2025 ADDITIVE MANUFACTURING MEETING

04-05 JUNE 2025

WROCŁAW, POLAND

BOOK OF ABSTRACTS

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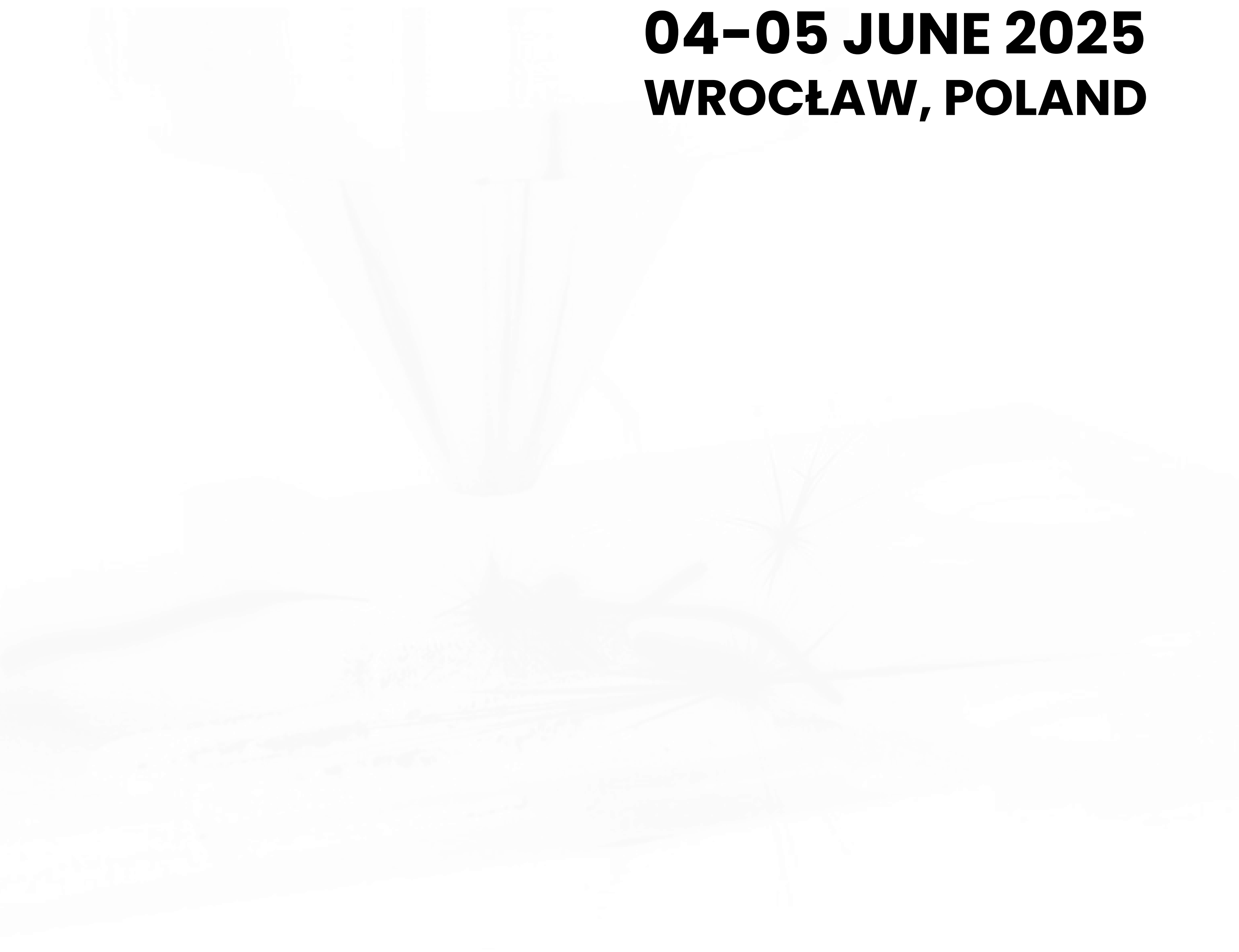

BOOK OF ABSTRACTS

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Contents

Welcome Letter 7
About AMM Conference 8
About AM&M Research Group 9
Partners of AMM 2025 10
Program of AMM 2025 11

Abstracts

Session: Opening of AMM 2025

Eric MacDonald "Additive Manufacturing of Elastomer, Ceramic and Metal Multi-functional Structures" 15

Akos Tottosi "Optimizing a permanent magnet electric motor by additive manufacturing" 16

Agnieszka Chmielewska-Wysocka, Bogdan Dovgyy "Advancing Aerospace and Defence Capabilities through Additive Manufacturing of High-Performance Alloy Components" 17

Jakub Aniulis, Grzegorz Dudzik, Krzysztof M. Abramski "Automated non-destructive monitoring and characterisation of longitudinal filament properties for material extrusion 3D printing" 18

Session: AM in Medical Applications

Dorota Bociąga "Additive techniques in medicine – small steps towards 3D printed tissues and organs" 19

Andrzej Zakręcki, Jacek Cieślik "Development of a method for the manufacture of medical devices using Powder Bed Fusion technology with the material polyamide PA12" 21

Marta Kozakiewicz-Latała, Monika Lewandowska, Doris Braun, Bożena Karolewicz "Effect of miscibility in multi-component systems on the mechanical properties of PVA and HPMC-based filaments for FDM" 22

Dariusz Brzozowski, Paweł Górniak, Mateusz Matuszak „Additive manufacturing in metrology concept" 23

Session: From Particles to New Materials

Manas V. Upadhyay "Advancing microstructure modeling of rapid thermomechanical processes: Experiment-modelling synergy using a novel CW Laser and SEM coupling" 24

Bartłomiej Wysocki "From quantum mechanics to new alloys for metal additive manufacturing" 25

Tomasz Choma, Jakub Ciftci, Wojciech Łacisz, Bartosz Kalicki, Bartosz Morończyk, Łukasz Żrodowski, Bogdan Dąbrowski, Adrian Truszkowski, Marcin Leonowicz "High performance powders via Powder2Powder technology" 26

Julia Chmielewska, Karol Kuglarz, Maria Watroba, Krzysztof Mackosz, Christian Leinenbach "High-Throughput Design of Refractory Multi-Principal Element Alloys for Additive Manufacturing" 27

Bartosz Jóźwik, Adrian Radoń, Marcin Polak, Santina Topolska "Additive manufacturing and post-processing of CuNi2SiCr" 28

Han-Zu Haller "Unlocking the Potential of Multi-Material Manufacturing: Advancements in DED 3D Printing and Industrial Applications" 29

Poster Session

Mateusz Banaszek "Mechanical response of bioinspired TPMS structures manufactured via EBM under quasi-static loading conditions" 30

Aleksander Banaś, Radosław Wojtuszewski "Advancing Aerospace Composite Additive Manufacturing: Integrating AFP Technology's Material, Structural, and Analysis Perspectives" 31

Paulina Dzienny, Michał Wójcik, Katarzyna Mroczkowska, Aleksander Kubeczek, Arkadiusz Antończak "Beyond the Macro: Unleashing Micro & Nano Functionality in Additive Manufacturing with Femtosecond Precision" 32

Marta Frankowicz "Extrusion-Based 3D Printing of Hybrid Plant-Based Meat Analogues" 33

Zuzanna Gembala, Emilia Grochowska "Application of additive manufacturing and XCT Imaging in Education and Biological Structure Reconstruction: A Case Study of a Lepidodactylus Lugubris Egg" 34

Katarzyna Jasik, Lucjan Śnieżek, Janusz Kluczyński, "Additive manufacturing of metal parts using the MEX method – investigation of process parameters and their influence on material structure" 35

Agnieszka Klimek, Janusz Kluczyński, Lucjan Śnieżek "Application of machine learning to predict porosity of 42CrMo4 steel components manufactured by PBF-LB/M technique" 36

Aleksander Kubeczek, Piotr Gruber, Michał Olejarczyk, Arkadiusz Antończak "Dual Beam Laser Sintering – closed loop PA12 reuse" 37

Anil Kunwar, Nele Moelans "Physics-informed neural network modeling of template-based copper electrodeposition for 3D printing design" 38

Tajwo Ladipo, Michał Olejarczyk, Patrycja Szymczyk-Ziółkowska "Optimizing Process Parameters for Laser-Based Powder Bed Fusion of PAEK at Reduced Temperatures" 39

Sofia Rayevska, Monika Lewandowska, Bożena Karolewicz, Marta Kozakiewicz-Latała "Carrageenan-based hydrogels for use in drug formulation via semi-solid 3D printing technology" 40

Agnieszka Łagoda "Ultrasonic Atomization of Waste Materials: A Case Study on MS1 Steel" 41

Jakub Marchewka, Maciej Sitarz "Evaluation of catalytic activity of nickel/silica catalysts for Sabatier reaction prepared by Direct Ink Writing" 42

Sebastian Müller, Meike Denker, Bahar Gharehpapagh, Magdalena Milek, Sindy Fuhrmann, Jaroslaw Domaradzki, Damian Wojcieszak, Michal Mazu, Diego Pozo-Ayuso "Copper conductive lines with glass insulation by a melt extrusion process – Coco" 43

Sebastian Müller, Philipp Klimant, Adam Wilczyński "Polymer-Metal 3D Printing using hybrid material extrusion – Pompey" 44

Małgorzata Noworyta, Weronika Wałczyk, Aleksandra Barczyk, Barbara Sajdak, Magdalena Jankowska, Klaudia Trembecka-Wójciga, Joanna Ortyl "Application of VPP 3D printing technique to obtain ceramic objects" 45

Joanna Ortyl, Filip Petko, Patryk Szymaszek, Andrzej Świeży, Agnieszka Sysło, Myong Joon Oh, Kasidid Yaemsunthorn, Małgorzata Noworyta, Mariusz Galek "New photoinitiators for 3D VPP printing with photopolymerization techniques for printing micro-needles for biomedical applications" 46

