REPORT DOCUMENTATION PAGE

Form Approved OMB NO. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
07-03-2017	Final Report	15-Aug-2015 - 14-Aug-2016

4. TITLE AND SUBTITLE

Final Report: Polarized Optical Microscope and Scanning Tunneling Microscope for a Hierarchical Material Characterization System.

5a. CONTRACT NUMBER
W911NF-15-1-0345

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
611103

6. AUTHORS
Adam B. braunschweig

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES

University of Miami - Coral Gables
1320 South Dixie Highway
Suite 650, LC 2960
Coral Gables, FL 33146 -2926

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES)

U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSOR/MONITOR'S ACRONYM(S)
ARO

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
66792-CH-RIP.1

12. DISTRIBUTION AVAILIBILITY STATEMENT

Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT

The aim was to acquire a variable temperature polarized optical microscope (POM) and a scanning tunneling microscope (STM), which together constituted a system for the purpose of characterizing hierarchical nanostructures at different length scales. The "Hierarchical Material' Characterization System", thereafter called System, which include two analytical instruments, namely a McCrone Variable Temperature Polarized Optical Microscope ($46,316) and a Nanosurf NairoSTM Scanning Tunneling Microscope ($11,721)

15. SUBJECT TERMS

polarized optical microscope

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Adam Braunschweig
UU	UU	UU	UU		19b. TELEPHONE NUMBER 212-413-3385

Report Title

Final Report: Polarized Optical Microscope and Scanning Tunneling Microscope for a Hierarchical Material Characterization System.

ABSTRACT

The aim was to acquire a variable temperature polarized optical microscope (POM) and a scanning tunneling microscope (STM), which together constituted a system for the purpose of characterizing hierarchical nanostructures at different length scales. The "Hierarchical Material' Characterization System", thereafter called System, which include two analytical instruments, namely a McCrone Variable Temperature Polarized Optical Microscope ($46,316) and a Nanosurf NairoSTM Scanning Tunneling Microscope ($11,731).

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)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

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

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

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

Received Paper

TOTAL:

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

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

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Post Doctorates

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Faculty Supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

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: .....

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

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:.....

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

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

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

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: .....

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See attached.

Technology Transfer

FINAL NARRATIVE 665229 ARMY DURIP

TITLE: Polarized Optical Microscopy and Scanning Tunneling Microscopy for a Hierarchical Material Characterization System

REPORT:

The aim was to acquire a variable temperature polarized optical microscope (POM) and a scanning tunneling microscope (STM), which together constituted a system for the purpose of characterizing hierarchical nanostructures at different length scales. The "Hierarchical Material' Characterization System", thereafter called System, which include two analytical instruments, namely a McCrone Variable Temperature Polarized Optical Microscope ($46,316) and a Nanosurf Nairo*STM* Scanning Tunneling Microscope ($11,731).

Due to lack of communication between the PI and the students involved in the projects proposed the STM was self-installed and not used for research after installation. On the other hand, the POM was installed by McCrone Microscopes, specifically Rubin Nieblas. After installation the microscope was used for approximately 2 months for conducting standards for the melting points of the diketopyrrolopyrrole (DPP) electron donors and perylene diimide (PDI) electron acceptors. Furthering the research, the donor and acceptor was combined to study morphological properties at various temperatures and concentrations. However, the project was not completed due to the PI's departure.

Even with the departure of the PI, the System is indispensable and can provide and develop other Facilities' research in the Department of Chemistry at the University of Miami with tools to characterize hierarchical materials with emergent properties.

The POM and STM instruments will become departmental instruments and will be available for use by any faculty member in the Department of Chemistry. Members of and research group can schedule experiments to be run on instruments within the departmental holdings. Faculty members pay suitable usage fees so that the members of their research groups can gain access to the department instruments.

The name and the discipline of each faculty that could use the System is given below with a brief description of their research activity. All the investigations make a reference to materials, nanomaterials and suprarnolecular materials that need an analysis of the topography of the surface of the materials. The System as described previously has the main characteristic needed to examine the surface topography of the synthetic materials developed in. the Faculty labs. A brief description of the research activity of the Faculty is the following:

Prof. B. Captain (Inorganic Chemist): The instrumentation will be used to investigate the chemistry of transition crystal complex materials with the objective to be applied in homogeneous catalysis.

