ADDENDUM

ADDITIONS

Presentations added since the program was printed.

Tuesday, August 8

Process Development 5: Material Extrusion and Surface Properties
3:40 PM

High-throughput Desktop-scale Extrusion Additive Manufacturing: *Adam Stevens*[1]; Jamison Go; A. John Hart; [1]Massachusetts Institute of Technology

Faster AM processes will improve competitiveness with traditional processing routes and enable new workflows for product design and customization. We present the design and validation of a desktop-scale fused filament fabrication (FFF) extrusion AM system that achieves far greater build rate than benchmarked commercial systems. This system, which we call 'FastFFF', is motivated by our recent analysis of the rate-limiting mechanisms to conventional FFF technology. The FastFFF system overcomes these limits by using a nut-feed extruder, laser-assisted polymer liquefier, and servo-driven parallel gantry system to achieve high extrusion force, rapid filament heating, and fast gantry motion, respectively. The prototype system achieves a volumetric build rate of ~127 cm3/hr, ~7-fold commercial desktop FFF systems, at comparable resolution; the maximum extrusion rate of the printhead is ~14-fold greater (282 cm3/hr). The performance limits of the printhead and motion systems are characterized, and the tradeoffs between build rate and resolution are assessed.

Poster Session

Industrial Robot Assisted 3D Scanning of Metal Parts for Component Repair Using Additive Manufacturing: *Kate Adkison*[1]; Xinchang Zhang[2]; Frank Liou[2]; [1]Penn State University; [2]Missouri University of Science and Technology

A significant application of Additive Manufacturing (AM) process is for component repair, in which the damaged region of a worn part is obtained and material is deposited on the defective area to regain the missing geometry. Reverse Engineering (RE)-generated models of damaged parts can be utilized to extract the repair volume to generate the tool path for material building up. However, specular materials like metal, reflect the light projected by structured light 3D scanners making these surfaces difficult to scan and error-prone. Therefore, the objective of this project is to propose a robot-aided scanning strategy to regenerate the models of parts with a high accuracy. For this purpose, an approach of using a structured light 3D scanner assisted by a 6-axis Nachi robot to scan the object at different angles in view of the scanner was evaluated. Additionally, tests were conducted where scans were taken at varying contrast levels. A precisely machined 0.85-inch steel gage block was scanned at different contrast levels and different angles to determine the method with the lowest error.

Additive Manufacturing of Metallic Glass: Emily Angell[1]; Qilin Guo[1]; *Lianyi Chen*[1]; [1]Missouri University of Science and Technology

Taking advantage of amorphous structure, metallic glass exhibits superior properties such as high strength, high hardness, and high wear resistance. However, the material usually needs to undergo a high cooling rate to obtain the amorphous structure, which limits the size of metallic glass parts that can possibly be built by traditional methods. Selective laser melting is a laser-based additive manufacturing process that produces 3-D parts by selectively melting successive layers of materials by a laser beam. The small laser-interacting volume can effectively prevent the crystallization by maintaining a high cooling rate. In this work, we carried out a parametric study of building a 3-D metallic glass sample under argon protection. The effect of laser power and scanning speed on scan track quality were discussed. The influence of beam size was studied by defocusing the laser beam. Two different layer thicknesses, 20 ěm and 150 ěm, were tested for comparison.

Relating Processing of Selective Laser Melted Structures to their Material and Modal Properties: *Nicholas Capps*[1]; James Urban[1]; Brian West[1]; Cody Lough[1]; Adriane Replogle[2]; Troy Hartwig[3]; Ben Brown[4]; Douglas Bristow[1]; Robert Landers[1]; Edward Kinzel[1]; [1]Missouri University of Science and Technology; [2]Lincoln University; [3]Kansas City National Security Campus; [4]Kansas National Security Campus

Selective laser melting creates metal parts by fusing powder layer-by-layer. It provides significant design flexibility and the possibility of low-volume production. The engineering properties of the printed metal are a function of the local thermal history. This creates challenges for validating additively manufactured parts. This paper correlates the engineering properties (density, modulus, yield strength and ultimate strength) for tensile test specimens created with different process parameters with the resonant frequencies determined using modal testing. The paper shows that yield and ultimate strengths for these specimens can be determined using modal analysis.