Marcin Orzechowski "SPARK (Strong Performance Alloys for Rocket Kinetics)" 47

Filip Petko, Andrzej Świeży, Katarzyna Starzak, Małgorzata Noworyta, Joanna Ortyl "Frontal photopolymerization as a new technique for additive manufacturing processes of obtaining composites materials" 48

Sachin Poudel, Anna Timofiejczuk, Dhruba Panthi, Nele Moelans, Anil Kunwar "Thermal-Structural Modeling of Additively Manufactured Ni-YSZ Layers for SOFC Electrodes applications" 49

Bartłomiej Sarzyński, Lucjan Śnieżek, Krzysztof Grzelak "Additive Manufacturing of Conical Interference-Fit Joints from 42CrMo4 Steel with Laser-Hardened Zones using the SLM Technique" 50

Maciej Sitarz, Jakub Marchewka "Composite metal/silica catalysts for Sabatier reaction prepared by Direct Ink Writing" 51

Upadesh Subedi, Nele Moelans, Tomasz Tański, Anil Kunwar "Digital Twin for Phase Transition Prediction in Laser-Based Additive Manufacturing: A Phase-Field and U-Net Model Framework" 52

Krzysztof Szcześniak "Selection of process parameters for the fabrication of lattice structures" 53

Urszula Tekień "Influence of Geometry on Energy Absorption Properties of Additively Manufactured Gyroid, Split P and Diamond TPMS structures" 54

Paweł Widomski, Marcin Kaszuba, Daniel Dobras, Maciej Zwierzchowski, Michał Kołodziński, Michał Ziętala, Bartłomiej Wysocki "Comparative Study of Binder Jetting, Fused Deposition Modeling and Sintering (FDMS), Selective Laser Melting (SLM), and Laser Metal Deposition (LMD) Printing Technologies for H13 Tool Steel Production" 55

Ayesha Zaka, Sven Bossuyt “Bulk metallic glass composites for green energy transition” 56

Dominik Zdybał, Aleksander Guzik, Andrzej Zakręcki “Revolution in polymer powder materials for Selective Laser Sintering industry” 57

Agnieszka Żuk, Paweł Kozioł, Adam Junka, Patrycja Szymczyk-Ziółkowska “Laser-induced periodic surface structuring of Ti-6Al-7Nb alloy manufactured by L-PBF for medical applications” 58

Welcome

The Additive Manufacturing Meeting (AMM) is a biennial conference organized by the Additive Manufacturing and Materials (AM&M) Research Group at the Department of Advanced Manufacturing Technologies, Faculty of Mechanical Engineering, Wrocław University of Science and Technology.

The 5th edition of the Additive Manufacturing Meeting (AMM 2025) brings together researchers, engineers, and industry professionals to explore the latest developments in additive manufacturing (AM). This year's event focuses on the current challenges and real-world applications of AM in both industry and medicine.

The conference program features plenary lectures delivered by distinguished scientists from leading research institutions, including prof. Eric MacDonald, Ph.D., University of Texas at El Paso, USA; prof. Manas V. Upadhyay, Ph.D., Ecole Polytechnique, France; dr Anna Ziefuß, Ph.D., University of Duisburg-Essen, Germany; prof. Dorota Bociąga, Ph.D., Łódz Technical University, Poland and prof. Wojciech Matusik, Ph.D., MIT, USA. We are also honored to host a special invited lecture from the industry, presented by Ms. Stefanie Brickwede, the managing director of Mobility Goes Additive.

A highlight of this year's program is the dynamic poster session, which includes both a traditional format and an engaging poster pitch session. During the pitch session, each presenter had 60 seconds to introduce their research to the audience, offering a unique opportunity for concise and impactful scientific communication.

The AMM Conference is held in Wrocław, one of Poland's most beautiful and vibrant cities. Known for its charm, Wrocław features numerous parks, green spaces, and 115 bridges spanning five rivers that run through the city. It is a shining example of a multicultural metropolis, situated at the intersection of diverse cultural and historical influences.

We warmly welcome all participants and wish you an inspiring and productive conference.

Organizing Team of AMM 2025

About AMM Conference

Title of the Conference

5. International additive manufacturing users' conference - **Additive Manufacturing Meeting, (AMM 2025)**

http://3dmeeting.pl

Date of the Conference

04–05 June 2025

Conference Venue

The AMM 2025 conference was held in the H-14 building located by the Boulevard of the Wroclaw University of Science and Technology at Wyb. Stanisław Wyspiański 40. The boulevard is located within the main campus of the university, near the largest of the Wroclaw rivers – the Oder.

Conference Organizers

- The Additive Manufacturing and Materials Research Group (Department of Advanced Manufacturing Technologies),
- Mechanical Faculty of Wroclaw University of Science and Technology.

About AM&M Research Group

The Additive Manufacturing and Materials Research Group (AM&M) operates within the Department of Advanced Manufacturing Technologies at the Faculty of Mechanical Engineering, Wrocław University of Science and Technology. AM&M is an interdisciplinary team of experts in manufacturing processes, materials science, engineering design, and measurement techniques.

The group's activities span a wide range of national and international research and application projects, conducted both independently and in collaboration with partners through consortia. AM&M shares its findings through publications in leading scientific journals, patent applications, and the practical implementation of developed technologies in industrial settings.

Key areas of expertise include the use of additive manufacturing techniques to produce customised and fully functional components with complex internal and external geometries. These parts are often designed to perform in demanding thermal, mechanical, and corrosive environments.

AM&M also conducts research and development projects focused on tailoring the material and mechanical properties of various engineering materials – such as ceramics, polymers, metals, and superalloys. These materials are manufactured using advanced additive manufacturing technologies, including Powder Bed Fusion (PBF), Material Extrusion (MEX), and Vat Photopolymerization (VP), for application in industries such as automotive, aerospace, medical, and energy.

Conference Organizers

Conference Partners

Media Partners

Honorary Patronage

Program | Additive Manufacturing Meeting 2025

WEDNESDAY, 04 June 2025 (Day 1)

Session 1 | Opening of AMM 2025 (Conference Center, building H-14)	
10^{30}–11^{00}	Registration & Coffee
11^{00}–11^{10}	Opening *Inauguration of AMM 2025*
11^{10}–11^{50}	Keynote lecture **Eric MacDonald**, University of Texas at El Paso *Additive Manufacturing of Elastomer, Ceramic and Metal Multi-functional Structures*
11^{50}–12^{20}	Special guest from industry **Stefanie Brickwede**, Mobility goes Additive *The beauty of an empty warehouse: saving millions with AM in rail*
12^{20}–12^{40}	**Akos Tottosi**, TCT Hungary Kft *Optimizing a permanent magnet electric motor by additive manufacturing*
12^{40}–13^{00}	**Agnieszka Chmielewska-Wysocka**, International Additive Manufacturing Group *Advancing Aerospace and Defence Capabilities through Additive Manufacturing of High-Performance Alloy Components*
13^{00}–13^{20}	**Jakub Aniulis**, Wrocław University of Science and Technology *Automated non-destructive monitoring and characterisation of longitudinal filament properties for material extrusion 3D printing*
13^{20}–14^{00}	Lunch
Session 2 | AM in Medical Applications	
14^{00}–14^{40}	Keynote lecture **Dorota Bociąga**, Lodz University of Technology *Additive techniques in medicine – small steps towards 3D printed tissues and organs*
14^{40}–15^{00}	**Andrzej Zakręcki**, AGH Kraków *Development of a method for the manufacture of medical devices using Powder Bed Fusion technology with the material polyamide PA12*
15^{00}–15^{20}	**Marta Kozakiewicz-Latała**, Wroclaw Medical University *Effect of miscibility in multi-component systems on the mechanical properties of PVA and HPMC-based filaments for FDM*
15^{20} – 15^{40}	**Dariusz Brzozowski**, ITA *Additive manufacturing in metrology concept*
Session 3 | Poster Pitch & Session	
15^{40}–16^{10}	*Poster presentations – 1-minute/1 slide presentation for each poster*
16^{10}–17^{20}	Poster Session (+ Coffee)
Networking Session	
17^{30}–18^{00}	Happy Transfer to Hydropolis
18^{00}–19^{00}	Visiting Hydropolis – Water Knowledge Centre (Na Grobli 17 street)
19^{00}–23^{00}	Networking – Gala Dinner at Hydropolis

THURSDAY, 05 June 2025 (Day 2)

Session 4 | From Particles to New Materials	
9^{30}–10^{10}	Keynote lecture **Manas V. Upadhyay**, Ecole Polytechnique *Advancing microstructure modeling of rapid thermomechanical processes: Experiment-modelling synergy using a novel CW Laser and SEM coupling*
10^{10}–10^{30}	**Bartłomiej Wysocki**, MCB UKSW *From quantum mechanics to new alloys for metal additive manufacturing*
10^{30}–10^{50}	**Tomasz Choma**, AMAZEMET *High performance powders via Powder2Powder technology*
10^{50}–11^{10}	**Julia Chmielewska**, EMPA *High-Throughput Design of Refractory Multi-Principal Element Alloys for Additive Manufacturing*
11^{10}–11^{30}	**Bartosz Jóźwik**, Łukasiewicz Research Network – Institute of Non-Ferrous Metals *Additive manufacturing and post-processing of CuNi2SiCr*
11^{30}–12^{00}	Coffee Break
Session 5 | Industrial Applications	
12^{00}–12^{40}	Keynote lecture **Anna Ziefuß**, University of Duisburg-Essen *Small Particles, Big Impact: Laser-Generated, Surfactant-Free Nanoparticles for Functional Materials in Additive Manufacturing*
12^{40}–13^{00}	**Rouslan Svintsitski**, 3D Ceram *Artificial intelligence and Automatization in Additive manufacturing for 3D Printing big ceramic parts and big series of parts*
13^{00}–13^{20}	**Han-Zu Haller**, INSSTEK *Unlocking the Potential of Multi-Material Manufacturing: Advancements in DED 3D Printing and Industrial Applications*
13^{20}–13^{40}	**Fabrizio Ragusa**, Nikon SLM Solutions *Qualification Strategies for Metal Additive Manufacturing in the Oil & Gas Industry*
13^{40}–14^{10}	Closing keynote lecture (online) **Wojciech Matusik**, Massachusetts Institute of Technology *Can Computers Beat Humans at Design?*
14^{10}–14^{20}	Closing remarks & best poster award
14^{20}–15^{00}	Lunch
	Official Closing of the Additive Manufacturing Meeting 2025
15^{00}–16^{00}	AM&M Laboratory Tour (Łukasiewicza 5 street)

