SFF SYMPOSIUM MANUSCRIPTS APPEARING IN THE MARCH 2017 ISSUE OF *JOM*

Ten materials-related manuscripts from the 2016 SFF Symposium were selected by the Organizing Committee for publication in the TMS journal *JOM*. Papers may appear in only one publication, or they must be substantially revised and improved for submission to *JOM*. Eight authors chose to publish their manuscript only in *JOM*, so their papers do not appear in this Proceedings. The titles and abstracts appear here so readers will know that the papers have appeared in print.

MAGNETIC CHARACTERISATION OF SELECTIVE LASER MELTED SAF 2507 DUPLEX STAINLESS STEEL

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Selective laser melting is disruptive in terms of the sensitive balance between constituent phases of the biphasic duplex stainless steel material options. The mechanical and corrosion properties are adversely affected due to the loss of the equilibrium austenite-ferrite structures. However, the predominantly ferritic structures resulting from the high thermal gradients were noted to impart significant magnetic responses. While this could lead to potential application in stators with controlled magnetic properties in permanent magnet motors, the material-process-magnetic response relationships require scientific attention to establish the underlying principles and critical responses. Duplex stainless steel specimens laser melted with varying process conditions were vibrated in constant magnetic fields and the resulting magnetic saturation hysteresis loop results led to magnetic characterisation. Austenite-ferrite ratios established allowed for identifying the structure-magnetic property relationships. Overall, the experimental results indicated strong process-property relationships, while the magnetic saturation levels of SLM samples are much higher compared to the wrought counterparts.

QUALITY CONTROL OF LASER BEAM MELTED PARTS BY A CORRELATION BETWEEN THEIR MECHANICAL PROPERTIES AND A THREE DIMENSIONAL SURFACE ANALYSIS

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Good correlations between three dimensional surface analyses of laser beam melted parts of Nickel Alloy HX and their mechanical properties were found. The surface analyses were performed by using a confocal microscope, which offers a more profound surface data basis than a conventional, two dimensional tactile profilometry. This new approach results in a wide range of three dimensional surface parameters, which were each evaluated with respect to their feasibility for quality control in additive manufacturing. Especially the motifs hill and volume of islands analyses show a good correlation concerning the tensile strength, the Young´s modulus and the elongation at break. The differences with regard to each feature and their influence on the mechanical properties are discussed within this study. Due to an automated surface analysis process by the confocal microscope and an industrial six axis robot, the results are an innovative approach for quality control in additive manufacturing.

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FATIGUE BEHAVIOR AND FAILURE MECHANISMS OF DIRECT LASER DEPOSITED INCONEL 718

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Inconel 718 is considered as a superalloy with a series of superior properties such as high strength, creep-resistance, and corrosion-resistance. Additive manufacturing (AM) is particularly appealing to Inconel 718 because of its near-net-shape production capability to deal with the poor machinability of the alloy. However, AM parts are prone to porosity which is detrimental to the alloy's fatigue properties. As such, further understanding of the fatigue behavior of AM Inconel 718 is much needed. The room temperature fatigue behavior of AM Inconel 718 produced by an Optomec Laser Engineered Net Shaping (LENSTM) system is investigated in this study. Build conditions are carefully controlled to minimize the scatter in fatigue data. The specimens are tested after being subject to a standard heat treatment. Fully reversed strain controlled fatigue tests are performed on round specimens with straight gage section at strain ranges of 0.1% to 1%. Fracture surfaces of fatigue specimens are inspected using a scanning electron microscope. Results are compared to literature for both AM and wrought materials.

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SIMULATION OF COOLING RATE EFFECTS ON TI-48AL-2CR-2NB CRACK FORMATION IN DIRECT LASER DEPOSITION

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Transient temperature history is vital in direct laser deposition (DLD) because it reveals the cooling rate at specific temperatures, which directly relates to phase transformation and types of microstructure formed in deposit. FEA simulation was employed to study the transient temperature history and cooling rate at different experimental setups in Ti-48Al-2Cr-2Nb DLD process. In this paper, an innovative model was described, which combines a moving Gaussian distribution heat source and element birth and death technology in ANSYS, help to analysis cooling rate control method and guide crack-free deposits build process.

BINDER-JET PRINTING OF FINE STAINLESS STEEL POWDER WITH VARIED FINAL DENSITY

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Binder jetting is a high speed and inexpensive method for additive manufacturing. In most material systems it produces relatively weak porous parts that are subsequently strengthened through sintering and/or infiltration. While much work has focused on producing fully dense final parts, there is also value in producing parts with controlled porosity. This paper reports on the two different methods of handling fine

316 Stainless steel powder and the impact of each on the density of the parts. The first method is the formation of agglomerates of fine powder. In the second, Nylon 12 powders are mixed with the steel powder as a fugitive space holder to increase the porosity. The shrinkage and density of these parts are compared to direct printing into -22 micron.

