SFF 2023 Addendum

From July 26 – August 9, 2023

Author Additions/Speaker Changes

3D Metal Nanoparticle-polymer Composites: Strategies for Integrating Metal Nanoparticles with Two-photon Polymerization Process: *Geoffrey Rivers*[1], Jisun Im[1]; Yaan Liu[2]; Qin Hu[3]; Gustavo Trindade[4]; Christopher Parmenter[1]; Michael Fay[1];Yinfeng He[3]; Derek Irvine[3]; Christopher Tuck[3]; Ricky Wildman[3]; RichardHague[3]; Lyudmila Turyanska[3]; [1]University of Nottingham; [2]University of Exeter; [3]Centre for Additive Manufacturing/University of Nottingham; [4]NationalPhysical Laboratory

A Case Study of Cognitive Workload and Design Knowledge Gaps in Hybrid Manufacturing Teams: Kenton Fillingim[1]; *Thomas Feldhausen*[1]; [1]OakRidge National Laboratory

Behavior of Additively Manufactured Plate-lattice Structures in Quasistatic, Dynamic, and Ballistic Testing: *Joseph Berthel*1; Yayati Jadhav1; Chunshan Hu1; Rahul Panat1; Jack Beuth1; Amir Barati Farimani1; 1Carnegie Mellon University

Efficient Thermomechanical Simulation for WAAM using Automated GPU-based Modeling: *Xavier Jimenez*[1]; Albert To[1]; Florian Dugast[1]; Alaa Olleak[1]; [1]University of Pittsburgh

Evaluating Residual Heat-driven Melt Pool Variation through GPU-based Thermal Process Simulation: *David Anderson*[1]; Haolin Zhang[1]; Shawn Hinnebusch[1]; Xiayun Zhao[1]; Albert To[1]; Florian Dugast[1]; Alaaeldin Olleak[1]; [1]University of Pittsburgh

Optimization of Computational Time for Digital Twin in Directed Energy Deposition for Residual Stresses: *Usman Tariq*[1]; Ranjit Joy[1]; Sung-Heng Wu[1]; Muhammad Arif Mahmood[2]; Michael M. Woodworth[3]; Frank Liou[1]; [1]Missouri University of Science and Technology; [2]Intelligent Systems Center; [3]The Boeing Company

State-of-the-art Cyber-enabled Physical and Digital Systems Deployed in Distributed Digital Factory Using Additive and Subtractive Manufacturing Systems: Open, Scalable, and Secure Framework: Ranjit Joy[1]; Sung-Heng Wu[1]; Usman Tariq[1]; Sriram Praneeth Isanaka[1]; Asad Malik[1]; Muhammad Arif Mahmood[1]; *Frank Liou*[1]; [1]Missouri University of Science and Technology

Thin Strand Printing of Silicone Ink with Direct Ink Write Process: *Siddharthan Selvasekar*[1]; Todd Weisgraber[1]; Joseph Bartolai[2]; Joshua Mendoza[1]; [1]Lawrence Livermore National Laboratory; [2]The Pennsylvania State University

Cancellations

Modeling: Machine Learning, Data Driven, Digital Twins Monday 1:30 PM Room: 415 AB
Validation of Simulation Based Predictions of Recoater Interference in Laser Powder Bed Fusion: *Chao Li*, Autodesk Inc.

Modeling: Uncertainty and Thermomechanical Monday 1:30PM Room 416AB
Uncertainty Quantification in Laser Powder Bed Fusion from Mesoscale to Part Scale: *Daniel Moser,* Sandia National Laboratories

Process Development: Hybrid and Convergent Processes- Robotics and Hybrid Polymer-metal Processes Monday 1:50 PM Room: 404
High-precision Camera-based Auto-calibration System for Cooperative 3D Printing: *Charith Nanayakkara Ratnayake*, University of Arkansas

