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3DPrinting-2022

2nd Global Summit on 3D Printing & Additive Manufacturing

June 13, 2022 **Copenhagen, Denmark**

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FOREWORD

Dear Colleagues,

It is a great pleasure to announce that The Scientistt will host the Global Summit on 3D Printing & Additive Manufacturing (3DPrinting-2022) will be held in Copenhagen, Denmark during June 13-15, 2022.

3DPrinting-2022 aims to bring together the renowned researchers, scientists and scholars to exchange ideas, to present sophisticated research works and to discuss hot topics in the field and share their experiences on all aspects of 3D Printing & Additive Manufacturing.

The 3DPrinting-2022 will be a 3 days event that means to gather the key players of the 3D Printing & Additive Manufacturing community and related sectors. This event is launched with the aims to become an established event, attracting global participants, intent on sharing, exchanging and exploring new avenues of 3D Printing & Additive Manufacturing-related scientific and commercial developments.

A wide-ranging scientific program consisting of plenary lectures, keynote lectures, Invited lectures, parallel sessions, as well as poster sessions for young scientists covering all topics in 3D Printing & Additive Manufacturing will be scheduled. This conference provides a wonderful opportunity for you to enhance your knowledge about the newest interdisciplinary approaches in 3D Printing & Additive Manufacturing.

Moreover, the conference offers a valuable platform to create new contacts in the field of 3D Printing & Additive Manufacturing, by providing valuable networking time for you to meet great personnel in the field.

We look forward to seeing you at 3DPrinting-2022 in Copenhagen, Denmark.

COMMITTEES

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Plenary Forum
Day-1

Ian D. Walker

Continuum Robot Hoses and 3D Printing Applications

Abstract

This talk will discuss issues in the design, modeling, prototyping, and deployment of continuum robot hoses. Operated as active hoses, continuous backbone continuum robots can use their inherent compliance to actively maneuver to access areas inaccessible to conventional hoses. They can be used to deliver payloads ranging from compressed air and water to medicines, fuel, or cementious materials. Alternative design options for continuum robot hoses, including pneumatic actuation and tendon-based designs, will be reviewed, along with approaches to their modeling and control. Potential applications, including firefighting, ship-to-ship refueling, and 3D printing of cement in construction, will be discussed.

Keynote Forum
Day-1

M. Chiumenti, M. Cervera, J. Baiges, M. Caicedo, C.A. Moreira

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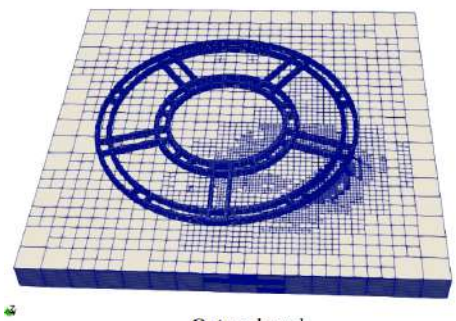
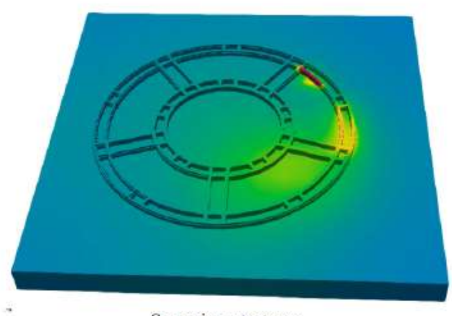
Computational Framework for the Simulation of Additive Manufacturing Processes

Abstract

In this work the current developments on the numerical simulation of different AM processesare presented. A fully coupled thermo-mechanical framework has been tailored to the analysis of several 3D-printing processes ranging from Wire-feeding, Blown-powder or powder-bed technologies. The accurate definition of the material deposition is addressed taking into account actual movement of the heat sourcealong the scanning path as defined through the use of the same g-code file as delivered to the AM machine. The result is a high-fidelity simulation of the AM process leading to an accurate layer-by-layer building sequence. An advanced high-performance and object-oriented software platform has been enhanced to simulate the fabrication process. The mesh adaptivity strategy makes use of Cartesian grids together with octree-type local refinements and global coarsening to keep controlled the total number of elements in the computational domain. The thermo-viscoelastic-viscoplastic constitutive model introduced is calibrated and the numerical results are validatedthroughan extensive experimental campaign carried out taking advantage of the partnership with several industrial partners and research center such as:ArcelorMittal (Spain) ,NorthwesternPolytechnical University (Xi'an, China), Monash and RMIT Universities (Melbourne, Australia), IK4-Lortek, Leitat, Eurecat (Spain), among others.



Octree-based
Automatic Mesh Refinement (**AMR**)



Scanning strategy:
Temperature evolution

Keywords

MetalAdditive Manufacturing, Metal Deposition, Thermo-mechanical modeling, Wire-feeding, Blown-powder, Powder-bed

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3D Printed Porous Ceramic Architectures for Functional Applications

Abstract
Additive manufacturing (AM) techniques are able to develop robust and multifunctional porous architectures with a precise patterning control of the macroporosity, which could tentatively be employed for advanced technological applications such as catalysts, energy absorbers, sensors, etc. In this way, Robocasting, a fast and versatile direct ink writing technique that requires concentrated colloidal aqueous inks, allows manufacturing self-supported 3D cellular ceramic parts with geometric and material complexities. The control over the ink rheology is critical to assure continuous and smooth flowing of the printed filament, preserving the overall scaffold integrity as well.

