

# Idaho Incubation Fund Program

## Progress Report Form

**Proposal No. IGEM16-02**  
**Name: Kurtis Cantley**  
**Name of Institution: Boise State University**  
**Project Title: Enhancing Capabilities in Microfabrication at Boise State**  
**Reporting Period: January 1, 2017 through June 30, 2017**

**Information to be reported in your progress report is as follows (attach additional information as needed):**

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period:

Since the last report submitted at the end of January 2017, we have continued work on facility infrastructure improvements, installation of new equipment, and upgrades and critical maintenance on existing equipment. Some of the items below were listed in that report, as most of the year two budget was already encumbered at that time. A list of specific project objectives and related outcomes during the past five month period is given below.

- We have moved forward with upgrades to the Oxford PlasmaLab 180 inductively coupled plasma (ICP) etcher, including an Ocean Optics USB3000 optical endpoint detection system and the addition of an argon gas delivery line with mass flow controller. This will greatly improve process control on the tool and expand its etching capabilities to other materials.
- Ownership of a recently acquired aerosol jet printer and sintering tool was transferred to the IML after departure of a faculty member from Boise State. Funds were used to install support infrastructure for these pieces of equipment, which furthers the stated mission of this grant in expanding expertise and augmenting existing capabilities in the emerging research areas of flexible/printed electronics and thin-film and 2D materials.
- The Quintel Q-4000 contact printer is the main system currently being used for photolithography with feature sizes down to 1  $\mu\text{m}$ . We have upgraded this system with a new control computer connected to digital high-speed, color cameras and high resolution monitors. These changes will greatly improve process control when performing mask alignment, resulting in better usability and higher device yield.
- The Veeco ion mill is critical equipment for memristor fabrication by Prof. Kris Campbell, and is used for general material etching by other groups. It has recently experienced several issues due to its age, but significant repairs, upgrades, and general maintenance has been provided through this grant.
- A new 200 A breaker will provide a power upgrade to clean room. To save money, this project was added on to the larger project involving a new power transformer servicing the ENGR and MEC buildings.

2. Summary of budget expenditures for the period just completed (include project burn rate):

As of June 30<sup>th</sup> 2017, all of the \$500,000 year 2 budget has been encumbered (including remaining salaries) or spent. This corresponds to a **burn rate (excluding remaining salaries) of approximately \$41,667/month** averaged over 12 months.

Major purchases and expenditures include:

- \$44,720 for the new asher/reactive ion etching system
- Approximately \$100,000 in salary and benefits for technical support engineering Travis Gabel (for the year)
- Approximately \$115,000 in salary and benefits for ECE faculty Dr. Harish Subbaraman (for the year)
- Graduate student stipends and benefits totaling approximately \$62,000 for the year
- \$25,000 for endpoint detection and Argon gas upgrades to the Oxford PlasmaLab ICP etcher
- \$25,000 dedicated to lab chilled water supply upgrade (joint project with Boise State Facilities Operations and Maintenance)
- \$65,000 in total for supplies, and facility and equipment upgrades and installation

3. Numbers of faculty and student participation resulting from the funding, including internships:

Currently, there are two full-time PhD students (Sumedha Gandharava and Ashita Chandnani) and one master's student (Binay Joshi) supported by the project. The new ECE faculty (Harish Subbaraman) and technical support engineer (Travis Gabel) are also supported with salary and fringe benefits. Funds provided through the grant include \$100,000 in research start-up needs to Dr. Subbaraman, which has been split between years 2 and 3. Sumedha Gandharava will be participating in a six month internship at Micron Technology for the second half of 2017, and Binay Joshi has been interning for FiberGuide during summer 2017.

4. List patents, copyrights, plant variety protection certificates received or pending:

None at the current time.

5. List technology licenses signed and start-up businesses created:

At this time there are no start-up businesses created as a result of the funding. However, memristor (resistive memory) technology developed by Prof. Kris Campbell in the ECE department has been licensed by Knowm, Inc. and M. Alexander Nugent Consulting (MANC) of Santa Fe, NM. Their projects have been ongoing, resulting in significant use of and revenue for the IML.

6. Status of private/industry partnerships (include enough information to judge level of engagement):

Several new agreements with Idaho businesses have been put in place since the start of the project to use the IML and new equipment and processes contained in it. These include:

- American Semiconductor, Inc. (Boise, ID) has heavily used the new Bruker stylus profilometer and presented results at multiple conferences and workshops with credit to the IML at Boise State. They have also expanded contract usage to include lithography and chemical processing.
- Fiberguide, Inc. (Caldwell, ID) was previously using the old wet bench for process development and anticipates heavy use of the new benches in the coming months.
- Collaborative use of the Bruker stylus profilometer for a joint project with Idaho National Laboratory (INL), with additional use planned for the future.
- Emerson Cargo Solutions (formerly PakSense, Inc.) has been collaborative research, particularly with the new ECE faculty member, Dr. Harish Subbaraman.

7. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.

Below is a list of **grants awarded** to Boise State College of Engineering faculty in FY2017 that either directly make use of the IML facility and equipment or complement it. White rows are grants that were already listed in the HERC presentation follow-up document compiled in May 2017. Highlighted rows are new awards received in May and June, and there are three awards from the original table still pending a decision.

PI Name	Co-PI(s) and Affiliation	Project Title	Sponsoring Agency	Total Requested Funds	Total IML Budget	Duration (years)
Campbell, Kristy A.		Memristor BEOL through Knowm Inc for Dietmar Fey, University of Erlangen	University of Erlangen, Germany	\$10,000	\$8,000	1
Estrada, David	Emily Heckman (AFRL)	2D materials for Flexible Hybrid Electronics	AFRL	\$52,000	\$2,500	1
Estrada, David	Maria Mitkova, Yanliang Zhang, Jessica Koehne (NASA Ames), Harish Subbaraman, Kris Waynant (U. Idaho)	Space Grade Flexible Hybrid Electronics	NASA EPSCOR	\$750,000	\$30,000	3
Graugnard, Elton	David Estrada	Synthesis and Characterization of Atomic-Layered Transition Metal Dichalcogenides	Micron Foundation	\$62,835	\$780	2
Mitkova, Maria	Harish Subaraman	Integrated Silicon/Chalcogenide Glass Hybrid Plasmonic Sensor for Monitoring of temperature in Nuclear Facilities	DOE	\$890,000	\$9,000	3
Estrada, David	Harish Subaraman	Development of Nuclear Grade Nanoparticle Ink Syntheses Capabilities for Advanced Manufacturing of Nuclear Sensors	DOE	\$295,392	\$0	1
Ubic, Rick	Noah Salzman	REU Site: Materials for Society	NSF	\$425,984	\$1,050	3