Additive Manufacturing of Freestanding Glass Structures: *Bret Curtis*[1]; Daniel Peters[1]; Robert Landers[1]; Douglas Bristow[1]; Edward Kinzel[1]; [1]Missouri University of Science and Technology

The properties of glass, such as low temperature sensitivity, chemical inertness, biocompatibility, and, transparency, that make it valuable for scientific and engineering applications such as chemical handling, electrical insulators and optics. Additive manufacturing has several advantages relative to traditional fabrication techniques including the ability to create complex three dimensional shapes without tooling and with lower material consumption, while maintaining or improving the structural performance. Compared to polymers, metals, and ceramics, there has been little work printing glasses. The high viscosity of molten glass makes it difficult to remove bubbles trapped during powder consolidation and leads to optical scattering and stress concentrations that minimize strength. The printing of three-dimensional free-standing glass structures using a filament-fed, laser-heated process is presented. A CO2 laser is used to precisely heat fully-dense feedstock. This allows deposition without trapping/generating bubbles. Parameterization studies were conducted to identify the optimum printing conditions for various types of prints that would result in the most accurate and desirable prints. The parameters studied were the direction of solidified glass exiting a melt pool, the ratio of the speed of the incoming filament to the speed of deposition determined by the speed of the substrate maneuvered on a four axis stage, the power of the laser used to melt the glass filament, the distance between deposition layers, and the effects of various re-melting processes using the laser. These parameters were studied using different printing types such as 2D and 3D raster patterns, unsupported horizontal printing, and 3D free form printing. Lessons learned from these studies are applied to print a free-standing 3D truss structure with single track elements. The truss structure supports a continuous sheet of glass. This artifact can be extended to create scaffolded 3D glass parts or light weight reflective telescope blanks.

Trajectory Effect on Part Height for Laser Metal Deposition: *Michael Dvorak*[1]; Michelle Gegel[1]; Douglas Bristow[1]; Robert Landers[1];[1]Missouri University of Science and Technology

Laser Metal Deposition (LMD) is an additive manufacturing processes that utilizes blown powder to deliver material to a molten pool generated by a laser. The typical approach to printing with the LMD process is to come to a complete stop every time the path sharply changes direction. When this approach is used the machine must slow down and speed up at each corner, which produces undesired material buildup at these locations. The purpose of this project is to prevent the undesired buildup at these points. In this work, two methods to accomplish this are implemented and compared to the typical approach. The first method maintains a non-zero velocity while traversing through each corner location. The second method is to insert extra motions at the corners where the laser turns off after completing a line segment and then turns back on once the motion system has aligned itself in the direction of the next line segment, obtained the printing velocity, and is at the start of the next segment. The three methods where implemented for a thin wall with multiple angles between line segments and then scanned. The methods were compared in terms of height buildup, acceleration, and jerk at the corners, as well as the time to complete the operation.

Additive Manufacturing of Current Collectors for MicroBatteries through Aerosol Jet Printing: *Galvin Greene*[1]; Brandon Ludwig[1]; Heng Pan[1]; [1]Missouri University of Science and Technology

Aerosol jet printing is the non-contact process of depositing nebulized particles onto a substrate for use in printable electronics and manufacturing of microbatteries. The ability to print complex patterns has made aerosol jet printing more frequently used in recent years. This analysis was performed in order to determine types of nanoparticle ink that are conductive with minimized linewidth. Material inks tested included 16 wt% Copper Oxide ink and Copper Powder ink consisting of 40 wt% Copper Powder, 35 wt% Polyvinylpyrrolidone (PVP) Binder, and 30 wt% N-Methyl-2-pyrrolidone (NMP) Solvent. To analyze and measure the conductivity of each material, substrates used required high temperature resistivity and were flash annealed at 3KV and measured with a Fluke Digital Multimeter. It was determined that the use of a shielding gas significantly increased the uniformity of the deposited material while also minimizes the linewidth. Additionally, due to the substrate surface properties, in order to increase adhesion to the substrate, a cleaning process was required, starting with an acetone bath followed by deionized water would result in an increase in adhesion.

