Updated 2/17

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EDUCATION

VANDERBILT UNIVERSITY, Nashville, TN.
PhD in Physics, May 10, 2002.

VANDERBILT UNIVERSITY, Nashville, TN.
MS in Physics, May 12, 2000

CENTER OF INVESTIGATION AND ADVANCED STUDIES (CINVESTAV), Mexico City, MEXICO
Partial credit- MS in sciences, July 15, 1998.

MONTERREY INSTITUTE OF TECHNOLOGY AND SUPERIOR STUDIES, Monterrey, MEXICO
BS in Industrial Physics and Engineering, December 18,1996

PROFESSIONAL EXPERIENCE

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
Associate Professor July 2012 – present
Assistant Professor July 2006-July 2012

VANDERBILT UNIVERSITY
Research Assistant Professor November 2004-June 2006
Postdoctoral Associate, June 2002 – November 2004

OAK RIGE NATIONAL LABORATORY (ORNL)
Research assistant, February 2000 – April 2002.

VANDERBILT UNIVERSITY
Research Assistant, July 1999 – January 2000

MATSUSHITA ELECTRIC COMPANY (PANASONIC), Tijuana, Mexico
Control Engineer, January 1997- March 1997

LABORATORY FOR THE DEVELOPMENT OF ELECTRONIC INDUSTRIES, Monterrey, Mexico.
Project Engineer, August 1995 – January 1997

HONORS

- DOE Office of Science Early Career award 2011
- Junior Faculty Development award 2008

- ORNL Wigner Fellowship 2006 (Decline ORNL position to take UNC tenure track professorship)
- Outstanding Student Research, presentation in Washington, DOE nanomeeting 2002.
- Southern University Association Scholarship to perform summer work at ORNL, 2000
- 1st Place, best grade average, Monterrey Institute of Technology, class 1996
- Monterrey's Institute of Technology, Excellency Scholarship award (full tuition covered)
- 1st Place academic Performance, ITESM High School Campus Chiapas, class 1993
- 3rd Place National Mathematical Olympics (Mexico), 1992
- 1st Place Mathematical Olympics Chiapas province (Mexico), 1992

BIBLIOGRAPHY AND OTHER PRODUCTS OF SCHOLARSHIP

APPLICATION FOR UNITED STATES PATENT

- Flexible conductive transparent films, articles and methods of making same by the inventors, UNC and Eastman Chemical Company
  Inventors: Qiang Dong, Yukihiro Hara and **Rene Lopez.** Submitted August 15 2016,
  Attorney Docket No. 37676.0001U1

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- *Christopher Miller, Yulan Fu,* ***Rene Lopez****," Enhancing energy absorption in quantum dot solar cells via periodic light-trapping microstructures",* ***Journal of Optics,*** *18, 094002, 7pp, 2016*
- *Call, Robert; Alibabaei, Leila; Dillon, Robert; Knauf, Robin; Nayak, Animesh; Dempsey, Jillian; Papanikolas, John;* ***Lopez, Rene****, "Growth and Post-Deposition Treatments of SrTiO3 Films for Dye Sensitized Photoelectrosynthesis Cell Applications",* ***ACS applied Materials and Interfaces****, 8 (19), pp 12282–12290, 2016, DOI: 10.1021/acsami.6b01289*
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- Taylor Moot, Cass Palin, Sorin Mitran, James Cahoon, **Rene Lopez** *"Designing Plasmon-Enhanced Thermochromic Films Using a Vanadium Dioxide Nanoparticle Elastomeric Composite"* ***Advanced Optical Materials****, Article first published online: 23 DEC 2015,* DOI: 10.1002/adom.201500586

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- **R. Lopez** , R. F. Haglund, Jr. *Ion beam lithography and fabrication ordered arrays of VO_2 nanoparticles,* **Mat. Res. Soc. Symp. Proc**. **820,** R1.5.1-1/ R1.5.1-6 (2004)

- A.B. Hmelo, M.D. McMahon, **R. Lopez**, R.H. Magruder III, R.A. Weller, R.F. Haglund Jr. and L.C. Feldman, "*Fabrication of Metallic Nanocrystal Arrays for Nanoscale Nonlinear Optics*", Ceramic Nanomaterials and Nanotechnology II, **Ceramic Transactions V. 148**, American Ceramic Society, 61-68, (2004).

