localized geometric reinforcement could improve compressive strength without significantly changing the initial stiffness of the scaffold. Three design strategies were considered: a radial-gradient (RG) architecture, a core-shell-gradient (CSG) architecture incorporating an external solid shell, and a hybrid-reinforced (HR) architecture containing two intersecting internal solid plates extending from the central region toward the corners. The specimens were fabricated using digital light processing with a standard photopolymer resin and were tested in the longitudinal and transverse directions based on ISO 13314. The longitudinal and transverse Young's moduli, compressive yield strengths, and failure patterns were evaluated and compared with those of a uniform reference design. The results showed that the longitudinal and transverse Young's moduli of all three graded architectures differed by less than 3% from those of the reference scaffold (RG), indicating that the proposed geometric modifications had a negligible effect on the initial elastic stiffness. In contrast, the compressive yield strength was substantially affected by the reinforcement configuration. The CSG architecture produced the greatest improvement in the longitudinal direction, increasing the longitudinal yield strength by 14.2%, whereas its transverse strength increased by 2.7%. The HR architecture increased the longitudinal and transverse yield strengths by 9.5% and 8.3%, respectively, and exhibited a more stable and uniform post-yield plateau than the CSG design. Failure occurred predominantly through diagonal shear bands inclined at approximately 45^°to the loading axis. The external shell restricted crack propagation along one diagonal, while the intersecting internal plates divided the failure path into smaller localized regions. These findings demonstrate that reinforcement topology can improve scaffold strength without compromising stiffness matching, while the optimal architecture depends on the principal loading direction.

Biography

Mohammad Hossein Sadeghi is a Full Professor of Manufacturing Engineering at Tarbiat Modares University (TMU), Tehran, Iran. He is an expert in computational design, advanced manufacturing, metal forming, machining, and additive manufacturing of lattice structures, with a particular in-

terest in their biomedical applications. He is currently the Head of the CAD/CAM/CAE Laboratory at TMU, where he leads and supervises research activities in advanced manufacturing and computational design. Prof. Sadeghi has authored more than 90 scientific papers, four books, and over 120 conference proceedings in his areas of research. He is also a founder and board member of the Society of Manufacturing Engineering of Iran (SMEI) and has served as chairman or board member of several national and international manufacturing engineering conferences. His research focuses on developing innovative computational and manufacturing approaches for lattice structures and advanced engineering applications, particularly in the biomedical field. He is actively involved in teaching, research supervision, and international scientific collaboration.

4D BIO-PRINTING APPLICATION IN PHYSIOLOGICALLY ADAPTABLE CARDIAC PATCH FABRICATION

Yimin Huang[1,2]
[1]*Cardiothoracic Surgery Research Program, National Heart, Lung, and Blood Institute, National Institutes of Health, USA*
[2]*Department of Molecular Biology, Capital Medical University Affiliated with Beijing Anzhen Hospital, Beijing Institute of Heart, Lung & Blood Vessel Diseases, China*

Abstract:

Methods and Results: This study was designed to evaluate the concept of a 4D printing fabricated cell-laden cardiac patch with physiological adaptability as a potential method for the treatment of MI. To evaluate this technology, we tricultured hiPSC-CMs, hMSCs, and hECs with 4D printed scaffold to obtain a complex cardiac tissue and also applied *in vitro* dual mechanical-stimulation (MS) to replicate the physiologically relevant conditions for the improvement of regenerated myocardial function. A 4-month *in vivo* study was conducted to assess the performance of our 4D cell-laden cardiac patches in the MI animal models. The sample size and power calculation were determined on the basis of our experience with the experimental models and the anticipated biological variables. Typically, the power is 0.8, and the significance level is 0.05 when the effect size is determined by the minimum sample difference divided by the SD (GPower 3.1). All experiments were blinded and replicated. Purposing to manufacture the biomimetic myocardium anisotropic architecture patch, firstly a four-dimensional (4D) mesh-patterned cardiac patch (8 mm diameter and 600 μm thickness) with physiological adaptability has been printed by using beam-scanning stereolithography printer (with parameters set of effective spot size of the emitted light: 150 ± 50 μm, energy output: ~20 uJ at 20 kHz, pulsed signal power at the material surface ranging from ≈40 to 110 mW,print speed: 6 mm/s, fiber pattern width: 200-μm, 5% GelMA and 15% PEGDA mixed ink, fill density: 40% and adjacent layers angle: 45°(1)). This 4D wavy- patterned patch as the scaffold emerged satisfied deformability and elasticity (Fig 1). According to previous studies, human mesenchymal stromal cells (hMSCs) have been widely used in coculture with cardiomyocytes and endothelial cells to improve cell viability, myogenesis, angiogenesis, cardiac contractility, and other functions due to their paracrine activity(2, 3). Hence, a triculture of human induced pluripotent stem cell derived-cardiaomyocytes (hiPSC-CMs), human endothelial cells (hECs), and hMSCs was performed to fabricate the vascularized cardiac patches. hiPSC-CMs, hECs, and hMSCs at initial ratio of 4:2:1 were seeded on the matrigel pre-coated printed 4D mesh-patterned patch. This