Abstracts

Additive Manufacturing of Elastomer, Ceramic and Metal Multi-functional Structures

Eric MacDonald[1]

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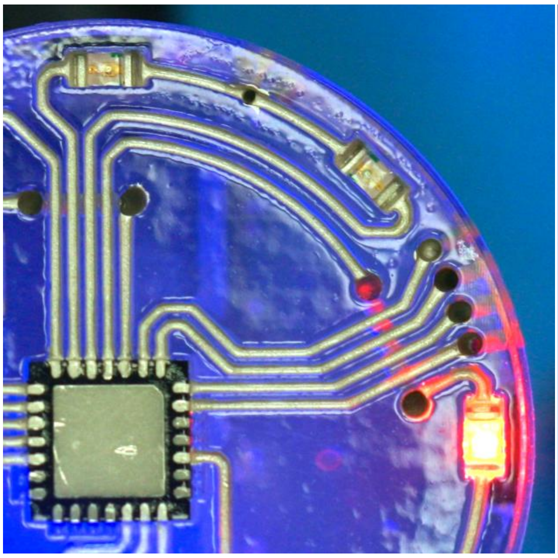
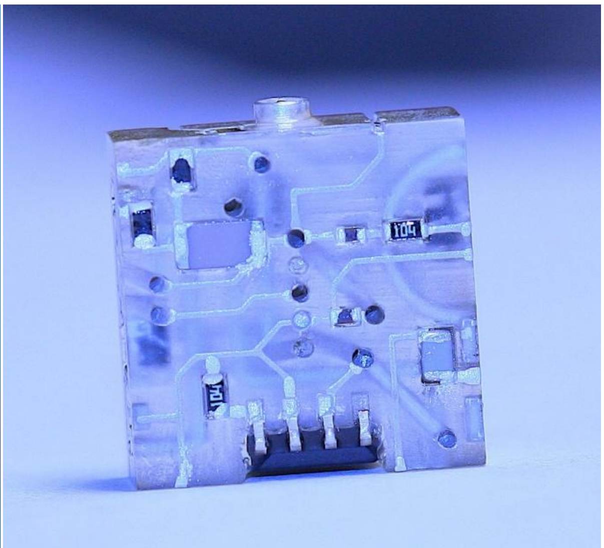
The University of Texas at El Paso; Joint Faculty Appointment, Oak Ridge National Laboratory

Keywords: 3D printing, additive manufacturing

Abstract

3D printing has been historically relegated to fabricating conceptual models and prototypes; however, increasingly, research is now focusing on fabricating functional end-use products. As patents for 3D printing expire, new low-cost desktop systems are being adopted more widely and this trend is leading to a diversity of new products, processes and available materials. However, currently the technology is generally confined to fabricating single material static structures. For additively manufactured products to be economically meaningful, additional functionalities are required to be incorporated in terms of electronic, electromechanical, electromagnetic, thermodynamic, chemical and optical content. By interrupting the 3D printing and employing complementary manufacturing processes, additional functional content can be included in mass-customized structures. This presentation will review work in multi-process 3D printing for creating structures with consumer-anatomy-specific wearable electronics, electromechanical actuation, electromagnetics, energy storage, propulsion, embedded sensors in soft tooling – in polymers, elastomers, metal and ceramic material systems.





Optimizing a permanent magnet electric motor by additive manufacturing

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Keywords: NdFeB, permanent magnet, metal 3D printing

Abstract
Permanent magnet electric motors are widely used in industry, automotive, home appliances, etc. Our project aims to optimize the motor characteristics by additive manufacturing in two ways.

We have developed a method to 3D print rare earth metal (NdFeB) powders to form magnet blocks of basically any geometry. This gives the freedom to use an optimized magnet geometry on the electric motor's rotor. These optimized magnets compared to the commonly used rectangle magnet blocks allows the tailoring of the motors characteristic in a better way.

Our second goal was to optimize the cooling utilizing additively manufactured cooling jacket of a sample electric motor, to achieve a better heat dissipation.

Advancing Aerospace and Defence Capabilities through Additive Manufacturing of High-Performance Alloy Components

Agnieszka Chmielewska-Wysocka[1, 2], Bogdan Dovgyy[1]
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Keywords: additive manufacturing, laser beam powder bed fusion, superalloys, nickel alloys, defence

Abstract

Recent geopolitical tensions highlight the need for advanced aerospace materials that can withstand extreme conditions. Therefore, the military and defence sectors utilize high-temperature alloys to produce durable aerospace components. Additive manufacturing techniques, including laser beam powder bed fusion (PBF-LB), facilitate the on-demand fabrication of complex components, thereby minimizing lead times and material wastage. However, not all materials suit PBF-LB, particularly those susceptible to solidification cracking. This research investigates how various PBF-LB processing parameters – including laser power, scanning speed, and layer thickness – impact the microstructure and mechanical properties of the ABD®-900AM alloy, which has been specifically engineered for PBF-LB applications. The ABD®-900AM alloy exhibits superior mechanical performance, as well as resistance to corrosion and oxidation at temperatures up to 900°C. By optimizing the PBF-LB parameters and heat treatment, this study aims to enhance surface quality and mechanical properties, while achieving high material density and a crack-free microstructure.

Automated non-destructive monitoring and characterization of longitudinal filament properties for material extrusion 3D printing

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Keywords: filament quality monitor, diameter characteristic, structural and thermal properties, digital twin, material extrusion filament manufacturing

Abstract

One of the factors that leads to inconsistencies and defects in the parts produced by material extrusion 3D printing is the uncompensated change in material properties. This creates the need for a real-time filament quality monitor (R-FQM) that can characterise the material properties of the filament along its length. This can be achieved by tracking the variation in measured capacitive tube capacitance and diameter by different sensor types over multiple selected axes and encoding the results to a specific fragment of filament. With such an approach it is possible to monitor factors such as material moisture, roundness, internal and external defects, compound ratio, relative electrical permeability, material homogeneity, Poisson's ratio and degree of crystallinity. Various applications of R-FQM have been investigated, such as material characterisation and type recognition, monitoring of filament manufacturing processes and the creation of digital twin of the printed object.

Additive techniques in medicine – small steps towards 3D printed tissues and organs

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Keywords: 3D biofabrication, factors important in bioprinting with hydrogels, 3D bioprinter for tubular structures, regenerative medicine

Abstract

In recent decades, additive technologies, including three-dimensional printing (3D printing), have found wide application in various fields of science and industry, including medicine. Combined with rapidly developing advanced imaging techniques and constantly improving and expanding data processing and simulation programs, they enable the creation of implants individually tailored to patients, precise mapping of anatomical structures and the development of innovative treatment methods. The dynamic development of 3D printing technology and the commensurate development of necessary and accompanying technologies open up new perspectives in the field of personalized medicine and biotechnology, although it constantly poses new challenges to researchers and clinicians [1].

One of the key achievements of 3D printing in medicine is the ability to produce implants and prostheses tailored to the individual needs of patients, whether in the field of orthopedic, dental or maxillofacial surgery. Thanks to the use of advanced biomaterials, including their hybrid systems, these implants are characterized by appropriate functional properties and biological compatibility [2].

The most innovative area of development of additive technologies is direct 3D bioprinting. This method involves extrusion of bioink – a mixture of polymers (both natural and synthetic), in which living cells are placed (including those taken from the patient and multiplied). Their growth can be additionally stimulated biologically, e.g., by growth factors introduced as a component of the bioink. Thanks to the appropriate composition of the bioink, it is possible to recreate the microenvironment of native tissue. Assuming optimistic scenarios of possible achievements of biomedical engineering, such printed structures will be able to serve as a new organ for direct implantation immediately after printing (or printing in situ) or after a period of maturation, e.g., in a bioreactor.

Additive technologies also enable the production of tissue scaffolds that can serve as matrices for regenerating cells. These applications include printing skin, cartilage, as well as initial attempts at printing organs such as kidneys, liver, pancreas. 3D bioprinting of organs and tissues

offers potential solutions to the shortage of organs for transplantation and enables the creation of models for pharmacological studies, which is consistent with the desire to minimize animal testing.

The research conducted by our team at the 3D Bioprinting and Biomaterials Research Laboratory at the Lodz University of Technology is focused on proposing new solutions in the field of 3D bioprinting technology (including printing devices [3] and material developments (bioinks and biomaterials for scaffolds [4–6])), which will allow to eliminate the current limitations (technological and material) in the field of tissue and organ production for applications in regenerative medicine.

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Development of a method for the manufacture of medical devices using Powder Bed Fusion technology with the material polyamide PA12

Andrzej Zakręcki[1], Jacek Cieślik[1]

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Keywords: SLS, HP MJF, medical device, post-processing, PA12

Abstract

Additive manufacturing technologies using plastics, particularly SLS and MJF, offer a versatile approach to producing customised medical devices. This study focuses on developing and optimising medical product manufacturing methods using the example of a forearm orthosis made of polyamide PA12, evaluating the mechanical properties and finishing treatments used, and examining the impact of the ageing process on the mechanical properties.