Here, I present some examples of 3D porous ceramics printed by Robocasting based on silicon carbide (SiC), SiC/carbon nanostructures, aluminum nitride, MAX-phase and clays, which exhibit good mechanical resistance and different functionalities for distinct applications [1-6]. Some of these 3D cellular architectures present excellent catalytic performance for wastewater treatments and synthesis of chemical products, superhydrophobicity for water/oil filtration, high electrical conductivity for electrodes, acoustic wave propagation control for sound absorbers, thermal dissipation for heat sinks, high thermal oxidation resistance for aeronautic applications, or high thermal energy storage efficiency for solar plants.

Keywords
Robocasting, direct ink writing, ceramics, porous scaffolds, environmental, energy

References
[1] B. Román-Manso, M. Belmonte, M.I. Osendi, P. Miranzo, J. Am. Ceram. Soc.,98, 2745 – 2753, (2015).
[2] A. Kruisová, M. Sevcik, H. Seiner, P. Sedlak, B. Roman-Manso, P. Miranzo, M. Belmonte, M. Landa, Ultrasonics,82, 91 – 100, (2018).
[3] A. Quintanilla, J. A. Casas, P. Miranzo, M. I. Osendi, M. Belmonte, Appl. Catal. B-Environ.,235, 246 – 255, (2018).
[4] M. Belmonte, M. Koller, J. J. Moyano, H. Seiner, P. Miranzo, M. I. Osendi, J. González-Julián, Adv. Mater. Technol.,4, 1900375, (2019).
[5] M. Belmonte, G. Lopez-Navarrete, M. I. Osendi, P. Miranzo,J. Eur. Ceram. Soc.,41, 2407 – 2414, (2021).
[6] A. D. Salazar-Aguilar, A. Quintanilla, P. Lopez, C. Martinez, S. M. Vega-Díaz, J. A. Casas, P. Miranzo, M. I. Osendi, M. Belmonte,ACS Appl. Mat. Inter.,14, 920 – 932, (2022).

Biography
I received my Ph.D. degree (1995) in Chemistry from University Autónoma of Madrid, Spain, developing ceramic matrix composites with improved tribological and mechanical properties at the

Institute of Ceramics and Glass (ICV-CSIC), Spanish National Research Council (CSIC). After six years industrial experience in Lucent Technologies Inc. as R&D photolithographic engineer and more than two years as postdoctoral fellow at NIST (USA) and University of Aveiro (Portugal), I joined at ICV-CSIC in 2004 as senior researcher. One of my current research interests is related to the 3D printing, by robocasting, of novel cellular ceramics and composites for energy (solar) and environmental (catalysis) applications. I have published about 130 peer-reviewed scientific papers (h-index = 31), co-invented 4 patents,and I am lecturer in Master and Doctoral courses in national and foreign universities.

Invited Forum
Day-1

R.E. Logé1*,J. Jhabvala1, T. Ivas1, E. Boillat1, H. Ghasemi-Tabasi1, J.E.K. Schawe2,3, J.F. Löffler2, N. Sohrabi1

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Laser Powder Bed Fusion of a Zr-based Bulk Metallic Glass: Numerical Modelling, Process Optimization and Final Properties

Abstract
Laser Powder Bed Fusion (LPBF, also known as SLM, Selective Laser Melting) is a well-known Additive Manufacturing (AM) technology, among the most studied in literature for metals and alloys. Bulk Metallic Glasses (BMGs) produced by conventional methods are limited in size due to the high cooling rates required to avoid crystallization and the associated detrimental mechanical properties. LPBFtherefore represents a way of producing larger parts with more complex geometries, as the interaction between the heat source and the powder is short and confined to a small volume. However, producing amorphous parts with mechanical properties comparable to as-cast samples remains a challenge for most BMGs, and a complete understanding of the crystallization mechanisms is missing.
In this work, we present a thermal finite element modelling of the LPBF process and show how it can help determining optimal process conditions. The approach is applied to a Zr-based BMG, and leads to excellent geometrical accuracy and static mechanical properties. A further step is then taken for predicting crystallized fractions in the fabricated part, exploiting time-temperature-transformation (TTT) diagrams measured via fast differential scanning calorimetry. This approach brings new degrees of freedom in the control of the final properties, leading to a subtle tradeoff between processing time and crystallized fraction.

Keywords
Laser Powder Bed Fusion, Bulk Metallic Glasses, crystallization, finite element.

Biography
Roland Loge is an associate professor at EPFL, with a primary affiliation to the Materials Institute, and a secondary affiliation to the Electrical and Microengineering Institute. He is the head of the Laboratory of Thermomechanical Metallurgy, and active in the field of processing of metals and alloys in the solid state, focusing on the ability to tailor microstructures, and the associated material properties. Phenomena of interest include recrystallization, precipitation, grain growth, textures and grain boundary engineering, phase transformations, internal stresses and cracking phenomena, with applications to bulk metal forming and additive manufacturing.

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Global and Local Buckling Phenomena in FFF Printed Polymeric Elements

Abstract

In recent years, many works discussed if, and to what extent, Fused Filament Fabrication (FFF) could shift from prototyping to manufacturing small productions or individual components. Several authors investigated some mechanical properties of FFF 3D-printed elements under specific printing parameters; others identified the influence of some processing parameters on those properties. Finally, still others tried to trace back their mechanical response with micro or macromechanical approaches. However, the compressive response received little attention.