cells-laden patch then incubated in our customerized bioreactor system. This device dynamically driven the optimized mixed culture medium (cardiomyocyte basic medium (NHLBI protocol (4)), endothelial growth medium (Thermo Fisher Scientific) and mesenchymal stem cell growth medium at a 1:1:1 ratio) to perfuse cultured patch with flow rate of 8.4 ml/min which facilitated the efficient transfer of nutrients and oxygen(5,6). All experiments were performed under standard cell culture conditions (in a humidified, 37°C, 95% air/5% CO2 environment) with hECs and hMSCs of six cell passages or less. After 14 days of dynamic perfusion culture, the printed construct showed a uniform cell distribution and longitudinal alignment of the cells along the fiber direction (Fig. 2). A higher expression of mature cardiomyogenic cTnI and angiogenic vWf with more longitudinally aligned vascular cells were observed. In addition, the patches exhibited enhanced sarcomere density and junctions, as identified by the α-actinin and Cx43 expression of the hiPSC-CMs. Moreover, the assembled hiPSC-CM fibers on the cardiac patch spontaneously and synchronously contracted along with the fiber direction (Fig. 3).Consistent with the immunostaining results, the expression of cardiac-related genes, including genes associated with sarcomeric structure, excitation-contraction coupling, and angiogenesis, was significantly increased on day 14 compared to day 7. These results suggest that there was an increase in maturation of the iPSC-CMs on the printed patches over time. In general, the gene expression on day 14 was up to 28-fold higher compared to day 1, and an average of 5.5-fold increase in the expression of maturation genes was observed. This observation further indicated that a physiological specific contracture of 4D cardiac patch was created *in vitro*. The *in vitro* cultured cellularized patches (4-mm diameter, 600-μm thickness) were entirely implanted onto the heart infarcted area in the I/R operation induced chronic MI mouse models (NHLBI) (Fig. 4/5). By 4 months implantation, compared to acellular patch group (~14.3 ± 2.3%), cellularized patch group showed a higher cell density in the patch and smaller infarct area (~5.6 ± 1.5%), simultaneously exhibited a series of strong integration within the epicardium and excellent connection with the mouse heart, up-regulated expression of mature cTnI indicated advanced structural maturation of the hiPSC-CMs in the treated region, and vWf staining identified the capillaries in the cell-laden patch (Fig. 4/5) with a 1.5-fold increase in blood vessel density. These evidences demonstrated the increased vascularization and vascular remodeling *in vivo* likely originated from the host vessel ingrowth as opposed to the implanted human vessels at the initial stage of implantation. It can be observed that the cell aggregation in the vertical direction showed a disordered assembly and 3D stacking behavior. Overall, these results demonstrated that the printed patches under-went progressive vascularization, largely remained on the epicardial surface of the LV over the 4-month implantation period, and effectively covered all of the infarcted area. Cardiac function was also evaluated at different time points after injury via cMRI assessments. The LV ejection fraction of all patch groups (~64.1

± 3.5%) was higher than the control group (~56.1 ± 1.5%); however, there was no difference observed between the cellularized patch group and the cellular group.