In addition, the tests included the production of components in SLS systems on the EOS P396 and HP MJF on the HP 5200 and various finishing methods using DyeMansion solutions, including Powershot C (cleaning), Powershot S (polishing) + DM60 (dyeing) and Powerfuse S (chemical smoothing). The analyses were conducted to assess the feasibility of using these materials in the production of medical devices, such as 3D-printed forearm orthoses. Key findings include:

1. SLS offers the most uniform and repeatable mechanical properties, making this technology more suitable for applications requiring stable strength parameters;
2. HP MJF provides high flexural strength and good elasticity but shows more variation in results than SLS;
3. The Powershot C method provides the highest repeatability of results, making it a more reliable choice in applications requiring stable mechanical properties. The Powerfuse S method shows more significant variability, especially in the elasticity and strain parameters modulus;
4. Ageing test analyses have shown that SLS technology has more excellent mechanical properties stability during ageing compared to HP MJF. Using the chemical finish Powerfuse S significantly weakened the mechanical properties after ageing and is not recommended in applications requiring long-term durability.

In addition, the project results provided key data for engineers designing medical devices and other products where material durability is essential. The information obtained can support the certification and testing of materials produced using 3D printing technology and contribute to the development of innovative solutions in medicine and other industries, such as automotive and aviation. Thanks to the project, it has become possible to design durable and safe medical products in a more informed way, which is of significant importance for both the development of science and industry.

Effect of miscibility in multi-component systems on the mechanical properties of PVA and HPMC-based filaments for FDM

Marta Kozakiewicz-Latała[1]*, Monika Lewandowska[1], Doris Braun[2], Bożena Karolewicz[1]
[1] Department of Drug Form Technology, Faculty of Pharmacy, Wroclaw Medical University, Wrocław, Poland
[2] Department of Pharmacy, Pharmaceutical Technology Section, University of Innsbruck, Innsbruck, Austria

Keywords: drug delivery, FDM, HME, pharmacy, miscibility

Abstract

Introduction

Personalized medicine aims to customize treatments based on individual patients' physiological and pathophysiological conditions to improve their quality of life. One way to achieve this is through additive manufacturing (AM), also known as 3D printing. AM offers a cost-effective and flexible approach to customize shape, dose, and drug release profiles, making it an attractive option for personalized drug delivery systems. One effective strategy is coupling hot melt extrusion (HME) with fused deposition modeling (FDM). The challenge is to produce pharmaceutical-quality filaments with incorporated APIs, as such are not commercially available. Knowledge of the fundamental processes that determine the macroscopic properties of extruded materials is vital for designing next-generation pharmaceutical materials for personalized medicines.

Materials

The physical mixtures (PMs), filaments, and prints were obtained using two different polymers: PVA with sorbitol (plasticizer) and HPMC HME with TPGS (plasticizer). Three model drugs that differ in structure, melting temperature, glass forming ability (S)-(+)-Ketoprofen (DEX, *Mp* = 78°C; Pol-Aura) indomethacin (IND, *Mp* = 160°C; Thermo Scientific) and meloxicam (MEL, *Mp* = 256°C; Pol-Aura) were incorporated into the polymer matrix.

Results

Four blends for each system were manufactured, each containing a plasticizer content of 10, 20, 30, 40, and 50% (w/w). The model drug was maintained at a constant 10% (w/w) content, with varying amounts of PVA or HPMC HME adjusted accordingly. PMs were processed via the co-rotating twin-screw extruder. A FDM printer was used for the printing process. Using HSM the exact process of melting and mixing of polymer and plasticizer in PM was observed.

Conclusion

When selecting blend components, it is important to consider the melting point of the API, which further affects the mechanical and thermal properties of the filament. The temperature during 3DP was primarily influenced via melting of the polymer rather than the addition of plasticizer. The miscibility of the systems has affected the 3D printing process.

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Additive manufacturing in metrology concept

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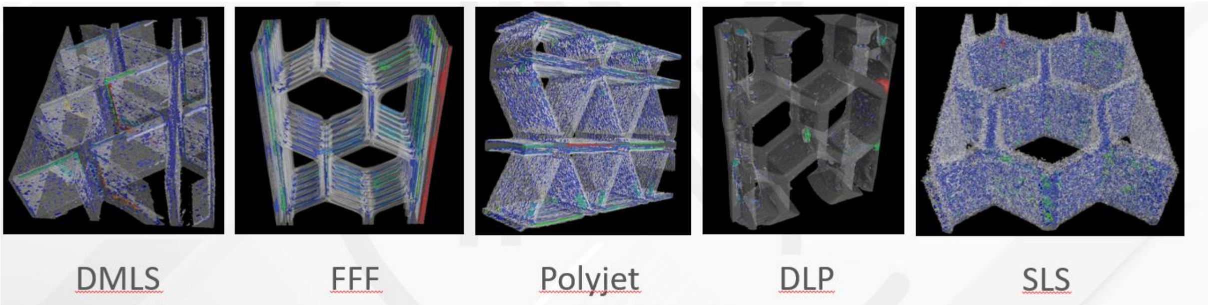
Keywords: computed tomography, 3D scanning, 3D metrology, CT

Abstract
Structures made with additive technologies are becoming increasingly common in the modern production of machine parts. They are particularly useful in small-batch or individual production, intended for special connecting elements or handles. However, additive manufacturing also requires a specific metrological approach, both from the point of view of length and angle metrology in various scales, as well as strength aspects. The results of research on samples made with various additive methods will be presented.



Advancing microstructure modeling of rapid thermomechanical processes: Experiment-modelling synergy using a novel CW Laser and SEM coupling

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Keywords: CWLaser-SEM, microstructure, additive manufacturing

Abstract

The last 10 years have seen the development of multi-physics models to predict microstructure formation during rapid thermomechanical processes, particularly in the context of metal additive manufacturing (AM), in order to eventually propose solutions to design microstructures for desired properties. A critical step to achieving this aim is to validate these models by performing a fair one-to-one comparison between simulation predictions and experiments; until recently, simulation predictions were being unfairly compared against vastly more complex results from AM experiments.

To remedy this problem, a novel coupling between a continuous-wave laser and a scanning electron microscope (CWLaser-SEM) was recently developed [1–4]. One of the biggest advantages of this coupling is that it allows performing laser scanning in the secondary vacuum of the SEM, which effectively eliminates the risk of surface oxidation. Therefore, the full range of SEM measurements can be performed before and after laser scanning at the same locations without any mechanical polishing in between measurements. This generates a clean set of experimental data that not only serves as input for the models but also allows performing a one-to-one comparison with their predictions.

The first experiments performed with the CWLaser-SEM were performed on 316L stainless steel. They were designed to validate a combined computational fluid dynamics and phase-field grain growth model for fast solidification at the polycrystalline level [4], as well as a thermo-elasto-viscoplastic finite element model to predict formation of residual intergranular stresses and plastic strains [3] due to laser scanning. The design of the CWLaser-SEM, development of the experiment-modelling synergy and results of these studies will be presented.

The aforementioned CWLaser-SEM device can be used to generate thermomechanical conditions that not only mimic AM processes but also other thermomechanical processes such as welding and quenching, and thus be useful to validate a host of different models. Furthermore, this device have been helpful in developing post-processing routes to engineer microstructures of additive manufactured stainless steels in order to enhance their overall mechanical properties (strength, ductility and fatigue limit) [2].

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From quantum mechanics to new alloys for metal additive manufacturing

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Keywords: alloys design, *ab initio*, Laser Beam Powder Bed Fusion (PBF-LB), machine learning, microstructure, titanium, copper

Abstract

Quantum mechanics provides the theoretical framework for understanding the behaviour of atomic bonds in a material, while ab initio methods use these principles to calculate material properties directly from first principles without empirical data. Ab initio methods can also provide knowledge how the properties change when modifications to the alloy composition are made. In our research, we are simulating the behaviour of various elemental combinations and predicting new alloys (e.g., Ti-X-Re, Cu-Ag, Ni-Ti-X) with unique properties, such as improved strength, corrosion resistance, or thermal stability. Designed alloys are melted in an arc furnace, atomized to powder form, and additively manufactured using the Laser Beam Powder Bed Fusion (PBF-LB) process. The PBF-LB process parameters are set using Artificial Intelligence (AI) methods. Our approach allows for bringing a product made from an innovative material with enhanced functional properties to market much more quickly than before.

High performance powders via Powder2Powder technology

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Keywords: ultrasonic atomization, additive manufacturing, metal powder, 3d printing

Abstract

Current methods for the production of spherical powders restrict the development of custom particles with tailored chemical compositions. This challenge is even greater when the input material is already powder. The proposed Powder2Powder ultrasonic atomization process based on plasma melting allows for changing particle size, morphology and forming an alloy in-situ.

During processing the liquid, in contact with a surface vibrating at ultrasonic frequencies, forms standing capillary waves that lead to the ejection of fine droplets. As the amplitude of these waves increases, the wave crests can reach a critical height where the cohesive forces of the liquid are overcome by the surface tension.

The material in the form of powder was used to prepare a custom alloy from the powder blend which was melted in the plasma stream and atomized from the sonotrode. Additional case studies will be presented using other out-of-spec additive manufacturing feedstocks.

