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14. ABSTRACT This award supports the update of an X-ray Energy Dispersive Spectrometer (EDS) on a JEOL JXA-8530F Electron Probe Microanalyzer (EPMA) at Fayetteville State University (FSU). The EPMA equipped was funded by the Army Research Office under Contract W911NF-09-1-0011. Its original Si(Li) EDS detector available at that time required liquid nitrogen cooling. It was proposed to trade in the original detector to the manufacturer and replace it with a liquid-nitrogen-free Silicon Drift Detector, which not only achieves improved performance with higher count rates, but also reduces maintenance cost and staff labor. The upgraded EDS detector will enhance the					
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				19b. TELEPHONE NUMBER 910-672-2647	

## Report Title

Final Report: Upgrading an X-Ray Energy Dispersive Spectrometer on the Electron Probe Microanalyzer for Materials Research and STEM Education at Fayetteville State University

### ABSTRACT

This award supports the update of an X-ray Energy Dispersive Spectrometer (EDS) on a JEOL JXA-8530F Electron Probe Microanalyzer (EPMA) at Fayetteville State University (FSU). The EPMA equipped was funded by the Army Research Office under Contract W911NF-09-1-0011. Its original Si(Li) EDS detector available at that time required liquid nitrogen cooling. It was proposed to trade in the original detector to the manufacturer and replace it with a liquid-nitrogen-free Silicon Drift Detector, which not only achieves improved performance with higher count rates, but also reduces maintenance cost and staff labor. The upgraded EDS detector will enhance the capability of the EPMA at FSU which is the sole field-emission instrument in the state of North Carolina, serving the academic, governmental and industrial communities for research and education.

The acquisition of the proposed instrument will support five ongoing research projects at FSU: (1) high-efficiency X-ray radiation detection; (2) high-efficiency ultraviolet to infrared radiation detection; (3) shape memory alloy nanowires for deformation behavior on nanoscale; (4) nanostructured explosive biosensors; and (5) surface treatment of biomaterials. The proposed EDS detector on the EPMA will be used to study the structure of these materials, advancing the research described in the Army Research Office Broad Agency Announcement for Basic and Applied Scientific Research (W911NF-12-R-0012-02).

FSU, located in Fayetteville City, North Carolina, is a Historically Black College and University (HBCU) focusing on the education of African American and military students from the local Fort Bragg US Army installation. Currently, approximately 75% of the student population is classified as minorities, primarily African Americans, and with a high female to male ratio (the ratio is greater than 2:1). Among them, about 19% students are military related. The proposed instrument will be used for education to enhance current STEM (Science, Technology, Engineering, and Mathematics) educational programs at FSU.

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**Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:**

**(a) Papers published in peer-reviewed journals (N/A for none)**

<u>Received</u>	<u>Paper</u>
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**TOTAL:**

**Number of Papers published in peer-reviewed journals:**

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**(b) Papers published in non-peer-reviewed journals (N/A for none)**

<u>Received</u>	<u>Paper</u>
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**TOTAL:**

Number of Papers published in non peer-reviewed journals:

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**(c) Presentations**

Number of Presentations: 0.00

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**Non Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

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**Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

---

**(d) Manuscripts**

Received      Paper

**TOTAL:**

Number of Manuscripts:

---

**Books**

Received      Book

**TOTAL:**

Received      Book Chapter

**TOTAL:**

**Patents Submitted**

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**Patents Awarded**

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**Awards**

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**Graduate Students**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

**Names of Post Doctorates**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

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**Names of Faculty Supported**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

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**Names of Under Graduate students supported**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

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**Student Metrics**

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: ..... 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense ..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: ..... 0.00

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**Names of Personnel receiving masters degrees**

<u>NAME</u>
<b>Total Number:</b>

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**Names of personnel receiving PHDs**

<u>NAME</u>
<b>Total Number:</b>

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**Names of other research staff**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