Discussion and Conclusion: In this study we have developed a 4D physiologically adaptable design for a cardiac patch, which includes hierarchical macro- and microstructural transformations attuned to the mechanically dynamic process of the beating heart, and a bioreactor system with dynamic perfusion and mechanical loading. By combined these techniques and device *in vitro*, we have successfully fabricated a specific cellularized and vascularized cardiac patch. Results indicated that the anisotropic mechanical adaption of the printed patches and highly biomimetic culture system performed mechanical stimulation (MS) all together contributed to improve the maturation of cardiomyocytes and vascularization . After implantation into the murine MI model, the printed patches exhibited high levels of *in vivo* cell engraftment and vascularization. However the enhanced cardiomyogenesis and neovascularization of humanized patches did not significantly improve the cardiac function of the MI mice. Moreover, the neovascularization effects of the cell-laden patches at the infarct region were also confirmed, suggesting that paracrine effects appear to be a major contributing factor. The printed patches exerted no adverse effects on the host cardiac function or vulnerability to arrhythmias. Nevertheless the cell transplantation improved the cellularized environment in the infarct area by, at least in part, promoting angiogenesis and increasing cell retention. By combining a unique 4D self-morphing capacity with expandable microstructure, the specific design has been shown to improve both the biomechanical properties of the patches themselves and the dynamic integration of the patch with the beating heart. Our results demonstrate improved vascularization and cardiomyocyte maturation *in vitro* under physiologically relevant mechanical stimulation, as well as increased cell engraftment and vascular supply in a murine chronic MI model. This work not only potentially provides an effective treatment method for MI but also contributes a cutting-edge methodology to enhance the structural design of complex tissues for organ regeneration(7).

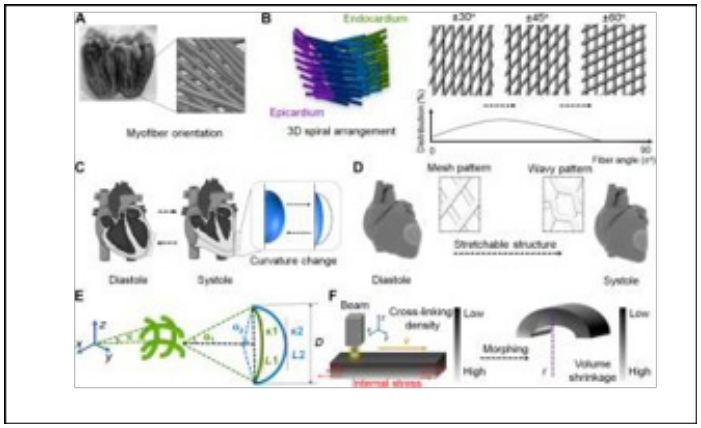


Figure 1: Design of a physiologically adaptable cardiac patch. (A) Photograph of the anatomical heart and the fiber structure of the LV visualized by DTI data. (B) Schematic illustration of a short-sectioned LV that illustrates the variation of fiber angle from the epicardium to the endocardium. The orientation (2D mesh pattern projection) of the fiber angles varies continuously with the position across the wall and distribution changes from the apical region to the basal region. (C) Curvature change of cardiac tissue at two different phases (diastole and systole) of the cardiac cycle, which occurs as the heartbeat and pumping blood. (D) CAD design of 3D stretchable architecture on the heart. It provides dynamic stretchability without material deformation or failure when the heart repeatedly contracts and relaxes. (E) Representation of a simplified geometric model of the fibers in the printed object. In the selected region, the angle (α), the length of fiber (L), spatial displacement (D) and the ventricular curvature (κ) are defined with systole (1) and diastole (2) states. (F) Mechanism of the internal stress-induced morphing process. Uneven cross-linking density results in different volume shrinkage after stress relaxation.