High-Throughput Design of Refractory Multi-Principal Element Alloys for Additive Manufacturing

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Keywords: refractory alloys, additive manufacturing, high-temperature materials, phase stability, MPEAs

Abstract

Refractory multi-principal element alloys (MPEAs) offer promise for high-temperature applications but face challenges in compositional complexity and manufacturability. This study uses a high-throughput computational-experimental approach to screen 3,421 ternary MPEAs in the Hf-Mo-Nb-Ta-Ti-Zr system, targeting 100% BCC phase above 1000°C, $\Delta T < 50$°C, and low crack susceptibility for additive manufacturing (AM). ThermoCalc simulations identified six compositions, experimentally validated via arc melting, heat treatment, and phase analysis. Nb25Ti20Zr55 and Hf45Nb30Ti25 showed stable BCC structures, refined microstructures, and superior processability. In situ XRD and DSC confirmed thermal stability, while laser scanning demonstrated defect-free processing. This study bridges computational design and manufacturability, advancing MPEAs for aerospace, nuclear, and energy applications.

Additive manufacturing and post-processing of CuNi2SiCr

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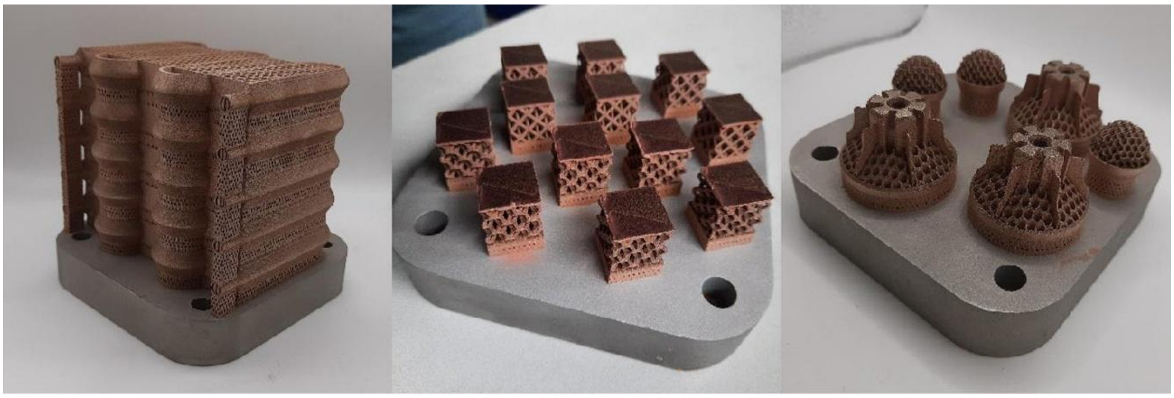
Keywords: additive manufacturing, selective laser melting, laser powder bed fusion, copper alloys, post-processing

Abstract

The main aim of this work was to optimize the printing strategy for CuNi2SiCr powder using L-PBF technology, focusing not only on the high volume parts with 99,7% of the theoretical density, but also investigating the role of printing parameters on the thin-walled, inclined structures, and also exploring the possibilities given by the introduction of engineered porosity in the sintering regime. The data acquired from the both approaches was tested by printing porous, thin-walled lattice structures, and a fully dense stack of modular radiators. The equally important part of the experiment involved exploration of available post-processing routes. The investigated treatments involved:

- Hot Isostatic Pressure as an attempt to reduce the porosity of sintered samples.
- Aging treatment as a mean to rise both mechanical properties and conductivity.
- Sandblasting and two chemical polishing techniques as the ways of lowering the high coarseness of prints which L-PBF is notorious for.



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Unlocking the Potential of Multi-Material Manufacturing: Advancements in DED 3D Printing and Industrial Applications

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Keywords: Multi Material, Direct Energy Deposition, DED, 3D Printing, Applications

Abstract

Advancements in Multi-Material Manufacturing, driven by innovative Directed Energy Deposition (DED) technologies, have greatly enhanced additive manufacturing capabilities. InssTek is central to this growth, utilizing unique innovations across hardware, software, and materials. Notable advancements include hardware solutions like the Hexa Powder Feeder and Zoom Optics, along with software improvements (5Axis-AM-CAM). Precision material technologies ensure accurate handling of various materials, enabling sophisticated processes such as In-Situ Alloying, bi-metal fabrication, Functionally Graded Materials (FGMs), Metal Matrix Composites (MMCs), and High Entropy Alloys (HEAs). These capabilities serve practical uses in medical implants, aerospace engine components, maritime valves, and space applications. This presentation highlights InssTek's technological expertise, emphasizing current capabilities and future opportunities in Multi-Material Manufacturing.

Mechanical response of bioinspired TPMS structures manufactured via EBM under quasi-static loading conditions

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Keywords: additive manufacturing; EBM, TPMS structure, energy absorption, computer simulations

Abstract

Regular structural materials based on cellular structures are the subject of many research works due to their high capacity to absorb mechanical energy. Majority of these type of structures are referenced in nature, such as in trees, bones, and mussel shells. Their common feature is high strength with low relative density. These materials have been classified into two main categories: 2D and 3D [1]. 2D materials are well-known, but 3D materials are still not explored enough due to more demanding manufacturing process. An example of spatial 3D structures is Triply Periodic Minimal Surface (TPMS). TPMSs are characterised by a minimum area bounded by a curve, which can be described by a mathematical function. Among this type of structures, we can distinguish: Schwarz Diamond, Gyroid or Split P [2, 3]. In addition, these structures have smooth connections between elementary cells compared to lattice structures. Additionally, these structures usually have a complex shape that is not easy to fabricate using traditional manufacturing methods. Due to this limitation, complex topologies are mostly fabricated using additive manufacturing (AM) techniques. Considering the complexity of TPMS geometry it is recommended to use Powder Bed Fusion (PBF) techniques, e.g., Electron Beam Melting (EBM) technique [4], which involves the melting of the metal powders by electron beam energy source. The manufacturing process based on the EBM method requires vacuum conditions in the working space. Models produced by this method are characterized by high quality (high density, low porosity) and very good strength parameters [4].

In the present paper, the EBM method was used to produce specimens of Diamond, Gyroid and Split P structures, which were then subjected to uniaxial compression tests under quasi-static loading conditions to analyse their deformation process and energy absorption capacity. Moreover, material model correlation was carried out in the LS-Dyna numerical environment on the results from the quasi-static uniaxial tensile test of the dog-bone specimens. The purpose of this paper is to present the results of experimental and numerical studies of TPMS--type structures manufactured by EBM technology and Ti6Al4V titanium alloy under quasi--static compression test conditions.

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Advancing Aerospace Composite Additive Manufacturing: Integrating AFP Technology's Material, Structural, and Analysis Perspectives

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Keywords: Additive Manufacturing, AFP, thermoplastic composite, analysis, airframe, manufacturing

Abstract

Automated fiber placement (AFP) is an advanced composite Additive Manufacturing technology that uses robotic systems to precisely lay down composite plies layer-by-layer. This approach significantly contributes to the field of aerospace engineering, highlighting its role in advancing the design and reliability of aerospace composite components. This poster integrates research on the materials, technological, analytical, and performance aspects of AFP technology used in the production of select aircraft structures with a novel methodology for calculating the strength and stiffness of thermoplastic composite structures. The study explores process parameter development and optimization, part behavior, and the creation of predictive computational models that assess performance under realistic operational scenarios. By detailing both experimental and analytical perspectives, the research demonstrates how AFP not only enhances structural performance and reduces weight but also improves production efficiency.

Beyond the Macro: Unleashing Micro & Nano Functionality in Additive Manufacturing with Femtosecond Precision

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Keywords: femtosecond laser, micro/nanofabrication, surface functionalization, laser micro/nanoprocessing

Abstract

Additive Manufacturing (AM) excels in the efficient fabrication of complex 3D structures. However, achieving intricate micro/nanoscale features and advanced surface functionalities on printed parts remains a challenge. Our aim is to present a complementary approach using an advanced femtosecond laser system as a powerful post-processing tool. The application of ultrashort laser pulses allows for precise surface modification and the incorporation of high-resolution features onto printed components without substantial material degradation. Consequently, printed parts can gain advanced functionalities, like integrated microfluidic channels, customized surface textures for controlled wettability and biocompatibility. This synergistic approach closes the gap between the macro-scale fabrication of AM and the micro and nanoscale precision of femtosecond laser processing, facilitating the development of a new generation of highly functional 3D-printed devices.

As part of presentation, we will showcase an advanced, multi-station system for subtractive microfabrication, along with selected examples of structures and applications that can be realized.

Extrusion-Based 3D Printing of Hybrid Plant-Based Meat Analogues

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Keywords: 3D food printing, sustainable food design, extrusion bioprinting, meat alternatives, hydrocolloids

Abstract

Additive manufacturing (AM) has emerged as a promising technology in the development of plant-based meat alternatives, addressing the environmental impact of animal farming. This study explores the use of extrusion-based 3D food printing (3DFP) to fabricate hybrid formulations replicating the structural and sensory characteristics of meat. Bioinks were prepared using soy protein isolate or chickpea flour, combined with wheat gluten and hydrocolloids (sodium alginate, agar, xanthan gum). A lipid-based matrix simulating animal fat was formulated with coconut oil, potato starch, inulin, and lecithin. Materials were printed using a Cellink Bio X bioprinter and evaluated for printability, shape fidelity, and hybrid integration. Optimal extrusion and formulation parameters were identified to ensure structural cohesion and stability. The results confirm the feasibility of AM in producing multi-component food structures and support further development of sustainable, customized food products.

Application of additive manufacturing and XCT Imaging in Education and Biological Structure Reconstruction: A Case Study of a Lepidodactylus Lugubris Egg

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Keywords: XCT imaging, digital reconstruction, Stereolitography, additive manufacturing

Abstract

The combination of additive manufacturing with X-ray computed tomography (XCT) imaging has been demonstrated to enhance biological sciences by enabling precise digital reconstruction and reproduction of delicate specimens. This study details the reconstruction of a mourning gecko (Lepidodactylus lugubris) egg using high-resolution XCT scanning and Stereolithography (SLA) 3D Printing.

