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1. REPORT DATE (DD-MM-YYYY) 19-02-2015		2. REPORT TYPE Final Report		3. DATES COVERED (From - To) 15-Feb-2014 - 14-Feb-2015	
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			5c. PROGRAM ELEMENT NUMBER 206022		
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14. ABSTRACT A state-of-the-art small angle x-ray scattering (SAXS) instrument with wide angle x-ray scattering (WAXS) and grazing incidence x-ray scattering (GI-SAXS) capability was purchased and installed in the R& D Center (Lab # GB-03 of) of the University of Puerto Rico at Mayaguez (Figure 1). The Anton-Paar SAXSpace equipment was properly installed and the training was conducted during August 18-22, 2014. The equipment was extensively used contributing to several publications described ahead. These non-invasive scattering techniques provide valuable information at the nanoscale regarding size, shape, morphology and even particle interaction. This facility will					
15. SUBJECT TERMS Nanostructure, Scattering, Polymer Nanocomposite Membranes					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON David Suleiman
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU			19b. TELEPHONE NUMBER 787-309-7126

Report Title

Final Report: Acquisition of a SAXS Facility for the Study of Novel Polymer Nanocomposite Membranes

ABSTRACT

A state-of-the-art small angle x-ray scattering (SAXS) instrument with wide angle x-ray scattering (WAXS) and grazing incidence x-ray scattering (GI-SAXS) capability was purchased and installed in the R& D Center (Lab # GB-03 of) of the University of Puerto Rico at Mayaguez (Figure 1). The Anton-Paar SAXSpace equipment was properly installed and the training was conducted during August 18-22, 2014. The equipment was extensively used contributing to several publications described ahead. These non-invasive scattering techniques provide valuable information at the nanoscale regarding: size, shape, morphology and even particle interaction. This facility will further advance the understanding of the resulting nanostructure of novel polymer nanocomposite membranes (PNMs) at the University of Puerto Rico at Mayaguez (UPRM). It supports our current efforts with novel polymer chemistries and architectures, which incorporate functionalized organic/inorganic additives creating unique PNMs. In addition, it can also be used in many other current research efforts at UPRM such as: pharmaceutical engineering, biological engineering, catalysis, adsorption, and the development of other complex nanomaterials. This facility is the only facility in UPRM and in Puerto Rico capable of performing these powerful characterization techniques. In addition, it supports the education of numerous underrepresented Hispanic graduate and undergraduate students in STEM at UPRM, where knowledge and application of scattering techniques was very limited (only through interactions with collaborators outside Puerto Rico).

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

- 1. A. Ortiz and D. Suleiman. “Polymer-Titania Nanoparticles for Energy Efficient.” Poster Presentation at the 2015 MRS Spring National Meeting, San Francisco, CA, April, 2015.
- 2. A. Millet and D. Suleiman “Sulfonation and Characterization of Poly(1,4-phenylene ether-ether-sulfone) (PEES) and Polyphenylsulfone (PPSF) for Fuel Cells and Specialty Separation Applications.” Poster Presentation at the 2015 ACS PRISM Meeting San Juan, PR March, 2015.
- 3. D. Suleiman “Polymer Nanocomposites: Technology for the XXI Century.” Oral Key Note Presentation at the 2014 Science & Materials Assembly. Mayaguez, PR, November, 2014.
- 4. M. Pérez and D. Suleiman Transport Properties of Sulfonated Poly(ether ether ketone) Membranes with Counter-Ion Substitution”. Poster Presentation at the 2014 AIChE National Meeting, Atlanta, GA, November, 2014.
- 5. M. Pérez and D. Suleiman. “Synthesis and Characterization of Poly(styrene-isobutylene-methyl vinyl ether) for Direct Methanol Fuel Cell Applications”. Poster Presentation at the 2014 AIChE National Meeting, Atlanta, GA, November, 2014.

Number of Presentations: 5.00

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

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

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

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

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

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

(d) Manuscripts

Received

Paper

- 02/19/2015 5.00 Maritza Pérez-Pérez, Edward M. A. Guerrero-Gutiérrez, David Suleiman. Synthesis and characterization of sulfonated fluorinated blockcopolymer membranes with different esterified initiators for DMFC applications, Journal of Applied Polymer Science (11 2004)
- 12/31/2014 1.00 Maritza Pérez-Pérez , David Suleiman, Edward M.A. Guerrero-Gutiérrez. Synthesis and Characterization of Sulfonated Fluorinated Block Copolymer Membranes with Different Esterified Initiators for DMFC Applications, Journal of Applied Polymer Science (11 2014)
- 12/31/2014 2.00 Edward M. A. Guerrero-Gutiérrez, Maritza Pérez-Pérez , David Suleiman. Morphology and Transport Properties of Sulfonated Fluoroblock Copolymer Blend Membranes, Journal of Membrane Science (12 2014)
- 12/31/2014 3.00 Maritza Pérez-Pérez , David Suleiman. Transport Properties of Sulfonated Poly(ether ether ketone) Membranes with Counter-Ion Substitution, Journal of Membrane Science (12 2014)