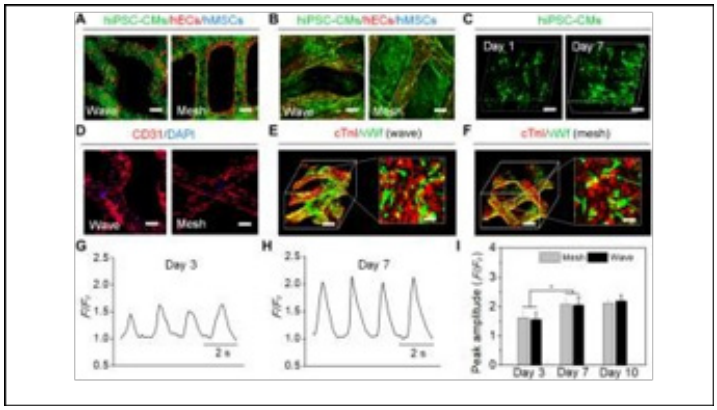


Figure 2: In vitro characterization of the printed cellularized patches. Cell distribution of tricultured hiPSC-CMs (green), hECs (red), and hMSCs (blue) on the cardiac patches using cell tracker staining after (A) 1 day of confluence and (B) 7 days of culture. Scale bars, 200 μm. (C) Autofluorescence 3D images of GFP+ hiPSC-CMs on the wave-patterned patch on day 1 and day 7. Scale bars, 100 μm. (D) Immunostaining of capillary-like hEC distribution (CD31; red) on the hydrogel patches. Scale bars, 200 μm. Immunostaining (3D images) of cTnI (red) and vascular protein (vWf; green) on the (E) wave-patterned and (F) mesh-patterned patches. Scale bars, 200 μm (3D image) and 20 μm (2D inset). Calcium transients of hiPSC-CMs on the hydrogel patches recorded on (G) day 3 and (H) day 7. (I) Peak amplitude of the calcium transients of hiPSC-CMs on the mesh- and wave-patterned patches on day 3, day 7, and day 10 (means ± SD, n ≥ 30 cells, *P < 0.05).

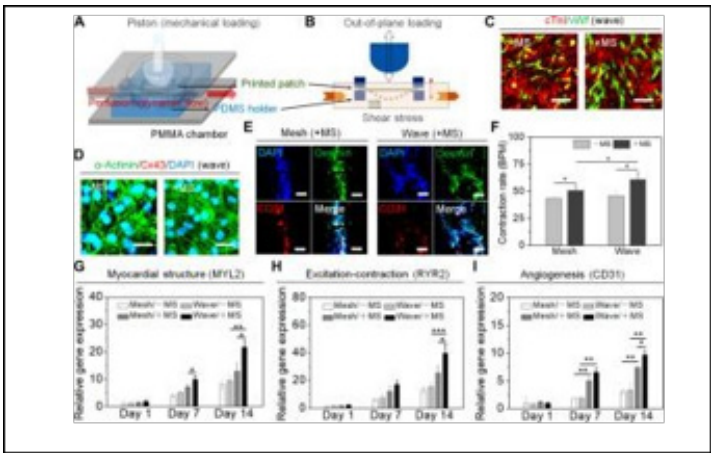


Fig. 3. Biomechanical stimulation and functional maturation of printed cellularized patches.(A) Schematic illustration of a custom-made bioreactor to apply dual MS for the maturation of engineered cardiac tissue. PMMA, polymethylmethacrylate. (B) Both the out-of-plane loading and fluid shear stress applied to the patches.C() Immunostaining of cTnI (red) and vWf (green) on the wave-patterned patch under MS condition (+MS) versus nonstimulated control (−MS). Scale bars, 50 μm. (D) Immunostaining of the actinin (green) and Cx43 (red) on the wave-patterned patch under MS condition (+MS) versus nonstimulated control (−MS). Scale bars, 20 μm. E( ) Cross-sectional immunostaining of the sarcomeric structure (Desmin; green) and vascular CD31 (red) on the patches under MS condition (+MS). Scale bars, 50 μm.F() The beating rate of hiPSC-CMs on the printed patches under MS condition (+MS) versus nonstimulated control (−MS) on day 14 (means ± SDn, ≥ 6, *P < 0.05). BPM, beats per minute. Relative gene expression of G( ) myocardial structure [myosin light chain 2 (MYL2)], H( ) excitation-contraction coupling [ryanodine receptor 2 (RYR2)], and (I) angiogenesis (CD31) on the patches under MS condition (+MS) versus nonstimulated control (−MS) on day 1, day 7, and day 14 (means ± SDn, ≥ 9, *P < 0.05, **P < 0.01, and ***P < 0.001).