The aim was to explore applications in museology, embryology, and evolutionary research. The methodology involved the segmentation of the eggshell from the internal structures, including the developing embryo, to create detailed 3D models with high anatomical accuracy. This approach addresses challenges in studying delicate biological specimens by providing non-destructive alternatives to traditional dissection methods. The results confirm that XCT and additive manufacturing produce accurate, realistic models that enhance education and scientific research, with potential applications in medicine, paleontology, and interdisciplinary studies.

Additive manufacturing of metal parts using the MEX method – investigation of process parameters and their influence on material structure

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Keywords: additive manufacturing, metal-polymer composites, MEX, porosity

Abstract

The study presents research on the optimization of process parameters for Material Extrusion (MEX) technology in the context of additive manufacturing of 17-4 PH stainless steel components. MEX, known for its low cost and ease of use, has evolved with the development of composite filaments containing metal powders, enabling the production of fully metallic parts after appropriate post-processing (debinding and sintering). The research investigated the influence of printing parameters on the density, porosity, and mechanical properties of fabricated elements. A parameter matrix was developed, test samples were produced, and subsequently subjected to microscopic analysis, hardness measurements, and mechanical testing. Preliminary results indicate that appropriate modification of printing parameters significantly improves the structural properties of the components. With further optimization, MEX technology may offer a competitive alternative to more expensive metal additive manufacturing methods, particularly in prototyping and low-volume production applications.

Application of machine learning to predict porosity of 42CrMo4 steel components manufactured by PBF-LB/M technique

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Keywords: powder bed fusion, porosity, machine learning, random forest algorithm

Abstract

One of the crucial limitations of additive manufacturing technique is porosity of the manufactured elements, as it strongly affects mechanical properties of the component. The way to limit this effect may be a proper set of process parameters. This research presents the application of supervised machine learning algorithm – RFR (Random Forest Regression) to predict porosity of 42CrMo4 steel components manufactured by PBF-LB/M technique depends on process parameters as laser power, scanning speed and hatch distance. As a result, the model for elements' porosity predictions has been presented.

Dual Beam Laser Sintering – closed loop PA12 reuse

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Keywords: additive manufacturing, 3D printing, dual beam laser sintering, polyamide 12, powder reuse

Abstract

Powder Bed Fusion (PBF) is an Additive Manufacturing technique that uses a laser beam to sinter polymer powders, primarily semi-crystalline polyamide 12. Despite its ability to efficiently produce complex parts in a single-step process, one of the main challenges limiting its large-scale adoption is the thermal degradation of the feedstock. Throughout the manufacturing cycle, continuous preheating degrades the material, making the process highly inefficient. Only about 10% of the raw polymer is effectively utilized [1]. The rest, having been subjected to extended heat exposure without melting, becomes unsuitable for direct reuse in subsequent manufacturing cycles – it needs to be mixed with virgin powder, doped, hydrated, recycled or upcycled [2–6].

In this work we demonstrate closed-loop reuse of polyamide 12 (PA2201, EOS, Krailling, Germany) in Dual Beam Laser Sintering [7–10] that uses two laser beams – one for heating and one for sintering. This change in heating strategy (from heaters/halogen lamps) ensures proper PBF process temperature, prevents material shrinkage and allows the process to be conducted at room temperature. To thoroughly test and demonstrate DBLS in closed-loop reuse scheme, 4 iterations of build processes were done. The first one was loaded with virgin powder, the later ones used material from previous ones, up until all input material was used. At each iteration produced specimens and postprocess powder were analysed.

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Physics-informed neural network modeling of template-based copper electrodeposition for 3D printing design

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Keywords: PINN, Nernst–Planck equation, template electrodeposition, porous electrode, lithium-ion battery

Abstract

Porous electrode design enhances lithium-ion battery performance by maximizing the surface area for electrochemical reactions, improving ion diffusion efficiency, and reducing mechanical damage during repeated charge-discharge cycles. This study employs Physics-Informed Neural Networks (PINNs) to solve the coupled Nernst–Planck and Poisson equations (D of Cu^{2+} = 1.2×10^{-9} m^2/s; applied potential ≤0.45 V) for modeling template-based copper electrodeposition. A polystyrene template is introduced as a parametric porous scaffold, featuring customizable cylindrical pores with adjustable radius, height, and spacing. By embedding the scaffold's geometry into the PINN framework through boundary conditions at sampled collocation points, the method enables the simulation of ion transport and electric potential distributions. The results enable the optimization of 3D-printed metal structures with resolution below 100 µm, paving the way for scalable electrodeposition manufacturing processes.

Optimizing Process Parameters for Laser-Based Powder Bed Fusion of PAEK at Reduced Temperatures

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Keywords: PAEK, PBF-LB, Processing parameters, Energy Density, Strategies.

Abstract

Polyaryletherketone (PAEK) is a high-performance polymer with significant potential in additive manufacturing, particularly Laser-Based Powder Bed Fusion (PBF-LB), due to its unique mechanical and chemical resistance. However, the high processing temperature required for PAEK in PBF-LB (≥340°C) poses a significant challenge. Most commercial mid-range PBF-LB systems, such as the Farsoon ST252P, are designed for medium-temperature polymers (≤280°C), like polyamides, and are not equipped to reach or sustain such high temperatures. This suboptimal temperature limitation of mid-range PBF-LB systems often results in issues such as distortion, incomplete melting or loose fusion of powder in the core, delamination, poor surface quality, and weakened mechanical properties, thereby limiting the broader adoption of PAEK in such systems.

This research aims to address this limitation by investigating strategies of PBF-LB process parameter to enable PAEK polymer processing in PBF-LB at a reduced temperature. A crucial aspect of this study is the systematic optimization of PBF-LB parameters, including scanning strategies, scan speed, laser power, and scan count, to precisely control energy density within the powder bed. The influence of these parameters on melt pool formation, part density, and mechanical properties will be thoroughly evaluated. It is hypothesized that by carefully tailoring the PBF-LB process to the PAEK polymer, it will be possible to achieve high-quality parts with enhanced dimensional accuracy and improved mechanical performance compared to parts produced at conventional high temperatures. The expected outcomes of this research include an expanded and understand processing window effects for PAEK in PBF-LB and the development of a robust processing strategy for manufacturing high-performance components for demanding applications in the aerospace, automotive, and medical industries.

Carrageenan-based hydrogels for use in drug formulation via semi-solid 3D printing technology

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Keywords: 3D printing, semi-solid extrusion, hydrogel printability, carrageenan, drug delivery

Abstract

Introduction

Hydrogels are three-dimensional networks formed by hydrophilic polymers. Due to their unique physicochemical and biological properties, they are widely used in medicine and pharmacotherapy, especially as carriers for drug delivery and dressings to promote wound healing. The semi-solid extrusion (SSE) 3D printing facilitates the extrusion of hydrogels using a syringe to produce the desired object, thereby enabling individualisation of a drug form. In this study, we used a natural polysaccharide, namely κ-carrageenan, as the base material of the designed formulations due to its characteristic gelation mechanism and favourable physicochemical properties.

Objectives

The aim of the proposed study was to design new hydrogel materials with an incorporated active pharmaceutical substance (API) based on a natural polymer – κ-carrageen, which could be used in SSE 3D printing.

Materials and methods

κ-carrageenan water-based placebo and drug-containing formulations were prepared. The obtained formulations were evaluated for their pharmaceutical properties (content uniformity, dissolution, etc.) and their application in SSE 3D printing. The influence of adjusting the printing parameters (e.g. extrusion speed, size and shape of the printing nozzle) on the final quality of the prints produced from each formulation was also investigated.

Results and conclusions

The study demonstrates the feasibility of using the designed hydrogels as inks for SSE 3D printer. A notable property of the developed hydrogels is their high-water content (over 90%), which contributes to their favourable biocompatibility with human tissues and facilitates the release and absorption of APIs from the designed pharmaceutical formulations. Considering their properties, the prints produced by this method show potential for use as convenient drug delivery formulations and may open the way for the use of carrageenan-based hydrogels in various drug delivery applications.

Ultrasonic Atomization of Waste Materials: A Case Study on MS1 Steel

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Keywords: ultrasonic atomization, 3D printing, maraging steel, metal powder

Abstract

This study explores the application of ultrasonic atomization for recycling metal waste, focusing on MS1 steel. In the process, molten MS1 steel was directed onto a vibrating sonotrode, where it was fragmented into fine powder particles due to high-frequency oscillations. This method enabled the effective recycling of 3D printing waste, converting it back into a reusable powder suitable for further additive manufacturing applications. From an initial 8 kg of metallic waste, 4 kg of high-purity powder was successfully recovered. The obtained powder was subjected to characterization, including chemical composition and material properties assessment. The study confirms that ultrasonic atomization is a viable and promising technique for sustainable metal recycling, offering a potential alternative to conventional powder production methods while reducing material waste in metal additive manufacturing.

Evaluation of catalytic activity of nickel/silica catalysts for Sabatier reaction prepared by Direct Ink Writing

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Keywords: Direct Ink Writing, composite catalysts, catalysis, Sabatier reaction

Abstract
3D printing methods make it possible to obtain catalysts with strictly designed geometries that influence heat and mass transport which provide the efficiency of the catalytic process. Among them, Direct Ink Writing can be used to prepare catalysts in which nickel is the catalytic active substance and silica is the support to ensure proper metal dispersion. In this research a detailed analysis of the microstructure of the obtained catalysts was made for assessing the geometry and reproduction of the predesigned virtual 3D models. For this, scanning electron microscopy (for the samples and their cross-sections) and micro computed tomography were applied. The catalytic activity of the obtained materials in the Sabatier reaction, in which methane and water are obtained from carbon dioxide and hydrogen, has been studied.