TOTAL: 4

Number of Manuscripts:

Books

Received

Book

TOTAL:

Received

Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Distinguished Professor of Chemical Engineering, University of Puerto Rico (May, 2014)

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

National Academy Member

David Suleiman

0.11

FTE Equivalent:

0.11

Total Number:

1

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: 4.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 8.00

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:..... 4.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 7.00

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

Edward M.A. Guerrero Gutierrez

Total Number:

1

Names of other research staff

NAME

PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Technology Transfer

See Attachment

**Acquisition of a SAXS Facility for the Study of Novel Polymer Nanocomposite Membranes
Interim Progress Report (IPR), Year 1: Scientific Progress and Accomplishments,
15 Feb 2014 – 14 Feb 2015, David Suleiman, PI (University of Puerto Rico at Mayaguez)
W911NF-14-10076**

Project Summary:

A state-of-the-art small angle x-ray scattering (SAXS) instrument with wide angle x-ray scattering (WAXS) and grazing incidence x-ray scattering (GI-SAXS) capability was purchased and installed in the R&D Center (Lab # GB-03 of) of the University of Puerto Rico at Mayaguez (Figure 1). The Anton-Paar SAXSpace equipment was properly installed and the training was conducted during August 18-22, 2014. The equipment was extensively used contributing to several publications described ahead. These non-invasive scattering techniques provide valuable information at the nanoscale regarding: size, shape, morphology and even particle interaction. This facility will further advance the understanding of the resulting nanostructure of novel polymer nanocomposite membranes (PNMs) at the University of Puerto Rico at Mayaguez (UPRM). It supports our current efforts with novel polymer chemistries and architectures, which incorporate functionalized organic/inorganic additives creating unique PNMs. In addition, it can also be used in many other current research efforts at UPRM such as: pharmaceutical engineering, biological engineering, catalysis, adsorption, and the development of other complex nanomaterials. **This facility is the only facility in UPRM and in Puerto Rico capable of performing these powerful characterization techniques.** In addition, it supports the education of numerous underrepresented Hispanic graduate and undergraduate students in STEM at UPRM, where knowledge and application of scattering techniques was very limited (only through interactions with collaborators outside Puerto Rico).

Figure 1: SAXS Facility in the R&D Center (Lab # GB-03) of the University of Puerto Rico at Mayaguez

Students Impacted:

Underrepresented Hispanic PhD Students in Chemical Engineering that are currently trained to use the equipment:

1. Edward M. Guerrero, **PhD obtained December, 2014**
2. Ariangelis Ortiz
3. Maritza Pérez
4. Karren Barrios

Underrepresented Hispanic undergraduate (BS) students in Chemical Engineering that have been using the equipment:

1. Rinaldo Díaz
2. Arnaldo López
3. Alexander Millet
4. Nataira Pagán
5. Luis Sotomayor
6. Vanessa Torres
7. Lorena Cruz
8. Edwin Torres

Technical Impact

Several research publications have been submitted by the time of completing this report. This award was acknowledged in the publications:

1. E.M.A. Guerrero-Gutiérrez, M. Pérez-Pérez, and D. Suleiman. *"Synthesis and Characterization of Sulfonated Fluorinated Block Copolymer Membranes with Different Esterified Initiators for DMFC Applications"*. *Journal of Applied Polymer Science*, 132, 42046, **2015**.
2. M. Pérez-Pérez, and D. Suleiman. *"Transport Properties of Sulfonated Poly(ether ether ketone) with Counter-Ion Substitution"*. *Submitted to the Journal of Membrane Science*, **2014**.
3. E.M.A. Guerrero-Gutiérrez, M. Pérez-Pérez, and D. Suleiman. *"Morphology and Transport Properties of Sulfonated Fluoroblock Copolymer Blend Membranes"*. *Submitted to the Journal of Membrane Science*, **2014**.
4. A. Ortiz-Negrón, and D. Suleiman. *"The Effect of TiO₂ Nanoparticles on the Properties of Sulfonated Block Copolymer Membranes"*. *Submitted to the Journal of Applied Polymer Science*, **2015**.

In addition to the previously submitted publications, several additional publications are expected to be completed this year as a consequence of the additional understanding provided by this equipment (this award). The next publications are expected to be higher impact factor publications (e.g., ACS Nano-12.033, Nano Letters-12.94) due to the more in-depth understanding of the resulting nanostructure provided by the 3D GI-SAXS capability. The GI-SAXS capability is currently being fully utilized with help from the University of Washington (L. Pozzo).