Bioactive Hydrogels for Bioprinting: *Sheridan Hounschell*[1]; Krishna Kolan[1]; Ming Leu[1]; [1]Missouri University of Science and Technology

The need for organs and tissues continues to rise each day. One solution to this problem is the bioprinting of these organs and tissues. Hydrogels are three-dimensional (3D) networks of hydrophilic polymer chains, which can hold copious amounts of water in their structure. Hydrogels are widely used in tissue engineering because of their biocompatibility, biodegradability, porosity, and the ability to carry cells during the 3D bioprinting process; though the lack of mechanical strength and bioactivity still limits their use for a variety of tissues. In this study, we add highly angiogenic bioactive borate (13-93B3) glass to two hydrogels, Gelatin Methacrylol (GelMA) and Pluronic F127, to improve their bioactivity and printability. We investigated the addition of 13-93B3 glass in different weight percentages (2.5 % to 5 % w/v) during the solution preparation stages and before the cross-linking of polymer chains. The viscosities of hydrogels were measured and the printability of multi-layered porous constructs evaluated.

Development of Low Temperature Co-fired Ceramic (LTCC) Extrudate for Ceramic On-demand Extrusion: *Shannon Jaeger*[1]; Devin McMillen[1]; Greg Hilmas[1]; Ming Leu[1]; Jeremy Watts[1]; [1]Missouri University of Science and Technology

To be announced.

Calibration of a Short Wave Infrared Camera for Use in a Selective Laser Melting Additive Manufacturing Process: *Russell McDonald*[1]; Cody Lough[1]; Lan Li[1]; Seth Lanius[1]; Edward Kinzel[1]; Robert Landers[1]; Douglas Bristow[1]; [1]Missouri University of Science and Technology

Technologies in additive manufacturing such as selective laser melting (SLM) and electron beam melting are promising manufacturing methods for effectively producing near net shape parts in rapid prototyping or complex low volume applications. A solid understanding of the processing parameters for SLM have yet to be fully determined for some important materials, such as 304L stainless steel. To better understand the effect of significant process parameters on part quality, a short-wave infrared camera was integrated into a Reneshaw AM250 to measure temperature. For accurate temperature measurements, a calibration utilizing the emittance of powder and as-printed forms of 304L, along with consideration of optical pathing must be performed. This poster illustrates the calibration process along with a short comparison of laser activity for parts built using different process parameters.

Optimization of Binder Removal for a Fused Deposition of Ceramics System: *Zachary Oakes*[1]; Austin Martin[2]; Greg Hilmas[2]; Jeremy Watts[2]; [1]University of Kentucky-Paducah; [2]Missouri University of Science and Technology

A heating schedule was developed to decrease the time required for binder removal, without producing defects, in green ceramics made using a fused deposition of ceramics (FDC) process. The heating schedule was developed based on thermogravimetric analysis (TGA) measurements and video monitoring of the samples during constant heating rates to record the temperatures at which defects formed. TGA was performed, with no additional air flow, at heating rates of 0.2, 0.4, 0.8, 1, 2, 5, 10, 20°C/minute for kinetic analysis. From TGA data it was found that the steepest rate of binder loss in the tested composition was in the range of 250 to 350ºC where 55.7% of the binder was removed. Video monitoring was performed using a camera programmed to take an image at a set time interval through a viewing port in a tube furnace. These tests were performed in an environment of flowing compressed air at 43 mL/s at heating rates of 1.0, 0.5 and 0.2°C/minute. After debinding, parts were fractured and examined using an optical microscope to observe the pore size and distribution of defects as a result of poor binder removal. A final heating schedule was then developed and utilized to evaluate the effectiveness of the study by comparing the Archimedes' density of sintered parts to that of the green ceramic parts, accounting for dimensional changes.

