LSAAT Meeting AGENDA

Thursday, June 22, 2023, Meeting Time: 8:00am-5:00pm

Dr. Victor Kenneth Champagne Jr. and Dr. Aaron Birt (Welcome Remarks) 0800-0815

Presenter	Presentation Topic	Time
1. Janice Bryant, NAVSEA	KEYNOTE: Additive Mfg. and Supply Chain Challenges	0815-0835
2. Alex Finch, Titomic	Cold Spray AM: The Integrated Spray Booth System	0835-0855
3. Dr. Sriram Manoharan, ADDiTEC	Portable Factories: Making Fwd-Deployable On-Demand Mfg a Reality	0855-0915
4. Anastasios Gavras, VRC Metal Systems	Wire Direct Energy Deposition & Cold Spray Additive Manufacturing	0915-0935
Exhibit Area	**BREAK AND NETWORKING**	0935-0955
5. Dr. Xuxiao Li, GEM	Material Flow in Additive Friction Stirred Deposition (AFSD)	1015-1035
6. Dr. Doug Bristow, Missouri S&T	Layer-to-Layer Dynamics and Control in DED	1035-1055
7. Dr. Paul Allison, Baylor U.	Influence of Deposition Pitch on Tensile Behavior in FSAM of Aluminum	1055-1115
8. Dr. Brian Jordon, Baylor U.	Preliminary Studies on AFSD Parameterization of Al Alloy 7020	1115-1135
9. Alex Michelson, Solvus Global	Limitations to (and Opportunities for) Scaling Large Scale AM	1135-1155
Exhibit Area	**LUNCH**	1155-1255
10. Jeremy Schreiber, HAMR	Large Format Cold Spray AM Components for Defense & Space	1255-1315
11. Dave Hofferbert, BOND Technologies	The Importance of Data in Driving AFSD Technology Development	1315-1335
12. Steven Camilleri, SPEE3D	Cold Spray Large Scale AM Advantages & Challenges	1335-1355
13. Logan McNeil & Dennis Harwig, EWI	Robotic Hybrid DED Mfg of Lg Format High Strength ST Aero Structures	1355-1415
14. Dr. Slade Gardner, Big Metal Additive	Accelerating Production and Acceptance for Wire Arc DED	1415-1435
Exhibit Area	**BREAK AND NETWORKING**	1435-1455
15. Sascha Bernhardt, Impact	Mechanical Material Properties of Cold Spray AM for Aircrafts	1455-1515
16. Jemery Iten, Elementum	Laser Powder Bed DED of A6061-RAM2	1515-1535
17. Ken Ross, PNNL	FSAM of Stainless, High Yield and ODS steels	1535-1555
18. Tanaji Paul, ColRAD – FIU	WAAM Titanium Resistance in Corrosive & Wear Environments	1555-1615
LSAAT Expert Panel	**Steven Camilleri, John Barnes, Dr. Tim Eden, Slade Gardner, Dennis Harwig, Dave Hofferbert *with* Janice Bryant as Moderator**	1615-1655
Dr. Aaron Birt	Wrap-Up	1655-1700
RECEPTION	**Solvus Global – Leominster Facility**	1700-2000

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LSAAT Meeting *ABSTRACTS*

Portable Factories: Making Forward-Deployable On-Demand Manufacturing a Reality

Speaker: Dr. Sriram Manoharan

Organization: ADDiTEC

The U.S. Department of Defense (DoD) has considerable interest to advance and modernize its manufacturing capability to be able to produce parts at an austere remote forward operating base (FOB) with no access to normal logistics support. Conventional manufacturing supply chains are not resilient enough due to pandemic induced back logs and low raw material readiness halting production lines. Additive manufacturing (AM) can enhance mission-readiness through cost-effective production of products which are on-demand and point-of-need, either at the base, at sea, or on the frontlines. This research discusses the design and development of robotic hybrid manufacturing portable cells rated for conventional, reactive, and refractory alloys. The portable cells provide all the benefits of a robotic architecture for additive and subtractive manufacturing in a compact hermetically sealed cell that is portable, allowing installation and the first printed parts in just one day making forward-deployable on-demand manufacturing a reality.