Process Development: Directed Energy Deposition and Cold Spray Monday 2:10PM Room: 410
Structural Integrity Assessment of Cold Spray Repaired High-strength Aluminium Alloy 7075 Specimens: *Ali Bakir*, Conventry University

Modeling: Machine Learning, Data Driven, Digital Twins Monday 4:00 PM Room: 415AB
Multi-scale Modeling of Thermal/reisidual Stress in Additive Manufacturing Across Grain- , track- and Part-scales: *Wentao Yan*, National University ofSingapore

Modeling: CAD, Scan Patterns, Contouring, Slicing I Monday 4:00 PM Room: Salon A
Computer Modelling of Residual Stress Development During Selective Laser Melting of 17-4 PH Stainless Steel and Experimental Validation via Contour Method: *Yusuf Polat,* Yunus Emre

Fiber Composites Tuesday 9:15 AM Room: 616AB
Direct Ink Writing of Frontally Polymerized Polymer Matrix Reinforced with Continuous Carbon Fiber Tows: *Nadim Hmeidat*1; Michael Zakoworotny1; Philippe Geubelle1; Sameh Tawfick1; Nancy Sottos1; 1University of Illinois Urbana-Champaign

Process Development: Powder Bed Fusion Monitoring and Imaging I Tuesday 9:35 AM Room: 410
In-situ Monitoring of Laser Powder Bed Fusion for Production Environments: *Jesse Adamczyk,* Sandia National Laboratories

Process Development: Material Extrusion II Tuesday 9:35 AM Room: 412
An Extrusion-based 3D Printing Method for Direct Deposition of Photopolymers: *Rencheng Wu*, University of Arkansas

Modeling: CAD, Scan Patterns, Contouring, Slicing Il Tuesday 9:35 AM Room: Salon A
Application of Implicit CAD System to Support Subtract-additive Hybrid Manufacturing: *Sang-in Park*, Incheon National University

Polymers: Functional Materials Tuesday 10:45 AM Room: Salon F
Charge Programmed Additive Manufacturing of High-performance Antennas: *Zhen Wang***,** UC Berkeley

Applications: Residual Stress Tuesday 10:45 AM Room: 615AB
Resonant Ultrasound Spectroscopy Modeling of Hybrid Metal Additive Manufacturing Samples with Residual Stresses: Jazmin Ley, University of Nebraska - Lincoln

Materials: Metals-Processing Strategies I Tuesday 2:20 PM Room: 616 AB
Laser Powder Bed Fusion Process Feedback Control Based on In-situ Powder Layer Thickness: *Jorge Neira,* National Institute of Standards and Technology

Materials: Metals-Characterization of AM Processes and Materials Tuesday 2:20 PM Room 602
In situ Layer-wise Optical Imaging for Defect Detection during Laser Powder Bed Fusion: *Sanam Gorgannejad,* Lawrence Livermore National Laboratory

And 2:40 PM **Challenges and Opportunities in Acoustic Emission Monitoring for Quality Control of Directed Energy Deposition Additive Manufacturing**: *Ehsan Dehghan Niri,* Arizona State University

Materials: Metals-Processing Strategies I Tuesday 3:40PM Room: 616AB
Effect of Build Height on Microstructure and Mechanical Behavior of Ti-6Al-4V Fabricated via Laser Powder Bed Fusion (LPBF): *MohammadBagher Mahtabi*, Purdue University Northwest

Wire-fed DED: Materials and Experiments Wednesday 9:20AM Room: Salon A
Process Development for the Wire Arc Additive Manufacturing of AlSi10Mg: Moritz Baldauf, BMW Group

Applications: Topology Optimization Wednesday 11:10 AM Room: 416AB
Constrained Topology Optimization using Mechanical Homogenization: *Ehsan Haghighat,* Carbon Inc.