Basis Function Superposition for Thermal Modeling of Selective Laser Melting: *Ben Rackers*[1]; Edward Kinzel[1]; [1]Missouri University of Science and Technology

The microstructure created in Selective Laser Melting (SLM) processes can be predicted with a thermal model. This project presents a new thermal model of the Renishaw AM250, which employs a stepping laser. Current thermal Finite Element Method (FEM) simulations of the SLM process are highly accurate. However, the computation power required to run an FEA simulation for a process with the size and required resolution for SLM is immense. This project presents an alternative method for predicting the thermal history using the principle of superposition and basis functions. For several unique conditions, the thermal response of individual laser pulses are computed using traditional methods. These thermal responses are adapted to build a library of basis functions in MATLAB. The library of precomputed basis functions are then used to populate the thermal history of large processes using superposition.

Control of Microstructure in Selective Laser Melting: *Adriane Replogle*[1]; Cody Lough[1]; Lan Li[1]; Edward Kinzel[1]; Robert Landers[1]; Douglas Bristow[1]; [1]Missouri University of Science and Technology

Selective Laser Melting (SLM) is an Additive Manufacturing (AM) process that is most commonly used for layered printing of metal parts. The SLM process uses a laser to locally fuse powder to a substrate. To begin, the part is divided into layers. For each layer, powder is dispensed, spread evenly, and the laser raster scans over the part geometry. After the process is completed, the bed is dropped, and the process is repeated. Microstructure control in SLM gives the opportunity to produce parts with designed mechanical properties. One possible way to control microstructure is through a feed-forward approach of process parameter mapping. A Renishaw AM250 was used in this work and printing parameters that can be controlled include, laser power, exposure time, point distance, and hatch spacing. This work was completed to understand how SLM process parameters control the microstructure of 304L stainless steel. Several specimens were built with different process parameters for mapping, these have been characterized through measuring melt pool and grain size, along with porosity through microscopy.

Composite Lithium Electrode Based on Silicon Nanofiber: *Kalani Rivera*[1]; Jie Li[1]; Jonghyun Park[1]; [1]Missouri University of Science and Technology

Lithium (Li) metal anode has been regarded as the "Holy Grail" of modern battery technology due to its light weight, low potential, and high specific capacity. However, several critical challenges, including dendrite formation, large volume change, and solid electrolyte interphase formation, hinder its practical applications. This project focuses on a fundamental understanding of dendrite growth mechanism of Li metal, and constructing a novel composite Li metal electrode based on nanofiber. The Li dendrite growth during the electrodeposition process of Li is a critical issue for the battery safety and performance since it may result in a short circuit and capacity fade. An effort is necessary to characterize and analyze the formation and growth processes of Li dendrites to reveal the mechanisms that contribute to them. An understanding on such mechanisms will lead to a novel composite electrode design by utilizing electrospinning process. A symmetric Li-Li cell was fabricated to perform both ex- and in-situ observations on dendritic growth and formation at various current densities. The parameters determining growth of dendrites, and therefore impacting battery performance, such as dendrite length as a function of time, solid electrolyte interphase (SEI) layer thickness on the dendrite surface, and density of the dendrites, are measured and will be used as input for predeveloped simulation tool and design criteria for a composite electrode. Such composite electrode will then undergo electrochemical testing and be compared to traditional lithium electrodes.

Additive Manufacturing of Glass-to-metal Seals: *Juanita Stephen*[1]; Edward Kinzel[1]; [1]Missouri University of Science and Technology

Glass-to-Metal Seals (GTMS) are generally airtight seals that are formed between the oxide layer of a metal and glass upon heating. These seals are applied in areas of design and developing products in many industries including aerospace, healthcare and automotive. The thermal expansion of the materials used must be similar for a successful seal to be made. Materials, like that of Kovar and Borosilicate glass, adhere together. The amount of oxide layer on the Kovar that forms on the metal when heated is a property that can help to determine a good seal. A Paragon Kiln Furnace was used to show that a seal can be formed. Then a CO2 laser was used to additively manufacture a GTMS. A previously oxidized sheet of Kovar and a filament of Borosilicate glass was used. Through this study, a GTMS was additively manufactured.