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**Sub Contractors (DD882)**

**Inventions (DD882)**

**Scientific Progress**

**Technology Transfer**

# PROJECT FINAL REPORT

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## Abstract

This award supports the update of an X-ray Energy Dispersive Spectrometer (EDS) on a JEOL JXA-8530F Electron Probe Microanalyzer (EPMA) at Fayetteville State University (FSU). The EPMA equipped was funded by the Army Research Office under Contract W911NF-09-1-0011. Its original Si(Li) EDS detector available at that time required liquid nitrogen cooling. It was proposed to trade in the original detector to the manufacturer and replace it with a liquid-nitrogen-free Silicon Drift Detector, which not only achieves improved performance with higher count rates, but also reduces maintenance cost and staff labor. The upgraded EDS detector will enhance the capability of the EPMA at FSU which is the sole field-emission instrument in the state of North Carolina, serving the academic, governmental and industrial communities for research and education.

The acquisition of the proposed instrument will support five ongoing research projects at FSU: (1) high-efficiency X-ray radiation detection; (2) high-efficiency ultraviolet to infrared radiation detection; (3) shape memory alloy nanowires for deformation behavior on nanoscale; (4) nanostructured explosive biosensors; and (5) surface treatment of biomaterials. The proposed EDS detector on the EPMA will be used to study the structure of these materials, advancing the research described in the Army Research Office Broad Agency Announcement for Basic and Applied Scientific Research (W911NF-12-R-0012-02).

FSU, located in Fayetteville City, North Carolina, is a Historically Black Colleague and University (HBCU) focusing on the education of African American and military students from the local Fort Bragg US Army installation. Currently, approximately 75% of the student population is classified as minorities, primarily African Americans, and with a high female to male ratio (the ratio is greater than 2:1). Among them, about 19% students are military related. The proposed instrument will be used for education to enhance current STEM (Science, Technology, Engineering, and Mathematics) educational programs at FSU.



## 1. Project Budget

This award is funded to purchase a new X-ray energy-dispersive spectrometer (EDS) – a dry Silicon Drifted Detector (SDD), replacing the original Si(Li) crystal EDS detector on the JXA-8530F HyperProbe that was purchased through DoD ARO award under Contract Number W911NF-09-1-001. The original total price of the instrument is \$72,000, while the old detector could be traded in to the manufacturer at \$18,000, so the funded amount is \$54,000. Table 1 lists the project budget.

Table 1 Project budget.

No.	Vendor	Justifications	Fund Requested
1. Dry SDD Detector	JEOL USA, Inc., <a href="http://www.jeolusa.com/">http://www.jeolusa.com/</a> . Phone: (978) 535-5900	(1) Improvement of the performance for higher count rate; (2) Reduction of instrumental maintenance cost; (3) Elimination of associated staff routine labor and safety concerns; (4) Trade-in discount.	\$60,000
2. Detector accessory	JEOL USA, Inc., <a href="http://www.jeolusa.com/">http://www.jeolusa.com/</a> . Phone: (978) 535-5900	Accessory associated with the installation.	\$10,000
3. Software update	JEOL USA, Inc., <a href="http://www.jeolusa.com/">http://www.jeolusa.com/</a> . Phone: (978) 535-5900	EDS software for this detector.	\$2,000
4. Discount	JEOL USA, Inc., <a href="http://www.jeolusa.com/">http://www.jeolusa.com/</a> . Phone: (978) 535-5900	The PI negotiated with JEOL to trade in the available EDS detector (purchased in 2009 from JEOL) to obtain the large discount.	-\$18,000
<b>Total</b>			<b>\$54,000</b>

## 2. Installation of New Instrument

With this award, a new SDD detector (serial # XM17000016) was purchased from JEOL and installed, as originally proposed. The previous old detector was traded in. The installation was completed on February 18, 2016 (Certification of Installation is attached).

Performances were conducted and all specifications were met. The new instrument has been in functioning since the installation.

## 3. Publications Produced by the Instrument

Christina H. Young\*, John G. Moch\*, Shardai S. Johnson\* and Zhiping Luo. Electrospun CeO<sub>2</sub>-ZnO Nanofibers Analyzed by Electron Probe Microanalyzer. *Microsc. Microanal.* **22** (Suppl 3), 452–453 (2016). (\* Undergraduate students.)