SPRAY DRYING AS A PROCESSING TECHNIQUE FOR SYNDIOTACTIC POLYSTYRENE TO POWDER FORM FOR PART MANUFACTURING THROUGH SELECTIVE LASER SINTERING

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Selective laser sintering (SLS) is a rapidly expanding field of the 3D printing concept. One of the stumbling blocks in the evolution of the technique is the limited range of materials available for processing with SLS making the application window rather small. This article aims at identifying syndiotactic polystyrene (sPS) as promising material. sPS pellets were processed into powder form using a lab scale spray dryer with vibrating nozzle. This technique is the focus of this scope as it virtually eliminates the agglomeration phenomenon often encountered with the use of solution based processing techniques by individually drying the atomized droplets. Particles are predominantly more spherical using said technique. Microspheres obtained were characterized in shape and size by SEM and evaluation of the particle size distribution. The effect the processing technique imparts on the intrinsic properties of the material was examined by DSC analysis.

FATIGUE BEHAVIOR OF FDM PARTS MANUFACTURED WITH ULTEM 9085

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The mechanical characterization of FDM parts is mostly done by static tests. In many applications parts are also dynamically loaded. Here, fatigue tests can help to identify the expected lifetime of a part. This paper discusses the fatigue behavior of FDM specimens manufactured with Ultem 9085. For this, tensile bars are manufactured according to ASTM D638 in different build orientations. Tests are performed in a range of pulsating tensile stresses, and S N curves are documented for different build orientations. For higher loads, the FDM anisotropy characterizes the lifetime of used specimens, similar to static tensile bars. For lower loads, including a higher number of cycles to failure, S N curves of different build orientations converge. In further tests, tensile bars were chemically smoothed using chloroform vapor. Chemical smoothing reduces surface roughness and increases tensile strength of specimens in the upright build direction. Fatigue tests of chemically treated specimens show no significant lifetime increase.

INVESTIGATING THE IMPACT OF ACETONE VAPOR SMOOTHING ON THE STRENGTH AND ELONGATION OF PRINTED ABS PARTS

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Acetone vapor smoothing is a chemical treatment that "melts" or dissolves the surface of material extrusion ABS parts. The process fuses the layers together and then allows them to reform when the vapor treatment is removed, resulting in a smoother surface finish. This treatment is commonly used to improve the surface finish of a print, but some recent work has been done to investigate the effect of acetone vapor smoothing on part strength. However, this work, for the most part, has failed to take into account the anisotropic nature of printed parts. Prior research shows that vapor smoothing reduces strength under best-case loading conditions, that is, when the direction of tensile load is parallel with the direction of the layers. The authors hypothesize that vapor smoothing may increase strength under non-optimal loading conditions due to increased cohesion between layers and a reduction in stress concentrations. The authors worked to compare the material characteristics of treated and non-treated specimens in various orientations and loading conditions.

PROCESS OPTIMIZATION FOR SUPPRESSING CRACKS IN LASER ENGINEERED NET SHAPING OF Al_2O_3 CERAMICS

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Direct additive manufacturing of ceramics (DAMC) without binders is a promising technique for fabricating high purity components with good performance rapidly. However, cracks are easily generated during fabrication due to high intrinsic brittleness of ceramics and great temperature gradients. Therefore, optimizing the DAMC process is a challenging and important work. In this study, direct fabrication of Al_2O_3 single-bead wall structures are conducted using a laser engineered net shaping (LENS) system. A new process optimization method for suppressing cracks is proposed based on analytical models, and then influences of process parameters on crack number are discussed experimentally. Results indicate that crack number decreases obviously with the increase of scanning speed. Single-bead wall specimens without cracks are successfully fabricated by the optimized process.

RETHINKING TIMBER: AN INVESTIGATION INTO THE USE OF WASTE MACADAMIA NUT SHELLS FOR ADDITIVE MANUFACTURING

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This paper examines the feasibility of turning macadamia nutshells, a waste product from the forestry and agricultural industries, into a 3D printed, innovative microtimber product by composing a wood plastic feed stock for fusion deposition modelling (FDM). Different ratios of micro-ground macadamia nutshells and acrylonitrile butadiene styrene (ABS) plastics were mixed with a binding agent to extrude a range of

filaments. Using a commercial 3D printer, these filaments were used to fabricate specimens that were tested in tension and compression. The results show that printed samples of macadamia nutshell-ABS composites offer a viable alternative to commercially available wood polymer composite filaments. Whilst possessing similar mechanical properties, they have a lower density, making them suitable for a range of lightweight product applications. The research demonstrates that there are new opportunities for the use of macadamia nutshell filament in additive manufacturing due to its enhanced properties compared to traditional wood filaments.