Photoelastic Analysis of Additive Manufactured Borosilicate Glass Walls: *Magel Su*[1]; Noor Shoaib[2]; Bret Curtis[2]; Daniel Peters[2]; John Hostetler[2]; Edward Kinzel[2]; [1]University of Michigan - Ann Arbor; [2]Missouri University of Science and Technology

While many techniques have been developed in recent years for producing polymer- and metal-based products by additive manufacturing, only a few additive manufacturing techniques exist for producing glass structures, and even fewer work has been done to explore additive manufacturing techniques for producing transparent glass products. While most current additive manufacturing techniques result in opaque glass structures, a recent modified selective laser melting/selective laser sintering method has shown the capability to print transparent borosilicate glass walls [1]. However, while these borosilicate glass walls demonstrate transparency, they tend to contain significant amounts of thermally-induced residual stress leftover from the manufacturing process. High temperatures introduced throughout the laser melting process induce thermal stress states which are visible in the final structure using photoelastic techniques. Even with deposition upon a heated substrate (450°C), significant thermally-induced residual stresses are introduced by the laser, leading to large temperature gradients and uneven heating/cooling in the glass. To observe the thermally-induced residual stresses resulting from this additive manufacturing technique, borosilicate glass walls are observed under a polariscope and the stress states are qualified. Different additive manufacturing parameters, including laser power and fluence, path speed, and deposition pattern, are also explored, demonstrating residual stress state similarities despite the different parameters. An annealing study is also done on the borosilicate glass walls, demonstrating that established annealing standards can be used to significantly reduce residual stresses in the glass walls without sacrificing form or structure.

Towards Defect Detection in Metal SLM Parts Using Modal Analysis "Fingerprinting": *James Urban*[1]; Nicholas Capps[1]; Brian West[1]; Troy Hartwig[1]; Ben Brown[2]; Robert Landers[1]; Douglas Bristow[1]; Edward Kinzel[1]; [1]Missouri University of Science and Technology; [2]Kansas City National Security Complex

The validation of Additively Manufactured (AM) materials is a difficult and expensive process because the local engineering properties are a function of the thermal history. The thermal history varies with the process parameters, as well as the part geometry. This paper presents a case study using modal testing to identify defects in a realistic AM part. A setup consisting of a l scanning laser Doppler vibrometer and a dynamic impact hammer was used to identify the resonant frequencies for several nominally identical parts on a build plate. Parts with suboptimal process parameters (as a result of purposely varying the process parameters) were identified by shifts in the mode peak frequency. Results from this study are compared to Finite Element Analysis models and generalized for identifying defects in parts created with AM on the basis of vibration/modal “fingerprinting”.

Thermal Recording Processing and Analysis for SLM: *Seth Lanius*[1]; Russell McDonald[1]; Edward Kinzel[1]; Douglas Bristow[1]; Robert Landers[1]; [1]Missouri University of Science and Technology

Selective Laser Melting (SLM), the process of hitting a powder bed with a high-power laser to form a part layer by layer, provides a method for making complex metal parts with ideal microstructure properties. For the purpose of controlling the microstructure, a thermal camera mounted in the printer records data of the melt pool path and temperature to find discrepancies that signify faulty parts. In order to determine how accurately the melt pool properties could be utilized in recognizing off-nominal parts, a method for analyzing the uniformity of the melt pool shape and path throughout the build was designed. Also, to improve the storage and analysis of the thermal recording, methods of filtering out unnecessary frames and distinguishing the build layer were developed. To prepare the recording for analysis, a MATLAB filter is used in Research IR to crop out frames without melt pool activity and save the retained frames as MAT-files separated by layer. To keep an accurate record of the build layer, a small part using a binary process was designed for the filter to read. For analysis, a MATLAB code is used to track the centroid and shape of the melt pool and compare similar layers. Further improvement and testing is planned for the analysis code.