In this work, the authors studied how Polylactic Acid (PLA) 3D printed specimens behaved under compression, focusing on the buckling problem. The anisotropy of FFF printed components is well-known; the study is limited to the normal direction to the build plate. The global and the local buckling problems have been considered; an extensive experimental campaign studied the critical load trends over a wide range of slenderness ratios. This has been coupled with a preliminary campaign devoted to tensile and compressive properties determination, which demonstrated a strong asymmetric behavior in tensile-compressive mechanical properties of FFF PLA, which suggests that such phenomena cannot be predicted without a dedicated approach. A single-camera Digital Image Correlation (DIC) system monitored the coupons all the test long; this allowed to evaluate the occurrence of buckling by observing the transverse displacements to the load application direction. To this end, the authors choose the specimen geometries to induce buckling in a specific plane. The global buckling phenomenon has been studied through specimens with a constant and squared cross-section. The local buckling investigation considered T-shaped coupons with such geometry to induce the web phenomenon. The analysis revealed that a linear relation well describes the transverse displacement vs. applied load in the pre and post-buckling: their intersection reported the buckling load of each specimen. The authors observed the critical loads decreasing with an increase in the slenderness ratio and evaluated the capability of established analytical models for buckling critical load estimation in isotropic materials to predict the failures. Regarding the global buckling, reference has been made to the Linear Euler model, the Tangent Modulus theory, and Johnson's formula. As to the local, the plate buckling equation has been considered to predict web buckling. In the first scenario, the Tangent Modulus theory well predicted the plastic field phenomenon and the Linear Euler model in the linear field. In the second scenario, the plate buckling equation slightly underestimated web buckling, still providing excellent indications. However, those estimations relied on the compressive mechanical properties: with the tensile ones, the estimates were poor.

Keywords

additive manufacturing, fused filament fabrication, buckling, digital image correlation, experimental analysis

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Predicting Laser Melting Deposition Outcomes by Computationally Efficient Analytical Models with Experimental Verification

Abstract

Laser melting deposition (LMD) is a 3D printing method that consists of depositing a metal or composite material from a powder precursor blown into a laser beam. Our group developed analytical models that predict the deposited layers' characteristics and induced residual stress distribution, profoundly influencing the manufactured parts' quality, mechanical, and physical properties. We can estimate the clad geometry of the 1st deposited layer. Further on, a hatch distance is used to calculate the re-melting depth and total clad geometry for all the deposited layers. We can also estimate the residual stress distribution within the substrate and deposited layers. These phenomena became incrementally iterative with the number of layers to be deposited, thus presenting a direct relationship between the residual stress distribution and the number of layers deposited on the substrate. We investigated the effect of the focal point position on powder stream distribution. It was found that the focal point position plays a key role in determining the shape of the powder stream, such that an increment in the distance from the focus point will gradually transform the powder stream from the Gaussian to Transition and from the Transition to Annular streams. The attenuation ratio prevails in the LMD process by raising the powder flow rate, decreasing the laser energy density arriving at the substrate. The model provides indications on the amount of powder and the optimal value of the laser power to be used to allow for a quality deposition process. We also developed a new mathematical model to calculate the number of grains and their average size inside a single printed layer. The printed layer's thermal history concerning the moving laser beam and co-axial addition of powder debits was analyzed and used to calculate the thermal stress and strain rate. The average grain size within the printed layer was calculated using the Johnson-Mehl-Avrami-Kolmogorov (JMAK) model. The mechanical properties, including ultimate tensile strength, yield strength, and hardness, were estimated using the average grain size. The computations were compared to experimental data to verify the model's trustworthiness. Scanning electron microscopy was used to quantify the number and size of grains. Vickers hardness tests were conducted to confirm the mechanical performances predicted by the developed model. A strong correlation between experimental and computational results, within the range of 10-15 %, and 8-10 %, was obtained for the average grain size and Vickers hardness test.

Keywords

3D printing; Laser melting deposition; Efficient analytical models; Experimental verification.

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Development of Ti based metal matrix composites by laser melting deposition technique

Abstract
Metal matrix composites are materials with a main metallic constituent and a dispersed phase of ceramic or organic material. They benefit from properties of interest of the metallic material such as low weight, elasticity or biocompatibility and add other properties such as high strength, low or high friction coefficient or high thermal conductivity. We synthesized composites using a 3D printing method called Laser Melting Deposition in which a powder jet is blown into a laser spot and is locally molten. The matrix was made of Ti, while the dispersed phase was a hard ceramic (TiC). After optimizations of process parameters, the deposited material was defects free, as shown by metallographic analyses and we obtained a composite with mechanical properties superior to bare Ti with a microstructure in which the particles are homogeneously dispersed. The rising ratio of the temperature gradient resulted in a gradual change from columnar dendrite growth to cellular grain growth in the solidification regime. The different sizes of cellular grains and dendrite spacing were attributed to the varied cooling rates of distinct regions in the molten pool. The interfaces presented good bonding between consecutive layers. The microhardness of the composite increased gradually with TiC volume fraction. The tensile strength of composite with 3 vol% TiCwas enhanced by nearly 18.4% compared with that of the Ti matrix. The highest microhardness of composite with 3% TiC is 407 HV, which was 13% higher than that of pure Ti. The composite also showed a better wear resistance than pure Ti matrix deposited material. Once the optimal powder feeding rate was established, a part with optimized topology was designed in a CAD/CAM software automatically, after analysis of the build constrictions and forces that will act upon the object's surface. The software generates an optimal shape that will have maximum resistance to the forces acting upon it. Such parts have convoluted shapes and could be difficult (sometimes impossible) to be produced by conventional manufacturing techniques. Additive manufacturing could be therefore the only method to produce in situ metal matrix composite materials simultaneously with building complex shapes with optimized topology.

