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RPPR Final Report

as of 11-Oct-2018

Agency Code:

Proposal Number: 65348MSH

Agreement Number: W911NF-14-1-0260

INVESTIGATOR(S):

Name: Ming Lee Tang
Email: mltang@ucr.edu
Phone Number: 9518275964
Principal: Y

Organization: **University of California - Riverside**

Address: 200 University Office Building, Riverside, CA 925210001

Country: USA

DUNS Number: 627797426

EIN: 956006142

Report Date: 08-May-2018

Date Received: 10-Oct-2018

Final Report for Period Beginning 09-Jun-2014 and Ending 08-Feb-2018

Title: Creating magnetic plasmons at visible frequencies: towards isotropic negative index metamaterials.

Begin Performance Period: 09-Jun-2014

End Performance Period: 08-Feb-2018

Report Term: 0-Other

Submitted By: Ming Tang

Email: mltang@ucr.edu

Phone: (951) 827-5964

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

STEM Degrees: 2

STEM Participants: 2

Major Goals: Multi-excitonic process that up- or downconvert photons can be used to surpass the Shockley-Queisser limit. It would be ideal to use molecules and semiconductor nanocrystals (NCs) for this purpose. As a practical matter, both these two classes of materials are generally earth-abundant, have high absorption coefficients and can potentially be deposited via a roll to roll printing process to fabricate inexpensive flexible optoelectronic devices. In order to promote exciton splitting and charge collection, it is strategic to focus on spin-triplet excitons. The microsecond lifetime in spin-triplet excitons may allow diffusion to compete with recombination, e.g. in bulk heterojunctions. Indeed, in the past four years, since the pioneering reports of Baldo and Bawendi, Rao and Friend, a number of reports have focused on spin triplet exciton transport from molecules to NCs and in the reverse direction. The goal has been to design semiconductor NCs as triplet photosensitizers for photon upconversion.

Accomplishments: In 2015, the Tang group was the first to document that photoexcited semiconductor nanocrystals can transfer energy to molecular triplet states. This observation has been the basis for the rational design of hybrid platforms that can harness multiexcitonic processes like singlet fission or upconversion, for photovoltaics, photocatalytic and biomedical applications. According to the Web of Science, as of May/June 2018, this highly cited paper received enough citations to place it in the top 1% of the academic field of Physics based on a highly cited threshold for the field and publication year.

Training Opportunities: This grant has supported the Ph.D. training of Mr. Zhiyuan Huang who received his Ph.D. in September 2017. Undergraduate students supported include Mr. Tony Dorado (a Hispanic first generation student now enrolled in the Chemistry-Biology Interface (CBI) Graduate Program at Johns Hopkins) and Mr. Carter Gerke, a senior at UCR, who will be applying to graduate school in materials. The summer of 2016, the PI Tang hosted two high school students, Andrew Pham and Jessica Kasamoto, courtesy of the ARO High School Apprenticeship Program (HSAP). Andrew also participated in the HSAP program in 2015. He is the third author in our 2016 Advanced Functional Materials paper. Andrew was accepted into top schools like UC Berkeley for engineering, but he chose Harvey-Mudd instead because of its more intimate setting.

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Results Dissemination: The PI has given the following invited talks during this grant period:

14th International Symposium on Functional π -Electron Systems, Humboldt-Universität, Berlin, Germany (Jun. 2019); Univ. of Washington, Seattle, Inorganic Chemistry Seminar (Feb. 2019); UT Austin Inorganic Chemistry Seminar (Nov. 2018); Colloidal Semiconductor Nanocrystals Gordon Research Conference (GRC, Jul. 2018); UC Davis Chemistry Seminar (May 2018); Keynote opening speaker at the 2nd International Symposium on Singlet Fission and Photon Fusion: Emerging Solar Energy Technologies, Chalmers Univ. of Technology, Sweden (Apr. 2018); American Chemical Society (ACS) spring national meeting in New Orleans (Mar. 2018); 5th Center for Molecular Systems (CMS) International Symposium on Photochemistry and Materials Science for Energy, Kyushu University, Japan (Dec. 2017), Materials Research Society (MRS) Boston (Nov. 2017), WUSTL Chemistry Seminar (Sept. 2017), Notre Dame Chemistry Seminar (Sept. 2017), UIUC Materials Chemistry Seminar (Sept. 2017), Singlet Fission Workshop (Jun. 2017), Boston College Chemistry Seminar (May 2017), MIT Excitonics Seminar (May 2017), Univ. of Rochester Physical Chemistry Seminar (May 2017), UCSD Chemistry Physical/ Analytical Seminar (Apr. 2017), Bowling Green State University Chemistry Seminar (Mar. 2017), UCLA Inorganic Chemistry Seminar (Jan. 2017), Purdue University Organic Chemistry Seminar (Sept. 2016), Electron Donor-Acceptor Interactions GRC (Aug. 2016), ACS New Orleans (Aug. 2013)

Mr. Zhiyuan Huang, a 5th year graduate student gave oral presentations on this work at the 253rd ACS National Meeting in San Francisco, CA in April 2017 and also at the 2017 MRS Spring Meeting & Exhibit in Phoenix, AZ.

Mr. Andrew Pham, an undergraduate mechanical engineering major at Harvey Mudd who participated in the Department of Defense (DoD) High School Apprentice Program (HSAP) in the summers of 2015 and 2016 in this laboratory won a Army Educational Outreach Program (AEOP) technical symposia travel award to present a poster at the 2017 MRS Spring Meeting & Exhibit in Phoenix, AZ.

Honors and Awards: 2016 Chinese American Faculty Association of Southern California (CAFA) Faculty Development Grant
2017 Sloan Research Fellow
2018 Department of Energy Early Career Research Program

Protocol Activity Status:

Technology Transfer: M. L. Tang, Z. Huang, X. Li and M. Mahboub. " Acene-based transmitter molecules for photon upconversion". Feb. 2017, U.S. Patent Application No. 15/932,326.

PARTICIPANTS:

Participant Type: PD/PI

Participant: Ming Lee Tang

Person Months Worked: 3.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Participant Type: Graduate Student (research assistant)

Participant: Zhiyuan Huang

Person Months Worked: 15.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Participant Type: Undergraduate Student

Participant: Tony Elijah Dorado

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Person Months Worked: 2.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Participant Type: Undergraduate Student

Participant: Carter Gerke

Person Months Worked: 2.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Participant Type: High School Student

Participant: Andrew Pham

Person Months Worked: 3.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

Participant Type: High School Student

Participant: Jessica Kasamoto

Person Months Worked: 2.00

Funding Support:

Project Contribution:

International Collaboration:

International Travel:

National Academy Member: N

Other Collaborators:

DISSERTATIONS:

Publication Type: Thesis or Dissertation

Institution: University of California, Riverside

Date Received: 10-Oct-2018

Completion Date: 9/16/17 3:54AM

Title: Hybrid molecule-nanocrystal photon upconversion across the visible and near-infrared

Authors: Zhiyuan Huang

Acknowledged Federal Support: Y

PATENTS:

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as of 11-Oct-2018

Intellectual Property Type: Patent

Date Received: **10-Oct-2018**

Patent Title: Acene-based transmitter molecules for photon upconversion

Patent Abstract: Provided herein are transmitter ligands that improve photon upconversion of near

Patent Number: 15/932,326

Patent Country: USA

Application Date: 17-Feb-2017

Application Status: 2

Date Issued:

Nothing to report in the uploaded pdf