Corrosion Behavior of Metals Manufactured by Selective Laser Melting: *Michelle Marrero-Garcia*[1]; Lianghua Xiong[1]; Lianyi Chen[1];[1]Missouri University of Science and Technology

The selective laser melting (SLM) process has gained much interest from both the scientific and industry communities because it offers the possibility of producing parts with complex geometries, without the need for assemblies, merely using a computer aided design (CAD) model. This research aims to study the corrosion behavior, a property that is not fully understood yet in AM parts, of one widely used metallic alloy, 304L stainless steel, made by the SLM process. Electrochemical measurements, including an open circuit potential and potentiodynamic polarization tests etc., were conducted. Optical microscopy and scanning electron microscopy techniques were used to analyze the microstructure of the materials. The pitting formation are widely seen after corrosion tests and accumulation of pits on the top surface leads to layer collapses and exposure of inner layers. Open circuit potential and potentiodynamic properties vary from sample to sample. The sub-grains and sub-grain boundaries might be sensitive to corrosive attack. Complicated microstructures in SLM parts contribute to the variation of corrosion behavior.

A Rheometry-validated Model for Predicting the Spreading Process in Metal Additive Manufacturing (AM): *Prathamesh Desai*[1]; Akash Mehta[1]; Wentai Zhang; Patrick Dougherty[1]; C. Fred Higgs; [1]Carnegie Mellon University

Powder-bed additive manufacturing (AM), colloquially known as three-dimensional (3D) printing, is one of the few types of technologies slated to disrupt the traditional manufacturing industry predominantly dependent on casting, molding and subtractive manufacturing. The state-of-art powder-bed 3D printers are optimized to work only with a handful of powders and the parts built using such printers have rough exterior and porous interior. The 3D printing process used involves repetitive spreading of powder and fusing or binding of the spread layer until the entire geometry is 3D printed. Most of the existing AM research is cluttered around binding (e.g., laser sintering or melting) process optimization. The step of powder spreading is not often studied and makes use of machine default spread settings obtained by a trial and error approach. However uniform spreading of powder layer is mandatory to 3D print dense, isotropic parts with a smooth surface finish. The authors of this study aim to study the spreadability of AM powders, i.e., the ability to spread or make powders flow under a given compressive load. First, a virtual powder is developed which has a rheological behavior similar to a real AM powder, using discrete element method (DEM). This powder is then used to perform virtual spreading experiments in silico, in scenarios similar to those found in real 3D printers. Since the DEM simulations are computationally expensive, only a few such simulations are run. Consequently, machine learning was employed to interpolate between the highly non-linear results obtained by the DEM simulations. Based on the spreading process predictions, the most efficient spreading parameters can be found to achieve an acceptable surface finish. This eventually saves the total time for printing and reduces the cost of build.

A Study of Nanoparticle Binder’s Impact on the Binder Jetting Additive Manufacturing Process: *Hannah Pham*[1]; Yun Bai; Christopher Williams[1]; [1]Virginia Tech

It is hypothesized that suspending nanoparticles into the binder used in Binder Jetting Additive Manufacturing of metals could improve a final part’s sintered density and structural integrity. In this work, nanoparticle suspension’s rheology, jettability, and interaction with powder were investigated to understand the nanoparticle’s influence on the Binder Jetting process. Copper nanoparticle suspensions were prepared by dispersing copper nanoparticles in polymer binders with the presence of dispersants. The solid loadings of the nanoparticles were varied to determine their effect on ink rheology and jettability. The viscosity and surface tension of the inks were measured, and a relationship between rheology and droplet size was established through inkjet printing test. Droplets of the inks were deposited onto a powder bed to determine the inks spreading and penetration behavior. The results show that the presence of copper nanoparticles in polymer binder decreased the surface tension, increased viscosity, which resulted in a large contact angle with slow binder penetration rate.

