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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.

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a. REPORT	b. ABSTRACT	c. THIS PAGE			Marina Leite
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RPPR Final Report
as of 02-Mar-2020

Agency Code:

Proposal Number: 72135CHRIP **Agreement Number: W911NF-18-1-0177**
INVESTIGATOR(S):

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Final Report for Period Beginning 27-May-2018 and Ending 31-Dec-2019
Title: Near-Field Optical Microscopy for Research on Electrocatalysts for Army's Hydrocarbon Fuels
Begin Performance Period: 27-May-2018 **End Performance Period:** 31-Dec-2019
Report Term: 0-Other
Submitted By: Marina Leite Email: mleite@umd.edu
Phone: (301) 405-4953
Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: 0 **STEM Participants:** 0

Major Goals: To purchase the equipment to augment and enhance research capabilities to measure the near-field optical and photoelectrical responses of electrocatalyst model systems. Through a combination of IR near-field scanning optical microscopy (NSOM) and illuminated kelvin-probe force microscopy (KPFM) the PI will map the optoelectronic response of electrocatalysts with unprecedented spatial resolution, <100 nm. Through IR NSOM the PI's group will elucidate the field enhancements dependence on different nanostructures shapes by locally mapping transmission/reflection. Using a novel method recently developed by Leite's group, illuminated-KPFM, they will spatially resolve the chemical potential of the electrocatalytic reactions.

Accomplishments: This DURIP award has enabled the characterization of advanced metallic materials for photonics and photocaltalysis. The PI's group is customizing the atomic force microscope (AFM) so that it can operate as a near-field scanning optical microscope (NSOM). All optical components and fibers are needed in order to accomplish the proposed experimental setup. Distinct materials have been investigated as potential electrocatalysts, including Au-Pd alloys and earth abundant options. The spectrometer and the single photon detector will be used to fully characterize the optical properties of the metallic nanostructures to be used as building blocks for electrocatalysis experiments. The mask flow controller enables us to quantify the amount of gas present inside the AFM environmental chamber, which will allows us to expand our current work on the optical characterization of thin film alloys – a fruitful collaboration with researchers from the Army Research Laboratory in Adelphi, MD.
Concerning other research work of interest to DoD, we plan to use the equipment purchased with this award to further develop the field of 'transient photonics'. We will fabricate and test photonic devices that can vanish on demand. Specifically, we will use Mg and MgO, metal and insulator, as the platform for the active layers of color pixels that can disappear when exposed to water, relevant for encryption, and
for biodegradable optical sensors, as both materials are biocompatible. Here, the PI's group plans to perform a series of experiments using both the AFM and the spectrometer acquired through this award.
The equipment acquired through this DURIP has also been used on research related to halide perovskite solar cells. Halide perovskite photovoltaics are an ideal option for the Army because the devices are lightweight, suitable for a variety of situations. Yet, it is currently unknown how these materials change upon exposure to humidity and prolonged illumination. Thus, we have used the AFM to perform photoconductive measurements on perovskite grains under distinct environmental conditions.

Training Opportunities: Nothing to Report

Results Dissemination: Nothing to Report

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Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

ARO – DURIP REPORT
PI: M. S. Leite
University of Maryland – College Park

I. List of equipment acquired:

1) Atomic force microscope, MFP-3D Infinity AFM System with Top-View Optics and probes
Manufacturer: Oxford Instruments
Cost: US$ 263,771.51

2) Spectrometer (HRS-300SS) + CCD camera (PIX-400B) system
Manufacturer: Princeton Instruments
Cost: US$ 51,622.06

3) Time-Correlated Single Photon Counting detector, Picoharp300
Manufacturer: PicoQuant
Cost: US$ 30,000.00

4) Optical components
Manufacturer: Thorlabs (stages, lenses, pillars, fiber adapter, etc.)
Cost: US$ 2,314.47

5) Optical fibers
Manufacturer: OZ Optics
Cost: US$ 383.50

6) Mass Flow Controller
Manufacturer: Bronkhorst
Cost: US$ 2,196.20

7) Optical filter
Manufacturer: AVR Optics
Cost: US$ 347.20

8) Function Generator
Manufacturer: Allied Electronics
Cost: US$ 4,890.06

II. Summary of the research projects on which equipment has been or will be used:

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III. Publications:

- J. P. McClure, J. Boltersdorf, D. R. Baker, T. G. Farinha, N. Dzuricky, C. E. P. Villegas, A. R. Rocha, M. S. Leite. "Structure−Property-Performance Relationship of Ultrathin Pd−Au Alloy Catalyst Layers for Low-Temperature Ethanol Oxidation in Alkaline Media". *ACS Appl. Mater. Interfaces* 2019, **11**, 24919−24932
- T. G. Farinha, C. Gong, Z. A. Benson, M. S. Leite. "Magnesium for Transient Photonics". *ACS Photonics* 2019, **6**, 272−278.
- T. G. Farinha, T. Gong, J. M. Hoerauf, M. S. Leite. "Selective Etching Properties of Mg Thin Films and Nanostructures for Dynamic Photonics". *In preparation*
- R. Lahoti, J. M. Howard, A. Mahmud, T. White, M. S. Leite. "Nanoscale Electrical Response of Quadruple Cation Perovskites". *In preparation*