

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 19-12-2019	2. REPORT TYPE Final Report	3. DATES COVERED (From - To) 1-Nov-2017 - 31-Oct-2019
---	--------------------------------	--

4. TITLE AND SUBTITLE Final Report: Exploring Fundamental Mechanisms of Near-Field Energy Conversion	5a. CONTRACT NUMBER W911NF-18-1-0004
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER 611102

6. AUTHORS	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES University of Michigan - Ann Arbor 3003 South State Street Ann Arbor, MI 48109 -1274	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) 70863-MS.5

12. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.
--

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

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:	17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Pramod Sangi Reddy
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU	19b. TELEPHONE NUMBER 734-615-5952

RPPR Final Report
as of 19-Dec-2019

Agency Code:

Proposal Number: 70863MS

Agreement Number: W911NF-18-1-0004

INVESTIGATOR(S):

Name: Edgar Meyhofer
Email: meyhofe@umich.edu
Phone Number: 7346477856
Principal: N

Name: Pramod Sangi Reddy
Email: pramodr@umich.edu
Phone Number: 7346155952
Principal: Y

Name: Stephen Forrest
Email: stevefor@umich.edu
Phone Number: 7346471147
Principal: N

Organization: **University of Michigan - Ann Arbor**

Address: 3003 South State Street, Ann Arbor, MI 481091274

Country: USA

DUNS Number: 073133571

EIN: 386006309

Report Date: 31-Jan-2020

Date Received: 19-Dec-2019

Final Report for Period Beginning 01-Nov-2017 and Ending 31-Oct-2019

Title: Exploring Fundamental Mechanisms of Near-Field Energy Conversion

Begin Performance Period: 01-Nov-2017

End Performance Period: 31-Oct-2019

Report Term: 0-Other

Submitted By: Pramod Sangi Reddy

Email: pramodr@umich.edu

Phone: (734) 615-5952

Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: 2

STEM Participants:

Major Goals: This proposal seeks to leverage novel thin-film based homo- and hetero-structured devices to elucidate a number of fundamentally new radiative heat transfer and energy conversion processes that arise in the near-field. In fact, near-field radiative heat transfer (NFRHT), which occurs in a regime where the gap-size between hot and cold objects is less than the Wien's wavelength, is an area of great current interest due to both its fundamental importance and technological potential. While far-field radiative transport is well understood, there remains a significant gap in current understanding of NFRHT. During the last decade, computational studies have predicted a number of novel transport and energy conversion phenomena which include potentially transformative approaches for: a) thermophotovoltaic energy conversion by leveraging near-field effects in conjunction with low band-gap materials and b) electro-luminescent based refrigeration using thin-film heterostructure devices.

Accomplishments: We accomplished several goals of the proposal.

Probing Energy Transport via Photons in Nanoscale Gaps and Nanodevices (A. Fiorino et al., Nano Letters (2018); A. Fiorino et al., ACS Nano (2018); D. Thompson et al., Nature (2018)): We made important breakthroughs in exploring nanoscale radiation. Specifically, we overcame several technical challenges to demonstrate that it is possible to achieve almost three orders of magnitude enhancements above the blackbody limit when the gap size between objects is reduced to the nanoscale(A. Fiorino et al., Nano Letters (2018), A. Fiorino et al., ACS Nano (2018)). In addition, by employing nanofabricated calorimeters we achieved detailed experimental evidence to demonstrate that heat transfer rates between sub-wavelength nanodevices located in the far- field of each other can surpass the blackbody limit by 100 times (D. Thompson et al., Nature (2018)).

Probing Energy Conversion in Nanoscale Gaps (A. Fiorino et al., Nature Nanotechnology (2018)): We also made major contributions to elucidate the potential of nanoscale thermal radiation for energy conversion. We showed for

RPPR Final Report as of 19-Dec-2019

the first time, by employing microfabricated scanning probes and a novel nanopositioning platform, that the power output for thermophotovoltaic energy conversion at the nanoscale can exceed that at macroscopic gaps by ~40 times due to strong contributions from evanescent modes (A. Fiorino, et al., Nature Nanotechnology (2018)).

Training Opportunities: This project resulted in the training of a number of graduate students and postdocs, who are listed below.

- 1) Dakotah Thompson (Graduated in 2019, currently an Assistant Professor at UW-Madison)
- 2) Anthon Fiorino (Graduated in 2018), currently Engineer in Si Time
- 3) Dr. Linxiao Zhu (Currently post-doc in Reddy and Meyhofer labs)
- 4) Dr. Dejui Fan (Currently a post-doc in the Forrest lab)
- 5) Byungjun Lee (Currently a graduate student in the Forrest lab)

Results Dissemination: The work done in this project has resulted in several publications. Further, work from this project has been reported online in several websites and has also been presented in a number of conferences in invited talks.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI

Participant: Pramod Reddy

Person Months Worked: 1.00

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Funding Support:

Participant Type: PD/PI

Participant: Edgar Meyhofer

Person Months Worked: 1.00

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Funding Support:

Participant Type: PD/PI

Participant: Steve Forrest

Person Months Worked: 1.00

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: Y

Other Collaborators:

Funding Support:

Participant Type: Postdoctoral (scholar, fellow or other postdoctoral position)

Participant: Linxiao Zhu

Person Months Worked: 8.00

Funding Support:

RPPR Final Report
as of 19-Dec-2019

Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Participant Type: Graduate Student (research assistant)

Participant: Dakotah Thompson

Person Months Worked: 8.00

Funding Support:

Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Participant Type: Graduate Student (research assistant)

Participant: Anthony Fiorino

Person Months Worked: 6.00

Funding Support:

Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Participant Type: Graduate Student (research assistant)

Participant: Dejiu Fan

Person Months Worked: 8.00

Funding Support:

Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Participant Type: Graduate Student (research assistant)

Participant: Byungjun Lee

Person Months Worked: 6.00

Funding Support:

Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

RPPR Final Report
as of 19-Dec-2019

Nothing to upload.