ADDENDUM

Wednesday, August 9

Process Development 11: Wire Processes and Ceramics
4:20 PM
Evaluation of Microstructure and Defects in Additively Manufactured Ceramics: Robert Begbie III[1]; Ahmed Wael[1]; Derek Haas[1]; *Desiderio Kovar*[1]; [1]University of Texas at Austin

Alumina ceramic disks with a nominal diameter of 1.25 inches and a thickness of 1/8" were formed using a paste-based additive process and then sintered. The parts were evaluated using a number of non-destructive and destructive techniques to assess microstructure and properties. These techniques included radiation attenuation using neutron and gamma-rays, x-ray tomography, Archimedes density measurements, optical and SEM microscopy, elastic properties measurements, and strength measurements. The microstructure was found to be similar for additively processed and conventionally processed ceramics, with grain sizes of approximately 1 -5 µm and relative densities of 95%, as determined by both gamma ray absorption and the Archimedes' method. The Poisson's ratio was measured to be 0.25 and the Young's modulus was measured to be 333 GPa, which are also broadly consistent with conventionally processed alumina that has a relative density of 95%. The mass attenuation coefficient for gamma rays was 0.27 (cm2/g) and the macroscopic cross section for neutrons was 0.073 cm-1, which are also consistent with a 95% dense alumina. The strength was found to vary more than conventionally sintered parts as a result of a small number of large pores which were observable by x-ray tomography, but not detectable by other techniques. This study highlights the need to employee a combination of characterization techniques that are sensitive to both average microstructural features that control many properties as well as statistically improbable feature that control properties such as strength.

CANCELLATIONS

Presentations cancelled after the program was printed.

Monday, August 7

Applications 3: Education and Future
2:30 PM
Roadmap for Multi-Material Additive Manufacturing; presenter: Amy Elliott, Oak Ridge National Laboratory

Physical Modeling 2: Novel Simulation Approaches
2:50 PM
A Proposed Framework for Material Jetting Process Modeling: Critical Issues and Research Directions; presenter: Chad Hume, Georgia Institute of Technology

Materials 1: Novel Polymers and Processing
4:20 PM
Process -- Structure -- Properties Relationships of a Novel Polypropylene Laser Sintering Material; presenter: Rob Kleijnen, inspire AG

Process Development 2: Photopolymers and Novel Processes
4:20 PM
Projection-based Stereolithography Using a Sliding Window Screen for Simultaneous Photopolymerization and Resin Refilling; presenter: Huachao Mao, University of Southern California

Physical Modeling 1: Design and Quality Control
4:40 PM
High-throughput Printing of Conductive Polymer Nanocomposites via Joule Preheating of the Filament; presenter: Adam Stevens, Massachusetts Institute of Technology

Tuesday, August 8

Process Development 3: Laser Processing and Monitoring 2
8:35 AM
Laser Sintering Exposure Parameter Optimization by CT Scan; presenter: Johannes Lohn, Paderborn Univ Direct Manufacturing Research Center

Physical Modeling 3: Powder Beds
10:45 AM
Experiments and Modeling of End Effects of Direct Laser Deposition; presenter: Jennifer Bennett, Northwestern University

Process Development 5: Material Extrusion and Surface Properties
2:40 PM
Material Addition and Continuous Sculpting as an Alternate Approach to Improve Surface Quality and Dimensional Accuracy of 3D Printed Parts; presenter: Rajeev Dwivedi

Poster Session
Fabrication of an Engine Cylinder Head via Binder Jet Additive Manufacturing; presenter: Derek Siddel, Oak Ridge National Laboratory

Printing of Neutron Collimators via Binder Jet Additive Manufacturing; presenter: Derek Siddel, Oak Ridge National Laboratory

Directional Dependence of Mechanical Properties and Defects of LENS 304L; presenter: Cole Britt

Wednesday, August 9

Materials 10: PBF: Multijet Fusion and Laser Sintering
8:40 AM
Pre-printing Quality Assessment of LS-PA12 Parts: Validating the Energy Density Mapping Approach through the use of X-ray Computed Tomography
Presenter: Michele Pavan, Materialise

Biomedical Applications 1: Tissue and Cellular
10:10 AM
Engineered Stem Cell Fibrous Substrates Using High Resolution Additive Biomanufacturing
Presenter: Robert Chang, Stevens Institute of Technology

11:30 AM
Three-dimensional Printing of Cellulose-laden Ionic Liquids
Presenter: Deshani Gunasekera, The University of Nottingham

Materials 11: 304L and Precipitation Hardened Stainless Steel
11:30 AM
Effect of Load Sequences on Fatigue Life of Direct Metal Laser Sintered Parts under Variable Amplitude Loading
Presenter: Sagar Sarkar, Indian Institute of Technology (IIT)