Keywords
laser melting deposition, metal matrix composite, mechanical properties of metal matrix composites, TiC particles

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Investigation of the Effect of Heat Treatment Atmosphere on Corrosion Properties of Direct Metal Laser Sintering of Maraging 300 Steels

Abstract
This study aims to systematically investigate the effects of various heat treatment atmosphere (Air, Ar, Ar/H2) and time (6 and 9 hours) on corrosion properties of the Additively Manufactured (AM) parts. AlSi10Mg specimens were manufactured by the Direct Metal Laser Sintering (DMLS) method using standard processing parameters. DMLS/Maraging 300 Steels offer a high toughness/strength ratio due to this they are used very often as mold material and sometimes the mold life can be very short due to corrosion. Surface properties are directly effect the mold life and this study aim to investigate the heat treatment atmosphere on surface characteristics.The corrosion properties deteriorated with increasing time.The corrosion potentials of the 9 hours aging heat treatments were close to each other.Surface morphology and SEM images after electrochemical test was observed that the molten pools, grain boundaries, and crack areas were corroded.Also, there is a decrease in cracks with the increase of the processing time, which positively affects the corrosion behavior.

Keywords
Additive manufacturing, Aging heat treatment, Maraging Steel, Corrosion properties,

References
1. Yao, Y., Huang, Y., Chen, B., Tan, C., Su, Y., & Feng, J. Influence of processing parameters and heat treatment on the mechanical properties of 18Ni300 manufactured by laser based directed energy deposition. Optics and Laser Technology 2018; 105: 171–179.https://doi.org/10.1016/j.optlastec.2018.03.011
2. Khan, H. M., Özer, G., Tarakci, G., Coskun, M., Koc, E., & Kaynak, Y. The impact of aging and drag-finishing on the surface integrity and corrosion behavior of the selective laser melted maraging steel samples. Materialwissenschaft Und Werkstofftechnik2021; 52(1): 60–73.https://doi.org/10.1002/mawe.202000139
3. Hamaid M. KHAN, Mustafa Safa YILMAZ, Gökhan ÖZER, "Review Paper of Additively Manufactured Parts Corrosion", Arabian Journal for Science and Engineering, DOI: 10.1007/s13369-021-06481-y

Biography
Dr. Yılmaz received his Ph.D Degree in 2018 from Gebze Technical University, Material Science andEngineering Department. His M.S and B.S. degrees in Metallurgical and Materials Engineering,Istanbul Technical University (2012) and Yıldız Technical University (2010) respectively. He had won a scholarship from the Scientific and Technological Research Council of Turkey (TÜBİTAK) and workedin the University of Nottingham Advanced Manufacturing Technology

Research Group for one year.After working as a researcher for 6 years in Gebze Technical University (2012-2018), he startedworking at ALUTEAM (Aluminium Testing, Education and Research Centre) as an Asst. Prof.His research interests include additive manufacturing, coating systems, surface modifications,aluminium and its alloys, biomaterials and mechanical testing. He published more than 35 scientificpublications (journal articles, book chapters, projects and conference articles). Dr. Yılmaz is currentlythe General Secretary of Turkish Additive Manufacturing Association (TAMA).

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Additive Manufacturing of 2-Component Rod Seals Based on NitrileButadieneRubber (NBR) and Thermoplastic Polyurethanes (TPU)

Abstract

The additive manufacturing (AM) of elastomeric parts based on high-viscosity reinforced rubbers has increasingly become a scientific topic in recent years. In addition to the viscosity, which is several decades higherduring processing than that of thermoplastics, the flowability of the compound after the printing process and the necessary chemical crosslinking of the printed component play a decisive role in producing an elastic, high-quality and geometrically stable part. After first technological achievements using the so called “Additive Manufacturing of Elastomers” process (AME), the gained knowledge has to be transferred to first concrete industrial parts. Therefore, the additive manufacturing of industrial 2-component rod seals based on a NBR rubber compoundin combination with a thermoplastic polyurethaneis being investigated in a research project funded by the “Deutsche Forschungsgemeinschaft” (DFG, file number: KL 3429/1-1 and OT 618/1-1).Especially the fabrication of rod seals could be facilitated using the AME technique to directly obtain asingle-step 2-component part, because the conventional fabrication is realized by two separated injection molding steps with subsequent assembly.

Keywords

Additive Manufacturing, Elastomer, Dynamic Seal, Rubber, AME, Rod Seal

References

[1] S. Leineweber, L. Sundermann, L. Bindszus, L. Overmeyer, B. Klie, H. Wittek, U. Giese, Rubber Chem. Technol. 95.1, 46-57, (2022)
[2] L. Sundermann, S. Leineweber, B. Klie, L. Overmeyer, U. Giese, KGK Kautschuk Gummi Kunststoffe, 73, 30-35, (2020)

Biography

in 2019	Master’s Degree in Material and Nanochemistry at Leibniz University Hanover, Germany
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The Effect of Process Parameters on Producibility of Airfoil Geometries by PolyJet

Abstract
Airfoils are very important part of aviation industry and producibility and surface roughness of these geometries directly affects aerodynamic performance. Since full-scale airfoil testing for evaluating the aerodynamic performanceis expensive, small-scale production and testing of airfoil designs attracts great attention. One of the production methods of small-scale airfoils is PolyJet technology. PolyJet technology is one of the additive manufacturing methods where photopolymer materials are deposited on build platform as droplets forming a very thin layer and ultraviolet light is used to cure the material on build platform. PolyJet technology enables production ofphotopolymer parts with high surface quality. However, this quality depends on different geometrical and process parameters. Therefore, to address this issue, this study focuses on the effect of tray location, build orientation and surface finish setting on producibility and surface roughness of small-scale NACA0008 airfoil geometry. Two variables for each parameter (along X and Y directions for tray location, horizontal and verticaldirections for build orientation and matte and glossy for surface finish setting) were used and producibility and surface roughness results were compared in terms of these variables. The result showed that airfoil geometries located along X directionand with horizontal build orientation showed lower surface roughness and less distortion. It was also observed that glossy or matte finish settings resulted in similar surface roughness.