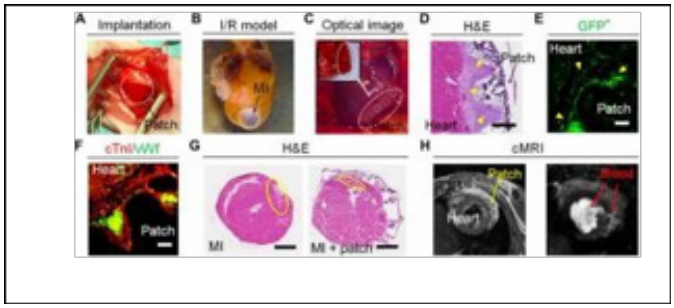


Fig. 4. *In vivo* implantation and long-term evaluation of 4D patches.(A) Optical image of surgical implantation of the patch. (B) Optical image of a heart I/R MI mod-el after 4 months. C( ) Optical image of the implanted cellularized patch at week 3, exhibiting a firm adhesion (inset). (D) H&E image of the cellularized patch at week 3, demonstrating the cell clusters with a high density (yellow arrowhead). Scale bar, 400 μm. (E) Fluorescent image of (GFP+) iPSC-CMs on the patch at week 3, showing a high engraftment rate (yellow arrowhead). Scale bar, 100 μm. F( ) Immunostaining of cTnI (red) and vWf (green) on the cellularized patch at week 3. Scale bar, 100 μm. G( ) H&E images of mouse MI hearts without treatment (MI) and with cellularized patch (MI + patch) at week 10. Infarct area after MI (yellow circles). Scale bars, 800 μm. H( ) Cardiac magnetic resonance imaging (cMRI) images of a mouse heart with patch at week 10. Left (spin echo): the position of the heart and implanted patch. Right (cine): the blood (white color) perfusion from the heart to the patch.

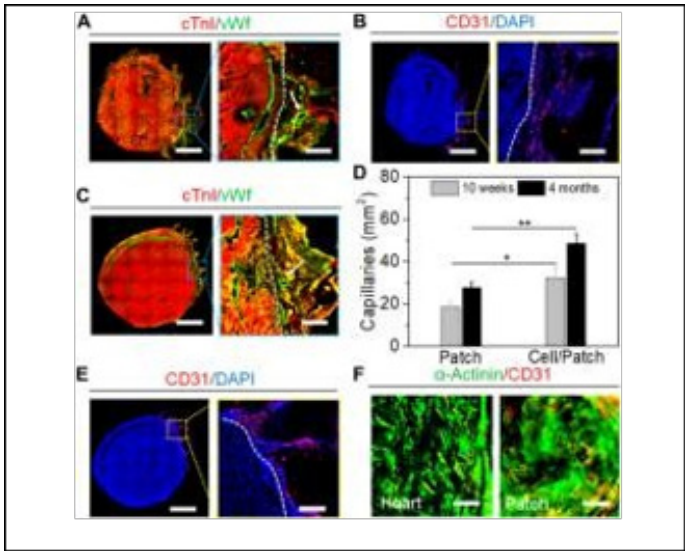


Fig. 5. *In vivo* implantation and long-term evaluation of 4D patches (continuous). (A) Immunostaining of cTnI (red) and vWf (green) on the cellularized patch at week 10. Scale bar, 800 μm. Border of the heart (white dashed line) and capillary lumen (white arrow). Scale bar (enlarged), 100 μm. (B) Immunostaining of human-specific CD31 (red) on the cellularized patch at week 10, showing the generated capillaries by hECs. Scale bar, 800 μm. Border of the heart (white dashed line). Scale bar (enlarged), 100 μm. (C) Immunostaining of cTnI (red) and vWf (green) on the cellularized patch for 4 months, showing the increased density of the vessels. Scale bar, 800 μm. Border of the heart (white dashed line) and capillary lumen (white arrow). Scale bar (enlarged), 100 μm. (D) Quantification of capillaries with vWf staining data for 10 weeks and 4 months (means ± SD, $n \geq 6$, $^{*}P < 0.05$ and $^{**}P < 0.01$). (E) Immunostaining of human-specific CD31 (red) on the cellularized patch for 4 months. Scale bar, 800 μm. Border of the heart (white dashed line). Scale bar (enlarged), 100 μm. (F) Immunostaining of actinin (green) and human-specific CD31 (red) on the cellularized patch at month 4. Scale bars, 50 μm.

SCI SYNOPSIS

Contact us:

Email: 3dprinting@speakersmeetings.com

WhatsApp: **+1-404-759-8307**

Phone: **+1-770-832-7291**