- M. D. MacMahon, A. B. Hmelo, **R. Lopez**, W. T. Ryle, Allen T. Newton, Richard F. Haglund, L. C. Feldman, R. A. Weller, R. H. Magruder III. *Fabrication of ordered Metallic nanocluster arrays using focused ion beam.* **Mat. Res. Soc. Symp. Proc. 739**, 53-57 (2003).

- García-Llamas R, Gaspar-Armenta JA, Ramos-Mendieta F, **López R.**, Haglund Jr. RF and Ruiz R: *Injection of light into a planar dielectric wave guide of metallic walls*. **Proceedings of SPIE. 4439**: 88-94 (2001)

ORAL PRESENTATIONS & INVITED TALKS

- Invited Talk: Optics and replication of the morpho butterfly wings", Soft matter workshop NC state university, may 2015, Raleigh NC

- Invited talk: "Photonic structure and Quantum dot solar cells". Colloquium at the University of the South, Nov.7th, 2014, Swanee, TN

- Invited talk: Holloway Lecture "Photonic structure and Quantum dot solar cells". Colloquium at Vanderbilt University, Nov.6th, 2014, Nashville, TN

- Invited participant: Scilog meeting on Energy conversion, Sponsor by the Research Corporation, October 11-13,, 2014, Tucson, Arizona

- Invited participant: Scilog meeting on Energy conversion, Sponsor by the Research Corporation, October 12-14,, 2013, Tucson, Arizona

- Invited participant: Scilog meeting on Energy conversion, Sponsor by the Research Corporation and the NSF, October 9-12,, 2012, Tucson, Arizona

- Invited Talk: AIP-ICTP INDUSTRIAL PHYSICS FORUM 2012* (16-20 April 2012 - ICTP, Trieste, Italy

- Invited talk: MRS 2011 Fall Meeting as part of the Symposium "Photonic and Plasmonic Materials for Enhanced Photovoltaic Performance". The meeting will be held between November 28th and December 2nd 2011 in Boston, USA.

- Invited talk: "Photonic structure and transport in polymer solar cells" Photonics Colloquium at Duke University, Nov.1st, 2011, North Carolina

- Invited talk: "Pulse laser deposition of high surface area photoanode materials" to be presented in the SESAPS meeting, October 20, 2011, Virginia.

- Invited talk: "Photonic nanostructure for polymer solar cells" to be presented in the SESAPS meeting, October 22, 2011, Virginia.

- Invited participant: Scilog meeting on Energy conversion, Sponsor by the Research Corporation and the NSF, Oct.11-14, 2011, Tucson, Arizona

- Invited talk: "High Surface Area vertically aligned metal oxide nanostructures for dye-sensitized photoanodes by pulse laser deposition". Materials for Solar energy conversion symposium, American Chemical Society meeting, Denver, Colorado, August 29, 2011

- Invited talk: 3rd annual 2011 Hybrid and Organic Photovoltaics Valencia, Spain 16-19th May 2011

- Invited talk: Seminar at Department of Materials Science and Engineering, Rutgers University, April 7, 2011

- Invited talk: “Photonic crystals in polymer solar cells” American Physics Society Annual March meeting, March 21, 2011, Dallas, Texas

- Invited talk: “Pulse laser growth of photoanodes from dye sensitized solar cells” American Physics Society Annual March meeting, March 22, 2011, Dallas, Texas

- Invited talk: North Carolina State University physics colloquium, Nov. 22, 2010

- Invited talk: Joint seminar School of Nanoscience and Nanoengineering, North Carolina A&T State University and The University of North Carolina at Greensboro Nov. 19, 2010

- Invited talk: North Carolina State University physics colloquium, Nov. 22, 2010, Raleigh NC

- Invited talk: Simple Demonstration of visible evanescent wave enhancement with far-field detection. Optical Society of America Annual meeting “Frontiers in Optics 2010”, October 26-28, 2010, Rochester, NY

- Invited talk: Controlled formation of SERS hot spots in gold nanoclusters. Federation of Analytical Chemistry and Spectroscopy Societies (FACSS **37th** annual meeting) October 20 2010, Raleigh, NC

- Invited participant: Scilog meeting on photovoltaic conversion, Sponsor by the Research Corporation and the NSF, Oct.13-15, 2010, Tucson, Arizona

- Invited talk: Organic Photonic solar cells. Colloquium at the University of Wake Forest. April 22 2010, Winston-Salem, NC, USA