Keywords
Airfoil, PolyJet, tray location, build orientation, surface finish setting

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Hybrid Optimization Framework to Generate Graded Multi-Lattice Structures

Abstract
Additive manufacturing (AM) has opened new avenues for the manufacturing of structures to meet challenging engineering needs. Triply periodic minimal surface (TPMS) lattices, a unique example of such structures, exhibits many remarkable properties, such as high stiffness-to- weight ratio and impact characteristics. The TPMS lattice topologies exhibit superior performance than others at certain relative densities. Therefore, the combination of the different TPMS structures can be jointly used to offer a better solution and meet the complex design requirements. However, there are limited number of studies in the literature; these studies are missing a systematic and formal approach to achieve this goal. Here, we propose a new optimization framework to generate multi-lattice structures utilizing from optimal material distribution attained by optimization solutions. This framework enables to obtain a better optimization solution and improves the mechanical performance substantially. The proposed method combines heuristic and mathematical optimization methods in two separate steps to eliminate the difficulties of analytical expression of the problem. In the first step, genetic algorithm attempts to determine the spatial distribution of the predefined lattice types into design domain and initial relative densities of each lattice unit cell. Next, an anisotropic homogenization-based topology optimization is performed to find optimal material distribution inside each unit cell and generate functionally graded lattice structure utilizing from lattice type and relative density information obtained in the previous step. The performance of the proposed optimization framework is studied numerically for a compliance problem. The comparative results show that multi-lattice structure converges a better compliance value than structures infilled with uniform lattices.

Keywords
Additive Manufacturing, Topology Optimization, Lattices, Homogenization, Genetic Algorithm

Biography
Ugur Simsek received his B.Sc. degree in mechanical engineering from Yıldız Technical University in 2012. He obtained M.Sc. degree in mechanical engineering from Istanbul Technical University in 2016. He completed his Ph.D degree in mechanical engineering at the Vibration and Acoustics Laboratory (VAL) at Ozyegin University in 2021. In his doctoral dissertation, he concentrated on dynamic characterization and optimization of additively manufactured TPMS lattice structures. He is currently working as advanced lead additive manufacturing engineer at General Electric Aviation (Kocaeli, Turkey). His research interests include vibration, structural dynamics, finite element modelling, model reduction methods, and additive manufacturing.

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Tailoring Dynamic Behavior of Additively Manufactured Structures with Particle Dampers

Abstract

Particle dampers dissipate energy due to the impact and friction as a passive damper technology. They provide low-cost solutions, simple design, alternative to work in harsh conditions and flexibility to be used in wide frequency bands. Instead of adding a damper to the structure that adds mass, and thereby increasing the cost, additive manufacturing offers an alternative solution with integrated design of the particle dampers inside the main body. Building up the part with damper in a single step is possible with powder bed fusion process. Although the powder bed fusion particle dampers are promising, its full potential cannot be untapped without understanding how it effects the dynamic behavior of the structure. For instance, in the design process, the size and the position of the particle damper play a critical role on vibration characteristics of the main body. Therefore, in this study, we evaluated the effects of body-integrated particle dampers on different modes that were produced by using the powder bed fusion in different sizes and located in different positions in main body. Finite element analysis was used to analyze frequency responses the results were validated via impact testing. The results show that the efficiency of particle dampers depend significantly on its geometry and location inside the main body.

Keywords

Additive Manufacturing, Particle Dampers,Damper Effectiveness

Biography

Birol Ozcevik received his B.Sc. degree in mechanical engineering from Yildiz Technical University in 2019. He is agraduate studentat Istanbul Technical UniversityMechanical Engineering Department. He is currently working as life management engineer at General Electric Aviation (Kocaeli, Turkey). His research interests include machine dynamics, finite element, vibration, fracture mechanics and additive manufacturing.

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Laser Directed Energy Deposition with Wire of Magnesium Alloys With and Without Aluminium

Abstract

Due to its low density, magnesium is an interesting metallic construction material, with sufficient strength for industrial applications. Casting, milling of parts made from different magnesium alloys is state-of-the-art, in Additive Manufacturing the developments recently started. Magnesium is a non-noble metal.Therefore, its reactivity is very high. Magnesium powder was used in the early years of photography for flashlamps, as itcan burn easily, so Magnesium wire is an attractive alternative for Additive Manufacturing. Drawn Magnesium wires are well known as filler material for welding, the manufacturing of new alloy wires, e.g. with calcium or silver containing for enhanced properties is currently under research in all industrial fields, from “green energy”to biomedical applications.

This work gives an overview to the processing of different Magnesium wires with and with-out aluminium content by coaxial laser directed energy deposition with wire.Magnesium wires from the alloy systems aluminium-zinc, zinc-calcium, silver and pure magnesium were used to buildsimple wall-like geometries. The processibility, macro and microsections, hardness values and mapping of the main alloying elements are compared for the different alloy systems.

Keyword

directed energy deposition (DED), magnesium alloy, wire, coaxial-optic, microstructure

Biography

Stefan Riekehr studied Materials Science at the TU Clausthal in Germany and received his diploma in 1995. He directly joined the Helmholtz-Zentrum hereon GmbH, formerly Helmholtz-Zentrum Geesthacht, as project engineer and specialist for characterization of power beam welded metals. He is working now for 25 years in the field of characterization of (laser) welded materials and since 2000 he is the responsible scientist for the laser manufacturinglaboratories at Hereon. The focus of his research lies on the influence of process parameters on the properties and the performance of laser manufactured light-weight materials.

