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Oak Ridge National Laboratory Innovation Crossroads CRADA Report

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OAK RIDGE NATIONAL LABORATORY
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Large Area Projection Sintering Technology Development

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ABSTRACT

This CRADA was formed through support of the Innovation Crossroads program, which has been an invaluable experience for Ascend Manufacturing and our additive manufacturing technology. Without Innovation Crossroads, the research, capital and operational requirements to develop our company would have been too high and Ascend Manufacturing simply would not exist. Our patented and federally funded technology would have gone to waste. Through this CRADA, Ascend has been able to collaborate with the worlds experts in additive manufacturing to assist in developing our state of the art technology. This project assisted in developing a fully scalable 3D printing process, developed an industrial and pilot system design, assisted in the fabrication of a pilot system, allowing us to print components with materials impossible by any other 3D printing process. This work has allowed us to achieve significant follow-on funding to fully commercialize this highly capable manufacturing technology.

STATEMENT OF OBJECTIVES

The statement of work for this CRADA was tailored to maximize the commercialization potential of our technology. Successful completion of the CRADA would provide a system capable of material and system development that would allow Ascend to start business opportunities with potential customers and suppliers. The tasks included co-designing our first-generation pilot system with ORNL staff which utilized fully scalable mechanisms, fabrication and testing of the system. Future CRADA work would involve planned system upgrades to incorporate advanced features such as high levels of automation.

BENEFITS TO THE FUNDING DOE OFFICE'S MISSION

Ascend Manufacturing is building a company based on a clean manufacturing process. Typical manufacturing processes such as punching, machining, molding, etc, produce large amounts of scrap waste that in some cases can’t even be recycled. Ascend’s additive manufacturing technology creates no waste feedstock material. Therefore, all the material that is used for manufacturing is directly used in the production process. No excess electricity or carbon emissions are created from transporting waste material to landfills or goes into a chemical or thermal recycling process.

TECHNICAL DISCUSSION OF WORK PERFORMED BY ALL PARTIES

The first task Ascend completed under the CRADA was by working with Amy Elliott and Brian Post was the development and design of a fully scalable 3D printing system. This design was developed through in-person meetings and included methods to scale up the fusing, powder deposition, layer spreading and build recovery aspects of the system. All of the mechanisms identified were created to be

fully scalable to larger systems. In addition, with assistance from Peter Lloyd, we were able to implement industrial controls on our pilot system. We were also able to design the system to the highest safety standards through guidance by ORNL's John Czachowski and Kris Thomasson who assisted in employing robust safety measures and fail safes. This allowed us to construct a system that meets the high level of standards and allows us to locate our next system at the MDF for future work. Locating a system at the MDF provides quick integration with ORNL staff and testing resources while providing a distinguished demonstration for future business opportunities with potential customers, strategic partners and investors.

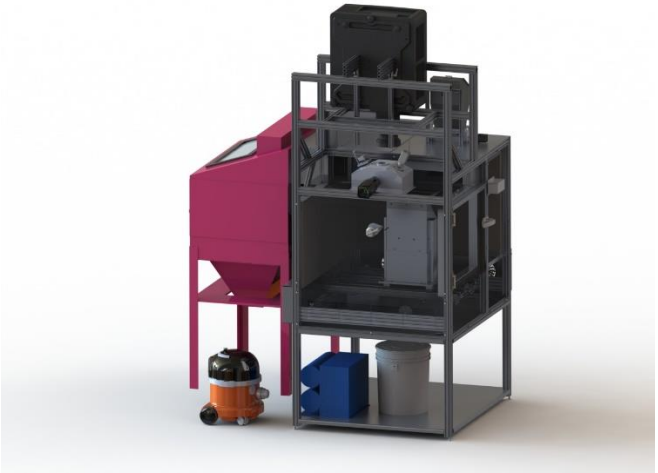

Figure 1: CAD rendering of pilot system.

Ascend was able to fabricate our fourth system, which is our first large pilot system which can be used for material studies, processing optimization and software development. With this system, we were able to develop a one-of-a-kind software program that allows our thermal camera to work in conjunction with our high intensity projection system. This allows every voxel (3D pixel) of the component to be programmed to follow a specific temperature profile. Ascend Manufacturing is the first and only company in additive manufacturing that is capable of full closed loop control manufacturing which leads to robust and high reproducible components. In addition, with ORNL assistance, we have a user interface that includes a slicing program. This program allows us to load in 3D models and create images for every layer to fuse powders and create a physical 3D component.