#### **4. Application for STEM Education**

The new instrument has been used for STEM education in the spring semester of 2016, and the following students have been trained using the new instrument:

- (1) MATS 160 Introduction to Materials Science: Diamond Gilliam, Brittanie Kittrell, Daniel Loeven, Laura Lovell, John Moch, Emily Oshita, Hellen Saira, Christina Young
- (2) MATS 311 Scanning Electron Microscopy and Microanalysis: Furaha Ive, Yavaughn Jackson, Shardai Johnson, Brittanie Kittrell, Daniel Loeven, Laura Lovell, John Moch, Emily Oshita, Shivaliben Patel, Doreen Rolstad, Mark Stultz, Chibu Umerah, Christina Young.

#### **5. Summary**

With the new instrument installed through this award, the following benefits have been obtained:

- (1) Improvements of performance. The SDD detector has the advantage of reaching higher count rates while maintaining the detector resolution, providing time-consuming mapping or line scan in shortened period of time.
- (2) Reduction of instrumental maintenance cost. The previous Si(Li) detector constantly consumed liquid nitrogen, resulting high maintenance cost. The upgraded SDD detector completely eliminates the liquid nitrogen.
- (3) Elimination of associated staff labor and safety concerns. The previous detector required filling liquid nitrogen twice a week. It also caused safety concerns dealing with hazardous liquid nitrogen. The replaced SDD detector eliminates such staff labor and associated safety concerns.

The new instruments enables the research in these areas: (1) high-efficiency X-ray radiation detection; (2) high-efficiency ultraviolet to infrared radiation detection; (3) shape memory alloy nanowires for deformation behavior on nanoscale; (4) nanostructured explosive biosensors; and (5) surface treatment of biomaterials. The research capabilities of the institution have been enhanced in the areas of Biology, Chemistry, Forensic Science, Materials Science and Physics at FSU.

The new instrument will be used for education to enhance current STEM education programs at FSU, including programs in the Departments of Chemistry and Physics, Biological Sciences, and Mathematics and Computer Science. The educational quality will be improved with the implementation of the research training. The new instrument will also be used for outreach to serve the local communities.

# Certificate of Installation

MAIN INSTRUMENT WITH ACCESSORIES

ACCESSORY ITEM(S) ONLY

<b>Organization:</b> FAYETTEVILLE STATE UNIVERSITY	<b>Cust ID#:</b> 11791
<b>Instrument Model:</b> JXA-8530F SYSTEM	<b>Serial #:</b> XM17000016
<b>Document Scope</b>	

This document signifies that the installation and satisfactory demonstration of performance specifications for the basic instrument and/or any of the check marked accessory items has been completed and is Accepted as of:

Acceptance Date: 2/18/2016

This document signifies that the instrument is being used, and therefore the Warranty period for the above instrument and/or any of the check marked accessories is to begin as of:

Warranty Start Date: 2/18/2016

Comments: Installation of Dry SD30 Detector Unit Model EX-74211U4L2Q, Dry SDD Accessory, and Version Upgrade software

<p>Authorized Signatures:</p> <p style="text-align: center;"><u>Zhiping Luo</u></p> <p>CUSTOMER NAME (please print)</p> <p style="text-align: center;"><u>Director of SENCR-MIC, FSU</u></p> <p>TITLE</p> <p><u>[Signature]</u>      <u>2/18/2016</u></p> <p>SIGNATURE                      DATE</p>	<p>Location:</p> <p style="text-align: center;"><u>FSU LS 117, 1200 Murchison Road</u></p> <p>ADDRESS</p> <p style="text-align: center;"><u>Fayetteville, NC 28301</u></p> <p>CITY                      STATE                      ZIP</p> <p style="text-align: center;"><u>FRANK MARIIC</u></p> <p>JEOL REPRESENTATIVE</p>
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