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3D Printed Spacers for Efficient Water Desalination

Abstract

Feed spacer is a crucial component of the spiral wound membrane moduleas its dictates the filtration performance [1].These spacers provide mechanical support to the membrane surface and aid fluid flow between the membrane sheets, allowinga reduction in concentration polarization/(bio)fouling by enhancing fluid unsteadinessinside the filtration channel [2]. Poor and unsuitable spacer designs are known to exacerbate (bio)fouling,leading to an increase in channel pressure drop and ultimately increasing the filtration energy expenditure. The formation of biofilm, which is the propagation of bacteria within the secreted extracellular polymeric substances (EPS) matrix, is one of the serious concerns in any water treatment technologies (Reverse Osmosis, Ultrafiltration, Nano-filtration, Micro-filtration, and so on) utilizing membrane modules [3]. Therefore, a pertinent feed spacer design should have the ability to mitigate growing biofilm on the membrane surface and, at the same time,should maximize clean water production.This presents an ultimate engineering and biological challenge to design an optimal feed spacer for different filtration techniques.

For decades, the commercial spacer design consists of two layers of non-woven quasi-cylindrical filaments, creating a narrow spacer-filled channel (low porosity) that intensifies the pressure drop.The present work proposes novel symmetric feed spacer designs by transforming the filament geometry using perforations, pillars, and spiral cuts. The thickness of these spacers generally varies from 800-1200 microns, with perforations and filament dimeter in 300-800 microns range. The design spacers are rapidly prototyped in-house using 3-D printing DLP technology. The designs are first evaluated using Direct Numerical Simulation (DNS) to elucidate the fundamental hydrodynamic occurring at an elemental level. This aid in optimizing the spacer design in a virtual environment to effectively select optimal geometry. Perorations are found to produce unsteady micro-jets inside the filament cells, potentially eliminatingfoulants/particles and aiding in minimizing bacterial attachment on the membrane surface. The optimal feed spacer designs were then experimentally investigated in an ultrafiltration labsetup to investigate the performance of each novel spacer design. Significant permeate flux production was observed in many designs which were up to 70% compared to standard spacers.Biofouling developmenton membrane surface spacer elements wasmonitored in-situ using Optical Coherence Tomography (OCT). The symmetric spacers were found to be quite effective in mitigating biofouling and enhancing permeate flux production while making the process energy-efficient.

References

[1]. Karabelas, A. J., Koutsou, C. P. &Kostoglou, M. The effect of spiral wound membrane element design characteristics on its performance in steady state desalination—A parametric study. Desalination332, 76–90 (2014).

[2]. Schwinge, J., Neal, P. R., Wiley, D. E., Fletcher, D. F. & Fane, A. G. Spiral wound modules and spacers: Review and analysis. J. Membr. Sci.242, 129–153 (2004).

[3]. Review and anAl-Abri, M. et al. Chlorination disadvantages and alternative routes for biofouling control in reverse osmosis desalination. NPJ Clean Water2, 2 (2019).alysis. J. Membr. Sci.242, 129–153 (2004).

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Metallic Implants Fabricated by Additive Manufacturing Technologies

Abstract
Recently, the additive technologies made the step from scientific research towards industry for the manufacturing of prototypes or niche parts with special shapes. Implantable medical devices represent a logical application target for 3D printing techniques due to the need for implants with customized shapes and dimensions. Selective Laser Melting and Laser Melting Deposition, two 3D printing methods dedicated to metals, were used for production of Ti6Al4V cranial prostheses [1], bone plates [2] and medical devices [3], using a high-power laser source and micronic Ti6Al4V powder as starting material. The size and shape of prostheses were chosen based on actual computer tomography images of patient skull or bone fractures supplied in the framework of a collaboration with a neurosurgery clinic. After optimizations of scanning speed and laser parameters, the printed material was defects free, as shown by metallographic analyses and radiographies of the samples, chemically uniform, without elemental segregation or depletion, as revealed by electron diffraction X-ray spectroscopy. The bulk had a martensitic metallographic structure with randomly oriented acicular grains. The prostheses produced by 3D printing were further coated by Magnetron Sputtering and Pulsed Laser Deposition (PLD) with a bioactive thin layer of a natural animal origin hydroxyapatite, obtained from calcination of bovine bones, in order to become bioactive. The X-ray diffraction structural investigations of films revealed a monophasic hexagonal hydroxyapatite phase. Degradation tests demonstrated the biomineralization capacity of the films and resistance to degradation in biomimetic environments. In vitro tests were conducted in order to test the natural apatite bioactivity. After being previously validated by in vitro cytotoxicity tests, the biological-derived hydroxyapatite (of animal bones origin) doped with lithium carbonate (Li-C) and phosphate (Li-P) coatings synthesized onto 3D implants was preliminary investigated in vivo, by insertion into rabbits' femoral condyles.

Keywords
additive manufacturing; 3D printing, laser melting deposition, selective melting deposition, metallic implants.

References
[1] D. Chioibasu et al., "Animal origin hydroxyapatite thin films synthesized by RF-Magnetron Sputtering on 3D printed cranial implants," Metals (Basel)., vol. 9, no. 12, pp. 1–24, 2019.
[2]
[3] D. Chioibasu et al., "Prototype Orthopedic Bone Plates 3D Printed by Laser Melting Deposition," Materials (Basel)., vol. 12, no. 6, p. 906, 2019.
[4]

[5] L. Duta et al., “In vivo assessment of bone enhancement in the case of 3d-printed implants functionalized with lithium-doped biological-derived hydroxyapatite coatings: A preliminary study on rabbits,” Coatings, vol. 10, no. 10, pp. 1–21, Oct. 2020.