Process Development: Powder Bed Fusion Fusion Process Wednesday 2:10PM Room: 400/402
Quality Prediction of AM Processes Using Volumetric CNNs with Spatialized Representations of Structure-borne Sound Sensor Data: *Jork Groenewold,* wbk Institute of Production Science, Karlsruhe Institute of Technology (KIT)

Materials: Metals-Novel AM Methods II Wednesday 4:00PM Room: 415AB **Diode Area Melting – A Multi-laser Alternative to Traditional Laser Powder Bed Fusion**: *Anqi Liang,* University of Southampton

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Session Chairs

Process Development: Material Extrusion I: Monday Room 412, Anthony Rollett

Wire-Fed DED: Geometric Characterization and Path Optimization: Monday Room 615AB, Somayeh Pasebani

Modeling: Deposition of Particles and Fibers: Tuesday Room 416AB, Alaa Elwany

Materials: Polymers - Material Extrusion: Tuesday Room 417AB, Chad Duty

Process Modeling: Tuesday Room 615AB, Conor Porter

Fiber Composites: Wednesday Room 616AB, John Pappas

Materials: Metals-Processing Strategies II: Wednesday Room 616AB, Frank Medina

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Time/Session Changes

Process Development: Hybrid and Convergent Processes-Robotics and Hybrid Polymer-metal Processes Monday 1:50 PM Room: 404 (was 1:30 PM)
Time-optimal Path Planning for Heterogeneous Robots in Swarm Manufacturing: *Ronnie Frank Pires Stone* , The University of Texas at Austin

Polymers: Functional Materials Tuesday 11:45 AM Room: Salon F (Was **Materials: Polymer AM Processes** Monday 3:40 PM Room: 417 AB)
Stimuli Driven Morphing of Printed Liquid Crystal Elastomers: *Caitlyn Krikorian*, Lawrence Livermore National Laboratory

Materials: Polymer AM Processes Monday 3:40 PM Room: 417 AB (was 4:00 PM)
Structural Stability During Thermal Post-curing of Direct Ink Write Thermoset Composites: *Stian Romberg*, National Institute of Standards and Technology

Modeling: CAD, Scan Patterns, Contouring, Slicing I Monday 4:00 PM Room: Salon A (Was 4:20 PM)
Developing an Application Programming Interface for

Hypocycloid-based Inner and Outer Gears of Progressive Cavity Pumps in Advanced Extrusion Applications: *Yusuf Furkan Ugurluoglu*, Newcastle University

Materials: Polymer AM Processes Monday 4:00 PM Room: 417 AB (was 4:20 PM)
Ultrasonic Non-destructive Characterization of Anisotropic Additively Manufactured Polymers: *Akash Nivarthi*, Applied Research Laboratories, The University of Texas at Austin

Materials: Polymer AM Processes Monday 4:20 PM Room: 417 AB (was 4:40 PM)
Magnetic Characterization of 3D Printed High-performance Polyamide Magnetic Composite: *Oluwasola Arigbabowo*, Texas State University

Fiber Composites Tuesday 9:15 AM Room: 616AB (Was 9:35AM)
Effect of the Print Bed Temperature on Void Distribution and Fiber Orientation within the Microstructure of Short Carbon Fiber Reinforced/ABS Manufactured via Large Area Additive Manufacturing: *Neshat Sayah*1; Douglas Smith1; 1Baylor University

Applications: Residual Stress Tuesday 10:45 AM Room: 615AB (Was 11:05AM)
The Effect of LaserSscan Strategy on Residual Stress of Titanium Alloys Using Laser Foil Printing Additive Manufacturing Processes: Ting-Chun Huang, National Cheng Kung University

Materials: Metals-Processing Strategies I Tuesday 3:40PM Room: 616AB (Was 4:00PM)
Influence of Silane-doped Argon Processing Atmosphere on Powder Recycling and Part Properties in LPBF of Ti-6Al-4V*: Nicole Emminghaus*, Laser Zentrum Hannover e. V.