Copper conductive lines with glass insulation by a melt extrusion process – Coco

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Keywords: additive manufacturing, fused filament fabrication, copper, glass, molten metal extrusion

Abstract

Due to its high conductivity and thermal conductivity, copper is a key element in renewable energy technologies and electronics. Printed copper structures with high temperature resistant dielectrics are of growing interest in power electronics, photovoltaics and aerospace. Glass is particularly valuable due to its chemical, mechanical and optical properties, its thermal stability and its electrical and thermal insulation. The aim of the Coco project is to develop a multifunctional material concept for electronics and sensor applications that combines copper and glass. Using additive manufacturing techniques, miniaturised, energy- and material-efficient 3D components with electrical functionality are to be produced. To this end, the development of a hybrid process based on FFF for the simultaneous processing of copper and glass in one machine is planned. In addition, low-cost, highly sensitive electrochemical sensors are to be developed and the use of hazardous substances reduced.

Polymer-Metal 3D Printing using hybrid material extrusion – Pompey

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Keywords: additive manufacturing, fused filament fabrication, polymer, metal, molten metal extrusion

Abstract

Innovative additive manufacturing (AM) technologies can produce custom products and open new possibilities for making electronic components. Multi-material technologies also allow electronic circuits and devices to be repaired, making them more durable. Today's challenges for AM technologies in electronics include multi-material processing and quality control of multilayer structures, high productivity, and advanced assembly and interconnection techniques. The Pompey project focuses on AM processes to produce multi-material components with defined electrical properties. It investigates metal and polymer combinations designed to exploit additive manufacturing for innovative applications such as electronics. Its multi-material extrusion process makes miniaturized electronic components with improved performance by integrating electronics into the structure of the component. This process is characterized by low material and energy consumption and allows for the repair of electronic devices.

Application of VPP 3D printing technique to obtain ceramic objects

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Keywords: nanocomposites, photopolymerization, 3D printing

Abstract

Photopolymerization based on the process of photo-curing photosensitive resins is a rapidly growing field of science that also includes the manufacture of ceramic materials. Pre-printed gyroidal objects consisting of an organic polymer matrix and a filler in the form of, for example, highly packed zirconium oxide is fired in special furnaces to obtain an inorganic skeleton. Such materials can be used, for example, in biomedical applications to study bone cell proliferation under conditions similar to actual bone tissue in the human body or directly as bone fillers.

In this paper, composite polymer objects were made in the form of prints made by the 3D VPP method, and the effect of the filler on photopolymerization processes, among other things, was studied.

Research funding from the National Center for Research and Development – LIDER PROJECT13/0081/2022 "Innovative porous ceramic materials printed by DLP technique using high-performance photochemical initiators dedicated to bone tissue integration".

New photoinitiators for 3D VPP printing with photopolymerization techniques for printing micro-needles for biomedical applications

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Keywords: photopolymerization, 3D printing, biomedical

Abstract

The VPP 3D printing method uses light-curing resins to produce precision polymer objects. It has found its application in biomedicine in the production of objects in the form of micro-needles that can minimally invasively deliver portions of drugs into the patient's body. The search for new photoinitiators and initiator systems plays a major role because an extremely important issue during this type of bioprinting is the use of non-toxic and biocompatible photoinitiators, which minimizes the occurrence of dangerous allergies. In addition, the selection of the right photoinitiator allows to increase the speed and efficiency of the photopolymerization process itself.

This paper presents a basic spectroscopic study of new photoinitiators and their application to photopolymerization processes and 3D printing by the VPP method, detailing micro-needle type objects.

Research financed within the framework of the competition no. 2024/ABM/03/KPO/ project no. KPOD.07.07-IW.07-0125/24 entitled: "Title of the Undertaking: Luminescent theranostic compounds with anticancer activity, i.e., combination of photodynamic therapy and diagnostics through imaging in a single molecule and development of 3D printed topical micro-needle systems to provide precise individualized cancer therapy" from the National Plan for Reconstruction and Enhancement of Immunity, part of Investment D3.1.1 Comprehensive Development of Research in Medical and Health Sciences, a project funded by the Medical Research Authority.

SPARK (Strong Performance Alloys for Rocket Kinetics)

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Keywords: Additive Manufacturing of RHEA, Refractory High Entropy Alloys, High-Temperature Materials, 3D Printed Engine Components

Abstract

SPARK (Strong Performance Alloys for Rocket Kinetics) is a joint project by Bimo Tech and ArianeGroup, focused on developing next-generation metallic materials for future European liquid propulsion systems. The goal is to enhance performance, durability, and thermal resistance of engine components operating under extreme conditions. The project includes the Additive Manufacturing of Refractory High-Entropy Alloys (RHEAs), enabling the production of complex parts designed for high-stress, high-temperature environments. Through advanced material design, prototyping, and validation, SPARK supports sustainable, high-efficiency propulsion technologies aligned with ESA's long-term space transportation strategy. The project brings together industrial and scientific expertise to strengthen Europe's competitiveness in space launch capabilities.

Frontal photopolymerization as a new technique for additive manufacturing processes of obtaining composites materials

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Keywords: photopolymerization, biomedical

Abstract

In recent years, frontal polymerization has received increasing attention in various fields. Its ability to solidify thick samples containing up to 50% different fillers by point delivery of energy highlights its potential as a highly effective curing technique. The method offers broad applications in materials science, industrial applications and the creation of three-dimensional structures. Frontal polymerization is distinguished by exceptional energy efficiency and minimal labor requirements. When a directed pulse of energy, such as a light beam, is applied, the material initiates curing through a self-sustaining thermal reaction driven by the heat generated during the process. The high-temperature polymerization front then propagates through the material, defining the technique's name. This approach not only reduces curing time from hours to less than 10 minutes, but also reduces energy consumption by at least 20 times.

Research funding from the project "Innovative iodonium initiators for curing prepreg composite materials by photoinduced frontal polymerization" carried out within the Proof of Concept programme of the Foundation for Polish Science co-financed by the European Union under the European Funds for Smart Economy 2021–2027 (FENG). Grant agreement number: FENG.02.07-IP.05-0074/23.

Thermal-Structural Modeling of Additively Manufactured Ni-YSZ Layers for SOFC Electrodes applications

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Keywords: additive manufacturing (AM), thermodynamic modeling, laser processing, energy conversion technology, solid oxide fuel cells (SOFC)

Abstract

This study presents a thermodynamic computational framework for modeling the additive manufacturing (AM) of nickel-yttria-stabilized zirconia (Ni-YSZ) materials through a layer-by-layer approach, with direct implications for solid oxide fuel cell (SOFC) electrode fabrication. The research is driven by the critical role of Ni-YSZ in SOFC anodes, where tailored porosity and microstructure govern gas diffusion, ionic conductivity, and electrochemical efficiency. A partial differential equation (PDE) governing heat transfer is formulated to describe the thermal behavior during AM, incorporating temperature-dependent material properties, phase-specific enthalpy, and a Gaussian laser heat source (Q laser) with a power input of 200 W and bidirectional scanning speed of 800 mm/s. The model introduces an apparent specific heat capacity derived from the enthalpy-temperature relationship of Ni-YSZ, enabling phase-specific (solid/liquid) and layer-specific (top/bottom) thermal characterization. The bottom layer is treated as a bulk continuum with temperature-dependent density and thermal conductivity, while the top layer is modeled as a porous medium with an initial packing density (ρ_c = 0.6), reflecting the unconsolidated powder state. This dual-layer approach directly addresses SOFC electrode requirements, where graded porosity is essential for balancing mechanical stability and catalytic activity. Temperature-dependent thermophysical properties are explicitly integrated, distinguishing dense and porous layers to capture their unique behaviors. By leveraging enthalpy data from literature, the framework predicts transient thermal profiles, phase transitions, and energy distribution during AM. The model's ability to correlate laser parameters (e.g., power, scan speed) with layer-specific porosity and thermal history provides actionable insights for optimizing SOFC electrode architectures. The results advance defect mitigation and microstructural control in ceramic-metal composites, offering a pathway to enhance the durability and performance of SOFC systems through precision AM.

Additive Manufacturing of Conical Interference-FIT Joints from 42CRMO4 Steel with Laser-Hardened Zones Using the SLM Technique

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Keywords: L-PBF, postprocessing, 4140 steel, mechanical joints, drive components

Abstract

The paper presents the process of manufacturing model components of a conical interference-fit joint made from 42CrMo4 steel using the Selective Laser Melting (SLM) technique. In the initial stage of the work, manufacturing parameters were selected for the SLM technique, with a focus on achieving the lowest possible porosity. Subsequently, volumetric heat treatment of the test samples was performed, and laser strengthening paths were applied. Measurements of microhardness were conducted on both the base material and the laser-strengthened material, followed by an analysis of their microstructure. The microstructure of the material produced by the SLM technique was studied in the state immediately after printing and in the heat-cured areas. Measurements were made of the width and depth of the laser enhancement paths depending on the parameters of the exposure process.

Composite metal/silica catalysts for Sabatier reaction prepared by Direct Ink Writing

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Keywords: Direct Ink Writing, composite catalysts, catalysis, Sabatier reaction

Abstract

Direct Ink Writing (DIW) is a versatile method of processing materials of different compositions (polymers, ceramics, metals) in the form of pastes with specific rheological properties. In particular, the method can be used to obtain composite catalysts in which the support material is silica, and the catalytically active substance is nickel. The research shows the full procedure for the preparation of nickel/silica scaffolds, starting from the preparation of the pastes (with a high content of a specific metal powder), through optimization of the processing (pressure, printing speed), and finally structural characterization of the changes occurring during thermal processing (X-ray diffractometry and infrared spectroscopy) and microstructural (evaluation of the geometry of the final samples and distribution of the catalytically active substance).