Poster Presentation

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Additive manufacturing of interstitial high entropy alloy: scanning strategy dependent anisotropic mechanical properties

Abstract

A non-equiatomic interstitial-strengthened high entropy alloy (iHEA), Fe49.5Mn30Co10Cr10C0.5 (at.%), was additively manufactured by laser powder-bed fusion with stripe and chessboard scanning strategies. The present study highlights the correlation between laser scanning strategies with resulted microstructure, textures, and anisotropic mechanical properties in as- built iHEA. The results show that the samples exhibit an excellent strength-ductility synergy due to the combined deformation mechanisms of dislocation slip and martensite phase transformation induced plasticity. The samples printed by the stripe scanning strategy exhibit more evident mechanical anisotropy than that of the chessboard-scanned samples. The difference in the degree of mechanical anisotropy is mainly attributed to the heterogeneous grain morphology and crystallographic texture resulted from different scanning strategies.

Keywords

laser powder-bed fusion, high entropy alloy, scanning strategy, heterogeneous microstructure, mechanical anisotropy

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3D Printed Models of Ear as a Tool for Comparison of Endoscopic Optics

Abstract
Otologists around the world use 0° and 30° endoscopes for various endoscopic ear surgeries (EES). However, there is still no agreement which of the endoscopes is better for EES. The main goals of this work were (1) to develop several models of different levels of complexity simulating middle ear cavity, (2) to visualize middle ear structures using 0° and 30° endoscopes and (3) to determine which endoscope provides a surgeon with better range of view.

Models of three levels of complexity have been designed. First two levels were designed using Tinkercad online software. The models of the first level consisted of two parts: a circular tube of 10 mm diameter and 27 mm length representing ear canal and a space (cubic and hourglass type) representing middle ear cavity. A millimetre paper was glued to the walls of these models to determine the range of visual field. The models of the second level of complexity with anatomical structures, i.e. lateral semi-circular canal, facial nerve, promontory, mastoid antrum, round window, oval window and Eustachian tube, were designed in the space representing the middle ear. The most complex model based on high-resolution computed tomography of healthy temporal bone of 33-year old man was reconstructed using 3D slicer software. All models were printed using fused deposition modelling (FDM) printer and polylactic acid (PLA) material. Range of visual field was assessed using image analysis in MATLAB software.

The models of first level of complexity showed that the millimetre paper on the lateral middle ear walls could be visualized using 30° endoscope already at distance of 4 mm, in contrast to a 0° endoscope, which allowed the walls to be seen at 12 mm. Number of visible squares at this distance increased by 20% using 30° scope. The models of second and third level of complexity were assessed by two independent Ear-Nose-Throat surgeons. They described wider field of view enabling visualization of more anatomical structures using 30° scopes such as Eustachian tube orifice, facial recess, mastoid antrum and lateral semi-circular canal in contrast to 0° scopes.

Our experiment showed that a 30° endoscope provides a surgeon with wider field of view. It was possible to visualize significantly more anatomical structures.

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Keywords

3D printing; Endoscopic ear surgery

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3D Printed Surgical Model for Training of Tympanostomy

Abstract

Various training task models have been developed for training of numerous surgical procedures. These models allow a trainee to practice particular skill without potential risk to an actual patient. Tympanostomy is a procedure during which a ventilation tube is inserted into an incision in the eardrum to promote drainage and aeration of middle ear cavity. It is performed in patients suffering from recurrent or chronic otitis media, Eustachian tube dysfunction and for barotrauma prevention. The main aim of this work was to develop a training model for tympanostomy.

High-resolution computed tomography (HR CT) of a healthy ear of 16-year old woman was used to create the model. 3D Slicer software was used for thresholding of bone structures (Hounsfield units from +250 to +3000). Firstly, a part representing the ear canal was created. The HR CT did not show sufficient resolution for meshing of the ossicles in sufficient detail, i.e. to create the manubrium of the malleus leaning against the eardrum. Therefore, 3D mesh of malleus was reconstructed using cadaverous middle ear ossicles and microCT scanner. Consequently, the second part of model representing middle ear cavity with malleus was reconstructed. The model was adjusted to fit into OtoSkills trainer (a validated training tool for otologist trainees). Both parts of the model were 3D printed using FDM printer and PLA filament. A stretched latex membrane representing eardrum was glued between both parts of final model.

The final model showed all crucial anatomical landmarks required for tympanostomy training (the tortuous ear canal and umbo), and allowed aspiration of the middle ear content and insertion of ventilation tube through a myringotomy. The model was presented to otologist trainees and consultants who gave positive feedback, confirmed its fidelity and suitability for training of tympanostomy as the model closely resembled a ventilation tube insertion in an actual patient.

We have created an authentic model allowing realistic tympanostomy training. The model will be produced in larger volumes and implemented in pregradual education of medical students. We will carry on working on other models for other otological procedures training.

Acknowledgements

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Keywords

3D print; training surgical model; tympanostomy

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3D Printed Glass: Novel Microfluidic Device Fabrication Using Selective Laser-Induced Etching

Abstract
Polydimethylsiloxane (PDMS) based micro-devices fabricated by photolithographic techniques and micro-machined polymers, such as poly(methyl methacrylate) or cyclic olefin copolymer, remain the standard in the field of microfluidics. Although these polymeric materials have numerous benefits such as the ability to rapidly prototype and a relatively low replication cost, they also have many drawbacks namely: PDMS's lack of rigidity, poor solvent resistance, high gas permeability, and two-dimensional limited designs. To overcome these drawbacks, we utilize a cutting-edge microfabrication technique called selective laser-induced etching (SLE) to fabricate truly three-dimensional monolithic structures within fused silica. SLE allows us to create transparent and chemically resistant microfluidic devices impossible with standard photolithographic or milling techniques. In this poster, we will present the selective laser-induced etching process, associated deign challanges, and recent experimental results of truly three-dimensional microfluidic devices.