Figure 2 (left): Dr. Nussbaum stands with the Ascend Manufacturing pilot system which was developed through this CRADA work, (right): example tensile specimens created during a time/intensity study from an "unsinterable" material.

Table 1 – Original CRADA tasks and their current state of development. Ongoing tasks are essentially never ending as the pilot program with the industry is constantly bringing in new materials for testing which each require their own material study and process optimization.

	Original CRADA Subtasks	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9+	Completed?
Task 1	1.1 - Prototype Machine Design/Evaluation										Yes
	1.2 - Evaluate Heat Patterning Device/Methods										Yes
	1.3 - Develop Control Processes for Prototype										Yes
Task 2	2.1 - Fabricate/Develop Prototype										Yes
	2.2 - Materials Study										Ongoing
	2.3 - Process Optimization										Ongoing
Task 3	3.1 - Design Prototype System Upgrades										Yes
	3.2 - Upgade Prototype										Yes
	3.3 - Begin Pilot program with Industry										Ongoing

COMMERCIALIZATION POSSIBILITIES

Due to the ability to fine tune and control the spatial heat profile over the entire surface, materials can be fused while mitigating warping effects. This, along with the ability to apply heat with the projector only where it's needed has allowed us sinter and fuse materials that were previously "unsinterable", such

as thermoset powders. These are materials that offer increased properties over the industry standard, have unique material properties and/or are available at a fraction of the cost (in some cases, as low as $8/kg instead of $100/kg). Processing these materials along with high speed/high quality printing, is what will allow Ascend Manufacturing to stand out among competition in the additive manufacturing industry. Due to our ability to process these materials, we've been awarded a $100k RevV grant to investigate and develop these powders for use in our systems.

Ascend Manufacturing is now in the late stages of closing our Series A round where we will bring in approximately $2M in funding. This funding will capitalize off the work conducted with ORNL and be used to fully fund our path to market. Ascend will use this funding to form and grow a contract manufacturing business in the Knoxville area, providing tax revenue to the state of Tennessee while providing high tech jobs. Sales targets put Ascend path to hit our first ten million in annual revenue by 2023.

PLANS FOR FUTURE COLLABORATION

Ascend Manufacturing plans to continue an ongoing relationship with ORNL into the foreseeable future. As previously mentioned, Ascend Manufacturing received a RevV grant which will extend our relationship for another year. During this time, we will investigate adapting materials from the matured powder coating industry for use in our systems. Upon successful completion of this project, we will be able to decreased manufacturing costs by a factor of ten, while increasing the material palette of the manufacturing industry. This project will allow us to locate and operate one of our systems purchased through CRADA funding at the MDF.

With a system already located at the MDF, we will continue to seek collaboration opportunities. One such opportunity currently in discussion is a phase I technical collaboration. This collaboration project will mostly likely be aimed at determining the suitability of this technology in highly technical/critical industries, such as the DoD and aerospace. The goal will be to investigate our systems for use in creating a digital twin of every component which is manufactured with our systems. Not only are these systems capable of creating full volume digital twins of each component, but they can also provide full volume digital twins of the temporal thermal profiles as well, which is a completely new capability never before achieved.

CONCLUSIONS

Through collaboration between Ascend Manufacturing and ORNL, we were able to design, fabricate and test our first large scale pilot additive manufacturing system based on the patented Large Area Projection Sintering technology. By using equipment purchased through this CRADA, we have been able to determine the required printing parameters which in turn were used to provide throughput and

performance metrics. Furthermore, future system upgrades were designed and implemented on our next generation system which will be capable of fusing higher performance materials and will have a significantly increased throughput. With the assistance of the Innovation Crossroads mentors, their mentor network and technical experts, we've been able to develop an industrial additive manufacturing system and validated business plan to take us to market. We now have a lead investor for our Series A round and are working to complete the round. This experience with ORNL has been invaluable and will lead to the creation of a multimillion-dollar business, piggybacking off the work completed under this CRADA.