- Invited talk: Integrated Electro-Photonic Development of Polymer Solar Cells. Third-Generation Solar Technologies Multidisciplinary Workshop: Synergistic Chemistry-Materials-Mathematical Sciences Approaches to Addressing Solar Energy Problems, Spring MRS meeting April 5-9, 2010. San Francisco, CA, USA

- Invited talk: Electro-photonic enhancement of bulk heterojunction organic solar cells through photonic crystal photoactive layer. Nanomaterials Simposium SACNAS Conference, Oct 15-18, 2009. Dallas, TX, USA

- Invited talk: Bio-inspired Phototonic solar cells. American black and Hispanic Physics meeting. February 13-15, 2009, Nashville, TN, USA

- Invited talk: Electro-photonic enhancement of bulk heterojunction organic solar cells through photonic crystal photoactive layer. Securing Our Energy Future: Next Generation Photovoltaics and Solar Fuels January 15-17, 2009, UNC Chapel Hill, NC, USA

- Invited talk: Electro-photonic enhancement of bulk heterojunction organic solar cells through photonic crystal photoactive layer. SESAPS Meeting, Oct. 30-Nov. 1 2008, Raleigh, NC, USA

- Invited talk: Organic Photonic solar cells. Colloquium at the University of North Carolina, Charlotte. 8 February 2008, Charlotte, NC, USA

- Invited talk: Photonic structures with chromogenic materials. Photonics Conference, University of Sonora, October 23th, 2007, Hermosillo Sonora, MEXICO.

- Invited talk: Photonic properties of thermochromic oxides. Colloquium at the University of North Carolina, Wilmington. 24 August 2007 Wilmington NC, USA

- Invited talk: Nanoscale Thermochromic oxides. Palo Alto Xerox Research Park, 12 July 2007, San Jose CA, USA

- *Optical diffraction in ordered VO_2 nanoparticle arrays.* 2006 APS March meeting Focus session in Nanoscale Physics and Phase Transitions. 13-17 March 2006, Baltimore, MD USA

- Invited paper *Optical nonlinearities and the ultrafast phase transition of VO_2 nanoparticles.* SPIE Photonic West'06 International Symposium on "Ultrafast Phenomena in Semiconductors and Nanostructures X, 21-26 January 2006, San Jose, California USA

- *Nanostructured VO_2 particle arrays as active elements of photonic devices.* 12th International Workshop on Oxide Electronics, October 2-5, 2005, Cape Cod, MA.

- Invited paper *Size-dependent optical properties of VO_2 nanoparticle arrays. NIRT Structure of nanocrystals workshop, December 5-8, 2004*, Tempe, AZ.

- *The optical resonances of VO_2 nanoparticles in ordered arrays.* Spring Meeting, Materials Research Society (MRS), April 13, 2004, San Francisco, CA.

- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation.* International workshop on interactions between nanostructures and particle beams (MRS), March 11-13, 2004, Shanghai Institute of Applied Physics, Shanghai, CHINA.

- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation.* Spring Meeting, Materials Research Society (MRS), April 21-25, 2003, San Francisco, CA.

- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation.* Conference on Accelerators Applications in Research and Industry (CARRI), November 12-16, 2002, U. of North Texas, Denton, TX.

- Invited paper *Metal semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation*. Ion Beam Materials Modification (IBMM) conference, September 1-6, 2002, Kobe, JAPAN.

- Invited paper *Nanoscale features of the VO_2 phase transition*. Gordon conference on Point and Line defects in semiconductors, July 7-12, 2002, Colby Sawyer College, New London, NH.

- *Optical properties of the semiconductor/metal phase transition in VO_2-precipitate SiO_2-host nanocomposites.*104th Annual Meeting American Ceramic Society, April 28-May 1, 2002, St. Louis, MO.

- *Metal-semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica by ion implantation*. March Meeting American Physics Society, March 17-22, 2002, Indianapolis IN.

- *Metal-semiconductor phase transition in nanoscale vanadium dioxide precipitates formed in silica and sapphire by ion implantation.* Fall meeting Materials Research Society, November 26-30, 2001, Boston, MS.

- *Effects of the structural phase transition on the optical response of vanadium dioxide nanocrystals.* Meeting of the Nanoscale consortium, October 25-27, 2001, Baltimore MD.