Prof. C. Hoff (Inorganic Chemist): The equipment will serve to control the reactions important for catalytic reactions. The materials studied include dinitrogen, nitriles, hydrogen, carbenes and sulfur to metal complex materials.

Prof. M. Knecht (Analytical Chemist): As stated in the original proposal under Project 2, one of the Co-PI; Marc Knecht employs biomimetic approaches to fabricate and assemble functional nanomaterials using materials-binding peptides and characterization of the orientation of the materials within the 3D assembly. Their resultant optical properties are key to advancing this research project, where the requested cross McCrone Variable Temperature Polarized Optical Microscope and Nanosurf NaioSTM instrumentation would greatly enhance efforts. Additionally, the *Nanosurf NaioSTM* will play an important role in characterization of the nanoparticle orientation at the surface the 3D assemblies. Taken together, the requested cross polarized microscope and STM will provide new avenues to characterize and advance these materials for important DoD applications in his current AFOSR grant, Sunny Buffalo Bio-Binatorics, UM grant# 66926X.

Prof. R.M. Leblanc (Physical Chemist): The system will be employed to study the surface chemistry, spectroscopic and microscopic properties of organic and biological supramolecular materials.

Prof. J.-H. Olivier (Polymer Chemist): New classes of structure-function optimized electronic materials that feature non-equilibrium supramolecular superstructure will be studied using the instrumentation.

Prof. V. Ramamurthy (Organic Chemist): The exploration in molecular and supramolecular assemblies with well-defined cavities as reaction space will benefit in the use of the instrumentation.

Prof. F. Raymo (Organic Chemist): To identify strategies to manipulate materials with photons on the basis of absorption and emission processes will benefit in the use of the microscopic system.

Prof. A. Scott (Physical Chemist): As stated in the original proposal under Project 4, Enhanced Energy Transport in Nanocrystal Superlattices. The Hierarchical Materials Characterization System will help aid in the development of design, and synthesizing of new liquid crystalline materials for strategies related to light harvesting and charge transport.

Prof. J. Wilson (Organic Chemist): The general area of bioorganic and materials chemistry with a specific focus on the development of fluorescent analogs of biomolecules need the microscopic system at different stages to facilitate the development.

The nine Faculty listed above have the inorganic, organic and physical expertise to synthesize hierarchical materials and consequently the necessity to characterize them using the System. The characterization includes the study of the nanostructures of the crystalline donor (D)- acceptor (A) complex, the interaction between D or A molecular components, the macroscopic observation of carbohydrate fibers, the liquid crystalline phase transitions, the inter-particle distance in nano-crystalline super=lattices and in bio-inspired nanostructures.

All the characterization of the materials and bio-inspired materials has a direct link with two programs at DOD, namely the program Reactive Chemical Systems (Program Officer: Dr. Jennifer Becher, Chemical Sciences Division, Army Research Office) and the program Natural Materials and Systems (Program Officer: Dr. Hugh Delong, Air Force Office of Scientific Research).

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
09-15-2016	Final Progress Report	8/15/2015 - 8/14/2016

4. TITLE AND SUBTITLE

Polarized Optical Microscope and Scanning Tunneling Microscope for a Hierarchical Material Characterization System.

5a. CONTRACT NUMBER

W911NF-15-1-0345

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Roger M. Leblanc, Professor and Chair

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

University of Miami
1320 S Dixie Hwy Ste 650
Coral Gables FL 33146

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The aim of this proposal is to acquire a variable temperature polarized optical microscope (POM) and a scanning tunneling microscope (STM), which together constitute a system for the purpose of characterizing hierarchical nanostructures at different length scales. These instruments supported the PI's currently funded research into developing donor-acceptor supramolecular polymer films with precise order at the molecular and micrometer length scales as a result of programmed noncovalent interactions, which leads to emergent optoelectronic properties such as photinduced electron transfer. These two microscopes has provided our research with tools to characterize hierarchical materials with emergent properties as a result of order across the molecular to-macroscopic continuum.

15. SUBJECT TERMS

Hierarchical Material, Scanning Tunneling Microscopy, Optical Microscope, Synthetic Materials, and Structure

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(Include area code)*