Cover Sheet

Ink Production Scale-Up

Semi-Annual Report

Reporting Period: Jul 1st, 2019 — Feb 1st, 2020

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1. Summary of Project Accomplishments and Plans

1.1 Accomplishments for this report period

Although the HERC project started on July 1, 2019, the PI did not have access to the funds until September 13, 2019 when the account was set up by the Office of Sponsored Projects at Boise State. This report covers the activities performed since September 13, 2019 until February 1, 2020.

Milestone Achievements

- Hired undergraduate student, Ms. Jasmine Cox, to work on ink synthesis and printing.
- Hired Post-Doc Dr. Josh Eixenberger (15% effort) to work on ink volume scale-up.
- Ordered and received microviscometer to measure the viscosity of material inks being formulated in the Advanced Nanomaterials and Manufacturing Laboratory (ANML).
- Placed an order for a Tangential Flow System to help scale up ink production.
- Ink 1: Started working on ZnO (Zinc Oxide) inks since there is an immediate interest from NASA and Boeing in getting this ink from us. These inks will be the first to be commercialized from partner, INFlex Labs, LLC.
- Ink 2: Worked on formulating Nickel ink and testing its performance. Nickel ink will also be commercialized through the company. Oak Ridge National Lab is an immediate customer.

1.2 Plans for the next reporting period

During the next reporting period, we plan to

- Fine tune the inks and processing parameters so that we can demonstrate compatibility and printability with the printer suite we have at Boise State. This will help create a datasheet for the different inks being formulated, and help the company market the ink to potential customers.
- Demonstrate the synthesis of higher volumes of inks so that the ink manufacturing could be made commercially viable. The Tangential Flow System will be set up specifically for this purpose.
- Develop a business plan together with the company. We will approach potential customers with prototypes and samples. We have already identified a few customers, including NASA Ames, Boeing Corporation, and Oak Ridge National Lab.

2. Summary of Budget Expenditures for the Period Just Completed

<u>Expenditure from Boise State University: $50,696.53 to date</u>

During this reporting period, we spent $50,696.53 overall. Within this, two pieces of equipment were purchased – (1) a RheoSense Microviscometer to measure the viscosity of ink synthesized ($9,977.40) and (2) a Tangential Flow System to help scale up the ink volume ($21,150). The remainder was spent to cover the salaries and fringe of the undergraduate student and the post-

doc. Expenses were also incurred for the printer use in the cleanroom and for ink characterization.

3. Number of Faculty and Student Participation Resulting from Funding

This project has had participation from one faculty member – Prof. Harish Subbaraman (PI), one undergraduate student, Ms. Jasmine Cox, and one post-doc, Dr. Josh Eixenberger. This project is providing hands-on ink synthesis and printing experience to the undergraduate student, and furthering the expertise of the post-doc who is skilled in the synthesis of nanoparticles and nanoparticle inks

4. Patents, copyrights, and plant variety protection certificates received or pending

While there is still great potential, as yet, there has been no idea or new technology reviewed on this project during this first time period that has led to any specific or particular new intellectual property.

5. Technology licenses signed and start-up businesses created

We have seen great interest from industry and national labs in trying to learn more about the project and procuring inks and associated processing information from us. Boise State and INFlex Labs are working on signing an agreement related to commercialization of the inks.

6. Status of private part/industry partnerships

PI Subbaraman received a NASA EPSCoR and NSF Nanomanufacturing awards. The incubation fund will enable setting up of state-of-the-art equipment for ink production scale-up. The EPSCoR grant will look into flexible electronic device development integration using a plasma jet printer for space applications. Currently, there are no ink vendors for the plasma jet tool, thus placing INFlex and Boise State in a very good position to work with the equipment manufacturer and promote our inks. The successful outcome from the current HERC project will lead to direct investment from interested companies and investors.

7. Additional Funding Received and Financial Burn Rate

As mentioned above, the PI has several other projects that utilize inks for developing flexible electronic devices and sensors. The work that will be performed in this project will be a natural extension of accomplishments in those projects. The PI is also constantly trying to secure extramural funding in this area, and we foresee efforts beyond the IF project going into further development of inks, sensors, and devices that can be used in the food storage, consumer electronics, space, and other markets.

In terms of financial burn rate, we will be using the remainder of funds on ink production, ink characterization, and development of processing recipes on the commercial printing tools at Boise State.