Topic: 3D printing materials

Virtual Presentation

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Preventing Premature Failure and Tuning the Strength-Ductility Trade-Off of Additively Manufactured Materials

Abstract

Additively manufactured metallic materials exhibit excellent mechanical strength. However, they often fail prematurely owing to external defects that act as sites for crack initiation. Cracks then propagate through grain boundaries and/or cellular boundaries that may contain brittle second phases. In this work, the premature failure mechanisms in selective laser melted (SLM) materials are studied. A submicron structure is introduced containingsemicoherent precipitates distributed in a discontinuous but periodic fashion along the cellular boundaries. Alternatively, martensitic phases are used to create alloys with modulation of phases and different strengthening mechanisms.The observed hierarchical microstructure combining different phases spanning over different length scales, consisting of remelted zones and track core regions at the macro-scale, regions with elongated columnar grains and equiaxed grains at the micro-scale, martensitic laths at the submicron-scale, and a high density of dislocations and stacking faults at the nano- and atomic scaleleads to outstanding tensile properties of as-prepared and annealed samples.The mechanisms determining the strength and ductility are discussed in terms of the hierarchical microstructure and internal defects. The cellular structure with a high density of dislocations along their boundaries and the martensitic structure are the reasons for strengthening, while the hierarchical microstructure helps to obtain appropriate ductility. Furthermore, martensitic transformation induced plastic bending of residual FCC plates helps to balance the different plastic strainswithin the heterogeneous structure. This work provides a material design approach for creating hierarchically structured additively manufactured materials with improved strength-ductility tradeoff provided that premature failure is alleviated.

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Continuous(Successive) Fabrication of Nano-Structured Ceramic Materials via Soft, Solution Processing without Firing

Abstract
Practical devices would be better to be fabricated via continuous and/or successive Processes. Presently, however, they have generally been fabricated artificially and/or industrially by so-called high-technology, where high temperature, high pressure, vacuum, molecule, atom, ion, plasma, etc. using expensive equipments thus they consumed huge amount of resources and energies thus exhausted huge amounts of wastes: materials, heats and entropy. The major reasons might be 1) The reactants should be nano-sized species, 2) high-energy reaction might be required, thus 3) They cost economically and environmentally. To save this tragedy, a) we must consider “Cascade use of Heats”, and b) “Low energy Production of advanced materials via solution-based technologies.” c) Continuous(Successive) Fabrication will be possible in solution process(es). Now,however, 3D-Printing with additive designed Powders have widely been studied, however, they are multistep butch systems with firing(s).

We proposed in 1995 an innovative concept and technology, “Soft Processing” or “Soft, Solution Processing,” which aims low energetic (=environmentally friendly) fabrication of shaped, sized, located, and oriented inorganic materials in/from solutions. When we have activated/stimulated interfacial reactions locally and/or moved the reaction point dynamically, we can get patterned ceramic films directly in solution without any vacuum, firing, masking nor etching. Direct Patterning of CdS, PbS and $CaWO_4$ on papers by Ink-Jet Reaction method,furthermore, we have succeeded to fabricate $BaTiO_3$ patterns on Ti by a laser beam scanning and carbon patterns on Si by plasma using a needle electrode scanning directly in solutions. Successes in TiO_2 and CeO_2 patterns by Ink-Jet Deposition, where nano-particles are nucleated and grown successively on the surface of substrate thus become dense even below 300 C could be prepared. Nano-structured films will be also talked[1-3].

1) MRS Bulletin,25[9],Sept. issue 2000, special issue for Soft Processing of Advanced Inorganic Materials ,Guest Editor:M. Yoshimura and J. Livage.
2) Yoshimura, M., J. Mater. Sci., 41 [5], 1299-1306 (2006), 3) ibid, Procedia Engineering, 171, 40-52 (2017)

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3D/4D Additive Manufacturing Based on Shape Memory Phenomenon

Abstract

The shape memory effect (SME) refers to the phenomenon that a quasi-plastically deformed material is able to return its original shape, but only at the presence of the right stimulus. Via different working mechanisms, most polymers have the heating/chemo-responsive SME. Such a SME can be utilized in additive manufacturing of polymeric components in both 3D and 4D printing.

This talk starts with a brief review of the SME and the basic working mechanisms for the SME in polymers. 4D printing using various commercial filaments will be demonstrated in a range of different applications, from bio-medical devices to comfort fitting. A couple of new approaches for digital manufacturing to rapid additive manufacturing in solid state will be presented with demonstrations.

About the speaker

Dr Wei Min Huang is currently an Associate Professor (tenured) at the School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore. With over 25 years of experience on various shape memory materials (alloy, polymer, composite and hybrid), he has published over 190 papers in journals, such as Accounts of Chemical Research, Advanced Drug Delivery Reviews, and Materials Today, and has been invited to review manuscripts from over 300 international journals (including Progress in Polymer Science, Nature Communications, Advanced Materials, and Advanced Functional Materials, etc), project proposals from American Chemical Society, Hong Kong Research Grants Council, etc, and book proposals from Springer, Elsevier and CRC. He has published two books (Thin film shape memory alloys – fundamentals and device applications, Polyurethane shape memory polymers) and is currently on the editorial board of over three dozen of journals.

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