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Final Report: Equipment For the Characterization of Synthetic Bio-hybrid Polymers and Micellar Nanoparticles for Stimuli Responsive Materials.

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5e. TASK NUMBER

5f. WORK UNIT NUMBER

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14. ABSTRACT

The DURIP was utilized for the purchase and use of three instruments. One was a plate reader for the analysis of enzyme kinetics related to propagating reactions at the interface of DNA- and Peptide-based polymeric nanoparticles and responsive materials. Another was a UV-Vis spectrometer used to generate melting curves for DNA- and PNA-based polymers and nanoparticles. The final instrument was a Carl Zeiss fluorescent microscopy used to analyze these classes of nano materials interacting with surfaces and with biological materials including cells.

15. SUBJECT TERMS

Plate reader, UV-Vis, Carl Zeiss Miscroscope

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Report Title

Final Report: Equipment For the Characterization of Synthetic Bio-hybrid Polymers and Micellar Nanoparticles for Stimuli Responsive Materials.

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The DURIP was utilized for the purchase and use of three instruments. One was a plate reader for the analysis of enzyme kinetics related to propagating reactions at the interface of DNA- and Peptide-based polymeric nanoparticles and responsive materials. Another was a UV-Vis spectrometer used to generate melting curves for DNA- and PNA-based polymers and nanoparticles. The final instrument was a Carl Zeiss fluorescent microscopy used to analyze these classes of nano materials interacting with surfaces and with biological materials including cells.

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
Matthew Thomson	0.00
Angela Blum	0.00
FTE Equivalent:	**0.00**
Total Number:	**2**

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Nathan Gianneschi	0.00	
Carrie James	0.00	
FTE Equivalent:	**0.00**	
Total Number:	**2**	

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: 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

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

The equipment grant was structured based on projects recently funded by the ARO at the time, through the award (W911NF-11-1-0264) “Signal Propagation and Detection via Catalytically Immolative Biopolymer-Programmed Nanomaterials”. This program aimed to develop an array of nanomaterials capable of undergoing amplified responses to their environment through cascade-type reactions. These materials couple together synthetic polymers with biopolymers including DNA, peptides and proteins. The project therefore requires a range of characterization and preparative tools in order to allow proper synthesis and analysis of the materials and physicochemical processes at play.

Plate Reader: As part of the development of polymeric materials, our lab synthesizes a range of fluorescent materials that behave as substrates for enzymes from proteases, sortases, to nucleases. In addition, we aim to observe how particles assemble utilizing fluorescent tags. To enable these studies, we perform kinetic experiments in 96-well plate format. Prior to acquiring this equipment, we would typically utilize old instruments in neighboring labs that often provided inaccurate and sometimes difficult to reproduce data. In order to control the quality of this data to a greater extent we require our own plate reader. This has greatly improved efficiency and has provided the graduate students and postdocs with the opportunity to more frequently and routinely make this type of measurement.

UV-Vis: The UV-Vis was purchased with this equipment money, providing tight control over temperature and a broad wavelength range. This enabled some of the high impact work produced as part of the above mentioned research grant, and a subsequent ARO-funded program (W911NF-14-1-0169). The second, ongoing program has resulted in a recent, high impact publication on PNA-based materials. The UV-Vis was used to characterize temperatures at which these materials hybridize nucleic acids. Indeed, this has been the key role of this instrument in terms of fully characterizing biomolecule interactions occurring at the interface of semi-synthetic biopolymer-based nano materials.

Carl-Zeiss Microscope: The microscope has made it possible to observe the above-mentioned materials as they interact with biomolecules associated with living systems including human cells. The scope is equipped with fluorescence detectors and light sources enabling the analysis of long-wavelength near-infrared probes built into the materials.

Key Results Enabled by this DURIP Funding of the above instruments:

Our research program has progressed on three key fronts. As an overview, in an effort to apply what we have learned regarding enzymatically responsive materials, we have demonstrated our systems capabilities as tumor targeting materials in a range of animal models for human cancer (Advanced Materials, 2013). This kind of directed assembly within tissue is unprecedented and has been made possible through our approach to utilizing highly selective interactions coupled with new approaches to biopolymer preparation. Therefore, the three key advancements have been: 1) Application of materials to selective sense-and-response systems in highly complex environments (Advanced Materials, 2013). 2) New polymerization approaches, including new ways of adding fluorescent labels to the nano materials (Polymer Chemistry, 2013 and Chemical Communications, 2013). 3) Stabilization of biomolecules within nanoparticle frameworks, with an emphasis on nucleic acid stabilized structures (ACS Nano, 2013). These collective efforts are expected to impact how synthetic materials are coupled with biomolecules to achieve adaptive and unique function in sense-and-response systems.

Through the publication of primary research articles, and presentations at top institutions worldwide and at conferences, we have aimed to establish biomolecules as tools for the programmed manipulation of nanomaterials. This is an important and powerful contribution to the field of nanoscale synthesis in general, and in the development of truly informational materials capable of interfacing with biological systems specifically. These adaptable, autonomic chemical systems are are now being utilized for detection strategies and in the assembly well-defined nucleic acid hybrid polymer materials. Furthermore, these projects have lead to collaborations with both Prof. Nick Abbott at Wisconsin and Prof. Thai Thayumanavan at UMass, Amherst aimed to developing new methods for propagating chemical responses through multiple length scales.

Technology Transfer