Process Development: Powder Bed Fusion Process Wednesday 2:10 PM Room: 400/402 (Was 2:30 PM)
Pushing Boundaries: Machine Learning Applied to Selective Laser Melting: *Mary Daffron*, Johns Hopkins University Applied Physics Lab

Materials: Metals-Novel AM Methods II Wednesday 4:00 PM Room: 415AB (Was 4:20 PM)
Nanoparticle-modification of NiCu-based Alloy 400 for Laser Powder Bed Fusion: *Jan-Philipp Roth*, Osnabrück University of Applied Sciences

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Abstract or Title Changes

Plenary Monday 11:40 AM Room: HJK Salon
Co-design of 3D Printing, Parts and Microstructure in High-temperature and High-pressure Heat Exchangers: *Anthony D. Rollett*, Carnegie Mellon University

Abstract Added:
We illustrate the importance of co-design with the example of high temperature heat exchangers that employ a pin-and-plate structure and integral headers. 3D printing complex geometries entails mostly empirical adjustments to, e.g., pin geometry and avoidance of sharp changes in cross-section. Concurrently, optimal print conditions must be identified for each printer that minimize porosity. Qualification involves predicting the process window from the physics of laser powder bed fusion and then printing test parts to measure porosity as a function of P, V, H etc. Characterization of single tracks calibrates absorptivity, e.g. The resulting mechanical properties in both Haynes 230 and 282 are comparable to standard product despite the fine grain structure. Microstructure simulation points to strategies for optimization but surrogate models offer potential for substantial speedup. High-speed visualization with synchrotron x-rays provides calibration data of all sorts and we end with select recent results on oscillation and pore formation detection.

Materials: Metals-Mechanical Properties I Monday 4:20 PM Room: Salon F
Influence of Steel Alloy Composition on the Process Robustness of As-built Hardness In Laser-directed Energy Deposition: *Jonathan Kelley*1; 1Missouri University of Science and Technology
To ensure consistent quality of additively manufactured parts, it is advantageous to identify alloys which can meet performance criteria while being robust to process variations. Toward such an end, this work studied the effect of steel alloy composition on the process robustness of as-built hardness in laser-directed energy deposition (L-DED). In-situ blending of ultra-high-strength low-alloy steel (UHSLA) and pure iron powders produced 10 alloys containing 10-100% UHSLA by mass. Thin-wall samples were deposited, and the hardness sensitivity of each alloy was evaluated with respect to laser power and interlayer delay time. The sensitivity peaked at 40-50% UHSLA, corresponding to phase fluctuations between lath martensite and upper bainite depending on the cooling rate. Lower (10-20%) or higher (70-100%) alloy contents transformed primarily to ferrite or martensite, respectively, with auto-tempering of martensite at lower cooling rates. By avoiding martensite/bainite fluctuations, the robustness was improved.

Applications: Residual Stress Tuesday 8:35 AM Room: 615AB
Effect of Inter-layer Dwell Time on Residual Stresses in Directed Energy Deposition of High Strength Steel Alloy: *Ranjit Joy*, Missouri University of Science and Technology
Adoption of metal additive manufacturing by various industries is being hindered by the presence of residual stresses and distortion in the deposited parts. Large thermal gradients during directed energy deposition often led to residual stresses in the final deposit. Parameter optimization is predominantly used for residual stress mitigation. However, the effect of process parameters is material specific. Current research aims to study the effect of inter-layer dwell time on residual stresses in directed energy deposition of high strength steel alloy. Specimens were deposited at three levels of inter-layer dwell time. Surface as well as bulk residual stresses were measured using X-ray diffraction. Both surface as well as bulk residual stresses were found to increase with an increase in the inter-layer dwell time.