Toward an Understanding of Material Flow and Mixing in Additive Friction Stirred Deposition (AFSD) Using a Combined Experimental and Modeling Approach

Speaker: Xuxiao Li

Organization: Global Engineering and Materials, Inc. (GEM)

The emerging technology based on the additive friction stirred deposition (AFSD) has shown its many attractive features and capabilities in performing the solid state based additive fabrication of large-scale structures and structural repair of corroded aluminum structural components. While bearing apparent similarity with friction stir welding, AFSD has a more complicated material flow due to a combination of material feeding, spreading, and stirring. A gap still exists in understanding the thermal-flow coupling, plasticity, stick-slide friction condition, and the bonding between the feed material and the underlying material. The material flow and mixing significantly affect the microstructure, such as grain recrystallization and precipitation aging, and the process-induced defects, such as the kissing disbond. In this work, a combined experimental and numerical study was performed using the single-track deposition of AA 7050 at various process conditions. The data collected from the sensors was used for the validation of a multiphysics process model based on the computational fluid dynamics and customized commercial software StarCCM+. The model predicts the thermal, flow, and pressure field which is compared with the thermal couple and force sensor data. customized StarCCM+. Advanced material characterization based on optical and scanning electron microscopy was further used to correlate process and microstructure. This study paves the way to establish a full understanding of process-structure-property-performance relationship and achieve performance-driven tailoring of AFSD parameters.

Influence of Deposition Pitch on Isotropic Tensile Behavior in Additive Friction Stir Deposition of High Strength Aluminum Alloys

Speaker: Dr. Paul Allison

Organization: Baylor University

Here, the influence of deposition pitch (DP), the ratio of tool rotation rate to tool traverse rate, has been investigated to achieve the necessary material mixing per unit of deposition length to achieve adequate interlayer bonding during Additive Friction Stir Deposition (AFSD) of high strength aluminum alloys. Specifically, there appears to be a critical DP value to achieve necessary mixing between deposited layers yielding high ductility in build direction samples to obtain isotropic properties. A necessary DP value directly correlates to effective solid-state bonding between deposited layers confirmed through fracture surface characterization of the specimens.

Limitations to (and Opportunities for) Scaling Large Scale AM

Speaker: Alex Michelson

Organization: Solvus Global

Large Scale Additive Manufacturing (LSAM) is a promising manufacturing approach which offers the potential to address disruptions of existing manufacturing supply chains for legacy components and challenge conventional design for manufacturing ideas for next generation components. However, in its current state, adoption of LSAM is slowed due to limited qualification pathways, and un-optimized production cycles. This presentation aims to explore these limitations and present the opportunities for scaling LSAM by leveraging its potential for part cost reduction, shorter lead times, and enhanced design flexibility.

Early Trials Towards Large Format CSAM Components for Defense and Space

Speaker: Jeremy Schreiber

Organization: HAMR Industries

The scalability of cold spray additive manufacturing (CSAM) promises utility for many applications. This presentation describes efforts to utilize CSAM in support of sustainment and point of need manufacturing capabilities, as well as research and development efforts for a variety of DoD and space applications. Applications well suited for CSAM in its current state will be discussed, along with lessons learned in alloy selection and part design. The presentation will also explore future applications and use scenarios that leverage cold spray's fundamental benefits versus other additive techniques: scalability, lack of melting, and ability to grade and layer.

Mechanical material properties of CSAM – Cold Spray Additive Manufactured parts for space propulsion and aircraft parts

Speaker: **Dr. Sascha Bernhardt**

Organization: Impact Innovations GmbH

In recent years, Cold Spray (CS) technology has entered in many industries not only for coatings, but also for additive manufacturing (AM), especially in aerospace or defense. The Cold Spray process offers substantial applications, for example, in-situ structural or dimensional restoration and as well in 3D build-ups. The highly flexible technology assures that even parts with large dimensions, i.e., up to 2 to 3 m, can be manufactured in ambient environment.

In space industry, following materials are used very often for propulsion components: CuCrZr, In625, In718. In aircraft industry often Titanium or Ti-6-4 is used. The following paper will show latest results on intensive investigations on material properties for these materials. All tested structures have been cold sprayed. One focus will be on thermal behavior of these materials, the thermal expansion coefficient and the thermal conductivity will be presented. Mechanical tests will deliver results on fatigue crack grow rates as well as on fracture toughness. All materials will undergo an extended low cycle fatigue testing. Basic parameters on densities and porosities will be determined during the voluminous testing program. Finally, microstructure analysis results performed with SEM (Scanning Electron Microscopy) technology will give deep insights into the cold sprayed structures.

Resistance of Wire Arc Additive Manufactured Titanium to Combined Corrosive and Wear Environments

Speaker: Tanaji Paul

Organization: CoLRAD FIU

Longevity of large-scale titanium components for marine applications is determined by their performance under environments combining wear and corrosive media. To that end, this study presents investigations on the electrochemical, tribological, and integrated tribo-corrosion responses of wire arc additive manufactured (WAAM-ed) single-phase commercially pure titanium (cp-Ti). Surface behaviors a mutually perpendicular deposition directions are unraveled by a combination of wear and integrated tribo-corrosion tests under varying aqueous media and loading conditions. Microstructural mapping of these surfaces before and after exposure enabled the identification of threshold tribo-corrosive environments for sustained marine performance of this material.