ADDENDUM

Process Development 11: Wire Processes and Ceramics
1:10 PM
Cost Competitive Wire Arc Additive Manufacturing (WAAM)
Presenter: Jonathan Hoffmann, Louisiana State University
Materials 14: Novel Materials and Processes
1:10 PM
Crack Initiation and Growth in Selective Laser Melted Pure Molybdenum
Presenter: Dianzheng Wang, Tsinghua University
Materials 16: Thermal Aspects and Porosity Effects
2:10 PM
Fracture Toughness of Additive Manufactured Composite Metamaterial
Presenter: Huachen Cui

4:20 PM
Design and Fabrication of Hierarchical 3D Architected Metamaterials with Programmable Damage Tolerance and Strength
Presenter: Huachen Cui, Virginia Tech

Applications 11: Honeycombs and Process Characterization
3:20 PM
Application of Integrated Computational Materials Engineering in Qualification of Additive Manufacturing Parts
Presenter: Guofeng Chen, Seimens Ltd. China

4:20 PM
New Benchmark Part Design for Characterising Accuracy in Binder Jetting Process
Presenter: Senthilkumaran Kumaraguru, Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

PRESENTER CHANGES

Monday, August 7
Physical Modeling 1: Design and Quality Control
1:30 PM
From CAD Models to Parts: Software Development for the Wire+ Arc Additive Manufacture Process will now be presented by: Jialuo Ding, Cranfield University

Tuesday, August 8
Applications 5: Residual Stress
8:55 AM
The Effect of Scanning Strategy on Residual Stress in Metal Parts Fabricated via Selective Laser Melting (SLM) Technique will now be presented by: Ajit Achuthan, Clarkson University

Poster Session
Understanding the Digital Thread: Investigating the Amount of Data and File Types Generated during Additive Manufacturing will now be presented by: Brant Stoner, The Pennsylvania State University

Long-term Effects of Temperature Exposure on SLM 304L Stainless Steel will now be presented by: Caitlin S. Kriewall, Missouri University of Science and Technology

Wednesday, August 9
Biomedical Applications 1: Tissue and Cellular
10:30 AM
3D Bioprinting Tissue Constructs will now be presented by: Juliana Bermudez, CSUN

Modeling 2
1:10 PM
Time-Optimal Scan Path Planning Based on Analysis of Sliced Geometry will now be presented by: Raya Mertens, KU Leuven

OTHER CHANGES

Monday, August 7
Applications 2: Design and Optimization
2:30 PM
Topology Optimization for 3D Material Distribution and Orientation for Additive Manufacturing presented by Doug Smith will now be presented as a poster.

Process Development 1: Laser Processing and Monitoring 1
2:50 PM
In-process Condition Monitoring in Laser Powder Bed Fusion (LPBF), presented by Mohammad Montazeri, University of Nebraska-Lincoln
Author's note: *"This work acknowledges the contribution of Dr. Brandon Lane and Dr. Jarred Heigel of the National Institutes of Standards and Technology (NIST), United States Department of Commerce; the data for this work was generated at NIST. Dr. Lane and Dr. Heigel do not appear on the list of authors of the article in the conference proceedings pending review of its scientific merits and subsequent approval by NIST's editorial review board per established policy*"

Tuesday, August 8
Process Development 7: Novel Processes
3:40 PM
Magnetohydrodynamic Drop-on-Demand Liquid Metal 3D Printing will also be viewable as a poster.

Wednesday, August 9
Process Development 8: Process Effects
Session will now be chaired by Hadi Miyanaji, University of Louisville

Modeling 1
9:20 AM
Effect of Implicitly Derived Infill Patterns on Mechanical Properties is now titled Implicit Slicing Method for Additive Manufacturing Processes and will be presented by: Davis W Adams, Clemson University

Modeling 2
1:50 PM
Study on STL-based Slicing Process for 3d Printing presented by Jing Hu, University of Colorado Denver will now be presented as a poster on Tuesday.