Digital Twin for Phase Transition Prediction in Laser-Based Additive Manufacturing: A Phase-Field and U-Net Model Framework

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Keywords: non-isothermal model, thermodynamic driving force, moving heat source, Virtual Digital Twin

Abstract

Laser-material interactions in additive manufacturing challenge precision engineering. We introduce a Virtual Digital Twin framework combining Phase-Field Simulations and a U-Net model to predict phase evolution in unary Au system under laser processing. We analyse Gaussian, Flat-Top, Ring, and Bessel beam profiles with two free energy models, showing their strong influence on melt pool dynamics. A lead-lag between heat and phase diffusion fronts emerges with thermodynamic database (TDB) based free energy. The U-Net achieves >90% accuracy in phase prediction from thermal data. An interactive tool enables real-time phase forecasts from user-input temperature fields, advancing physics-informed Virtual Digital Twins for laser-based manufacturing.

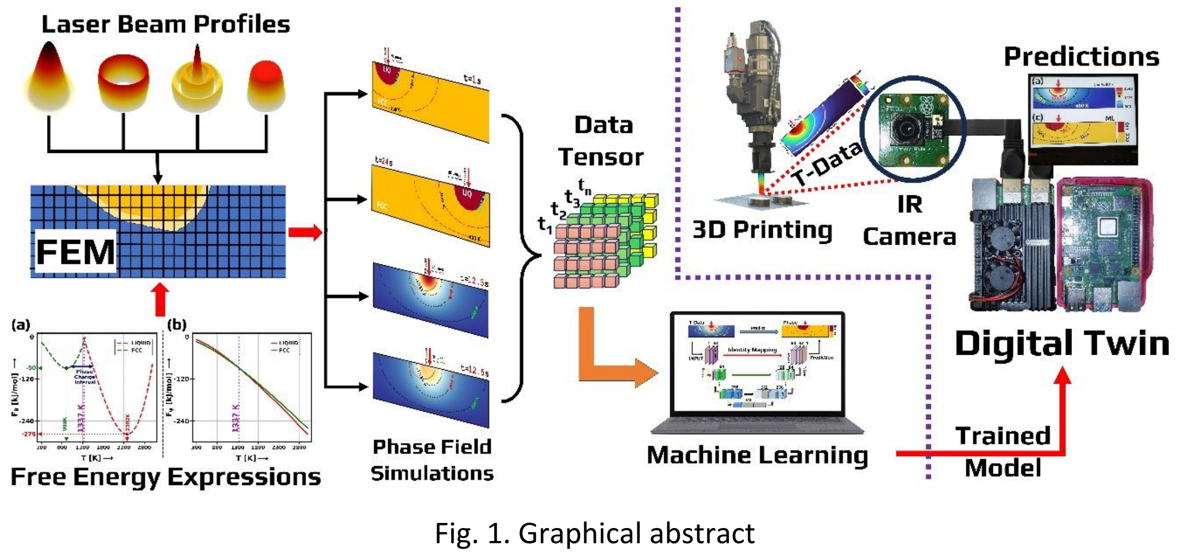

Fig. 1. Graphical abstract

Selection of process parameters for the fabrication of lattice structures

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Keywords: PBF-LB, process parameters selection, lattice structures, porosity formation

Abstract

The selection of process parameters in PBF-LB (Laser Beam Powder Bed Fusion) technology is mainly based on material and powder characteristics. Less discussed is the selection of process parameters in relation to the geometry to be produced. An example of a complex geometry widely used in additive manufacturing is lattice structures. This is due to their ability to reduce weight, minimize material usage, and tailor mechanical properties through geometric design. As these structures become more widely used, it is important to assess whether the process parameters should be different from those used for solid parts. Experiments with AISI 316L stainless steel have shown that lattice structures can be produced with significantly lower volumetric energy density while maintaining high relative material density. These results are particularly relevant for improving the manufacture of lattice structures, as lower energy input generally improves geometric precision and reduces internal stresses. In addition, the results indicate that the nodes of beam lattice structures are critical regions prone to porosity formation.

Influence of Geometry on Energy Absorption Properties of Additively Manufactured Gyroid, Split P and Diamond TPMS structures

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Keywords: TPMS, energy absorption, crashworthiness, deformation modes

Abstract

With the development of Additive Manufacturing, complex structures such as Triply Periodic Minimal Surface (TPMS) structures can now be produced and analysed. Their unique properties allow for a wide range of applications, sparking interest among researchers in numerous fields.

This work focuses on the analysis and comparison of Gyroid, Diamond, and Split P TPMS structures produced with use of powder bed fusion process in selective laser melting technology. The main area of interest was how the geometric differences, so the cell geometry and size, influence energy absorption properties and deformation modes under load.

Comparative Study of Binder Jetting, Fused Deposition Modeling and Sintering (FDMS), Selective Laser Melting (SLM), and Laser Metal Deposition (LMD) Printing Technologies for H13 Tool Steel Production

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Abstract

This study compares the properties of H13 tool steel produced using Binder Jetting, Fused Deposition Modeling and Sintering (FDMS), Selective Laser Melting (SLM), and Laser Metal Deposition (LMD) additive manufacturing methods. The results show significant differences in porosity and microstructure among these methods. SLM and LMD produced materials with minimal porosity and high hardness, reaching 600 HV0.5, while Binder Jetting and FDMS exhibited higher porosity and required heat treatment to achieve acceptable properties. Post-process heat treatment was crucial for enhancing hardness and microstructural uniformity. For Binder Jetting, heat treatment led to the formation of post-martensitic structures with fine precipitates, while SLM and LMD retained their martensitic structures with improved clarity of martensitic laths after heat treatment. The study emphasizes the importance of selecting appropriate additive manufacturing methods and post-processing techniques for hot working applications.

Bulk metallic glass composites for green energy transition

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Keywords: bulk metallic glass composites, additive manufacturing

Abstract

Bulk metallic glasses (BMGs) are a unique class of metallic alloys that possess a low melting point and solidify with an amorphous structure which makes them extraordinarily strong and elastic. One possibility to form functional composites, called bulk metallic glass composites (BMGCs), with high mechanical performance is through the addition of a second phase, called the functional filler, into the amorphous BMG matrix [2].

Fe-based BMGs are inherently soft magnetic in nature. However, they are susceptible to high eddy current losses due to the lack of high electrical resistivity. Zirconium based BMGs on the other hand have high fatigue strength. Their unique tribological properties make them suitable candidates for applications that require high wear resistance. Our aim is to produce composites with various functional filler particles to enhance the saturation magnetization of Fe based BMGs and the tribological properties of Zr based BMGs through various manufacturing routes such as hot pressing, Spark Plasma Sintering (SPS) and Additive Manufacturing (AM). Since BMGs undergo significant softening in the supercooled liquid region (SCLR), they can be processed at considerably lower temperatures(400–600°C) by thermoplastic forming. Low temperatures ensure increased stability of the temperature sensitive functional filler particles and prevent interfacial reactions between the two phases.

In recent years, Selective Laser Sintering (SLS) has emerged as a promising technology that allows the processing of BMGs and BMGCs [3, 4] at sufficiently high cooling rates while allowing the fabrication of complex geometries. The use of SLS presents a promising approach for developing prototypes with functional BMGCs that can be experimentally tested in operational environments.

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Revolution in polymer powder materials for Selective Laser Sintering industry

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Keywords: SpheroNANO, sferoidization, FOAMID, Polyolefine, recykling

Abstract

Alpha Powders is revolutionising the approach to producing 3D printing materials by offering spheroidisation technology that enables the production of powders of unprecedented quality and democratises access to powder production technology.

3D printing with polymer powders faces several problems, as a result of which the technology has not yet been widely implemented as a manufacturing technology in the industry. These problems include the high cost of powders, the narrow portfolio of available materials, waste management, and the quality of powders available on the market.

Alpha Powders offers comprehensive services in producing and optimising polymer powders for 3D printing, including a unique spheroidisation technology that transforms irregular powders into perfectly spherical ones with high flowability and packing density. The company offers laboratory services where customers can send suboptimal powder, have it spheroidised and receive the test results. In addition, Alfa Powders sells the spheroNANO device, which enables the production of experimental powder batches and offers powders by cryogenic grinding and composition according to customer requirements. In addition, the company provides a powder recycling service that restores the properties of used material and enables its further use in 3D printing.

The 3D printing market is characterised by very dynamic growth. Within this market, powder technologies such as SLS and MJF are growing by up to 22–23% per year and are expected to reach nearly 65 billion dollars by 2029. 3D printing with powders is being implemented in a wide range of industries, e.g., aviation, automotive, and medtech. Alpha Powders is part of this dynamic growth, offering completely innovative technologies that solve key problems with 3D printing materials.

Laser-induced periodic surface structuring of Ti-6Al-7Nb alloy manufactured by L-PBF for medical applications

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Keywords: laser-induced periodic surface structures, Laser Powder Bed Fusion (L-PBF), surface topography, biocompatibility, implantology

Abstract

Additive manufacturing, particularly Laser Powder Bed Fusion, is increasingly used in implantology to produce complex, patient-specific implants. This technology enables the creation of customized components with geometries, which are difficult to achieve using conventional methods.

Titanium alloy samples were fabricated using L-PBF and modified through laser surface structuring to obtain periodic patterns. Surface roughness, wear resistance, and microstructure were evaluated.

Laser structuring and surface preparation were found to influence the biocompatibility of the material. The surface topography and overall characteristics are key factors in enhancing biological response and tissue integration.

L-PBF offers a promising method for producing customized, biofunctional implants. Combining surface structuring and material preparation enhances biocompatibility, making L-PBF a key technology in implantology.

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