Data Analytics: Laser Powder Bed Fusion Wednesday 11:30 AM Room: 412

Investigating Correlation Between Melt Pool and Overhang: *Zhuo Yang*[1]; Jaehyuk Kim[2]; Yan Lu[2]; Brandon Lane[2]; Yande Ndiaye[2]; [1]Georgetown University; [2]NIST

Real-time control through the use of sensors and controllers is being applied in powder bed fusion AM systems to manage in-situ process features like melt pool size and temperature. Despite this technology, geometry deviation and surface roughness defects still persist due to difficulty of obtaining accurate geometric information during the build. Although in-situ monitoring captures several in-process data, precise geometric information is challenging to acquire. To address this problem, a statistical approach is proposed to predict material formation in 3D, particularly the geometry of overhang surface using process parameters and coaxial melt pool images. The preliminary results from an experiment involving four overhang parts, with 100,000 melt pool images generated, indicate that the proposed method provides a solution for real-time control of part geometry and surface roughness. This presentation would present the findings of overhang dross depth, related melt pool features, and their statistical correlations.

Additional Posters

Poster Session Tuesday 4:00PM Room: Salon JK

Analysis of Porosity in LPBF SS316L by X-Ray Computed Tomography *Tasrif Ul Anwar*1; Patrick Merighe1; Nadia Kouraytem1; 1Utah State University

Laser Powder Bed Fusion (LPBF) is a widely utilized additive manufacturing process for fabricating small parts with complex features. However, one notable drawback of LPBF is the potential variation in mechanical properties caused by the influence of key process parameters on the underlying structures. Thus, understanding the relationships between process and defect structure in printed components is crucial. In this study, Stainless Steel 316L (SS316L) test coupons were produced using LPBF with different laser parameters. To examine porosity and its spatial distribution, X-ray computed tomography (XCT) was utilized. Lack of fusion (LOF), sintering (an extreme of LOF), near dense, and keyhole defects were identified using the XCT data. These discoveries make it possible to print nearly dense samples, which are expected to exhibit superior mechanical properties compared to their porous counterparts. The results of this study will facilitate the widespread use of LPBF SS316L components, particularly in the energy industry.

Poster Session Tuesday 4:00PM Room: Salon JK

Double-pulse Femtosecond Laser Sintering of Metal Nanoparticles on Flexible Substrate: *Janghan Park*1; Yaguo Wang1; 1University of Texas at Austin

Selective laser sintering (SLS) is a branch of additive manufacturing, utilizing powder beds and laser irradiation. SLS is a promising manufacturing method for flexible electronics because it does not require a high-temperature environment, which is not suitable for flexible substrates. Femtosecond laser (fs-laser) has received attention due to its ultra-short irradiance time which is less than electron-phonon coupling time, resulting in minimized heat-affected zones. Despite the advantages, it has been challenged to utilize fs-laser due to a high possibility of having ablation caused by hot electron blast effects. Here, we propose double-pulse fs-laser sintering which can reduce ablation by avoiding high peak power. We verified there is a suppression of metal nanoparticle ablation with double-pulse laser for spot sintering. We plan to further develop our study from spot sintering to line sintering on flexible substrate. Lowering surface roughness and enhanced electrical properties are expected with applying double-pulse sintering.

Poster Session Tuesday 4:00PM Room: Salon JK

Molybdenum Trioxide (MoO3) Nanosheets Imbedded Carbon Nanofibers for Lithium-ion Batteries: *Kevin Lantz*[1]; Kiernan O'Boyle[2]; Jonghyun Park[2]; [1]Miami Dade College;[2]Missouri University of Science and Technology

Molybdenum trioxide (MoO3), a layered transition metal oxide electrode material, possesses unique properties and a high theoretical capacity. However, it encounters challenges such as volume change, poor conductivity, and limited ion diffusion during deintercalation. To address these limitations, we have explored embedding MoO3 nanosheets into interconnected carbon nanofibers. This integration improves the diffusion rate within the material. The synthesis of carbon nanofibers is accomplished through the electrospinning technique, known for its simplicity and cost-effectiveness. The resulting composite, MoO3@CNF, has shown promising performance when incorporated into lithium-ion batteries.