TEACHING

Teaching at UNC

- ELECTROMAGNETIC THEORY I (PHYS 211/311), FALL 2016, 45 students (on going)

- THERMAL PHYSICS (PHYS441), FALL 2015, 35 students, 32 students (evaluation 3.5/5-4.5/5)
- INTRO MATERIALS SCIENCE (BMME150), SPRING 2015, 68 students (evaluation 4.0/5-4.4/5)
- ADVANCED LABORATORY (PHYS 481L), FALL 2014, 11 students (evaluation: 3.8/5-4.2/5)
- INTRO MATERIALS SCIENCE (APPL150), SPRING 2014, 38 students (evaluation: 4.0/5-4.3/5)
- ADVANCED LABORATORY (PHYS 481L), FALL 2013, 18 students (evaluation: 4.0/5-4.2/5)

SPRING 2013, No teaching assignment, meant to teach Optics but Chair cancelled class due to low enrollment.

- ELECTROMAGNETISM AND OPTICS (PHYS117), FALL 2012, 45 students (evaluation: 3.5/5-4.0/5)
- ELECTROMAGNETIC THEORY I (PHYS 312), SPRING 2012, 13 students (evaluation: 4/5)
- ELECTROMAGNETIC THEORY I (PHYS 211/311), FALL 2011, 25 students (evaluation: ~ 4/5)
- INTRO MATERIALS SCIENCE (APPL150), SPRING 2011, 43 students (evaluation: 3.5/5-4.5/5)
- ELECTROMAGNETIC THEORY I (PHYS 211/311), FALL 2010, 30 students (evaluation: 4.4/5-4.5/5)
- ELECTROMAGNETISM AND OPTICS (PHYS117), SPRING 2010, 65 students (evaluation: 3.9/5-4.1/5)
- SOLID STATE I (1/4 of the teaching load) (PHYS871), Fall 2009, 7 students (No teaching evaluation was conducted on my part of this class)
- ELECTROMAGNETISM AND OPTICS (PHYS117), FALL 2009, 60 students (evaluation: 3.5/5-3.9/5)
- ELECTROMAGNETISM AND OPTICS (PHYS117), SPRING 2009, 55 students, (evaluation: 4.0/5-4.1/5)
- INTRO MATERIALS SCIENCE (APPL150), SPRING 2008, 39 students (evaluation: 3.8/5-4.0/5)
- MODES OF INQUIRY (SPCL390), FALL 2007, 12 students (no teaching evaluation was conducted)
- STRUCTURES AND PROPERTIES OF SOLIDS (MTSC615), FALL 2007, 8 students (evaluation: 3.9/5-4.1/5)
- INTRO MATERIALS SCIENCE (APPL150), SPRING 2007, 28 students,(evaluation: 4.3/5-4.4/5)
- STRUCTURES AND PROPERTIES OF SOLIDS (MTSC615), FALL 2006, 7 students (no teaching evaluation was conducted)

Teaching before UNC position

- GENERAL PHYSICS II (PHYS117B), Summer 2006, 30 students at Vanderbilt University (Nashville, TN)
- PHYSICS MATTERS, Spring 2005, 20 Students at Belmont University (Nashville TN)

Graduate students supervised

- Yingchi Liu, Physics Ph.D. (June 2013) "*Charge Carrier Transport and Nanostructures in Photovoltaic Devices*" he went to work on at IBM, Durham, NC.

- Emily Ray, Physics Ph.D. (May 2012) "*Enhanced electromagnetic fields via surface plasmon coupling in patterned metallic nanostructures*" she went to IBM, Yorktown, NY

- Rudresh Ghosh, Physics Ph.D. (May 2012) "*Metal Oxide Thin Film Growth by Laser Ablation and Its Applications in High Surface Area Photoanodes*" Currently posdoc at UT-Austin, TX.

- Kristen Alexander, Physics Ph.D. (May 2011)," *Fundamentals and technology of surface-enhanced Raman spectroscopy through the fabrication and manipulation of plasmonic gold metal nanoparticle dimers*" went to postdoctoral position at Notre dame University. Currently in publishing company.

- John Tumbleston, Physics Ph.D. (May 2011), "*Photonics and Transport in Bulk Heterojunction Organic Solar Cells*" he went to a postdoctoral position at NC state University. Now at startup company Carbon3D

- Matt Baker, Materials Program, Materials M.S. (Spring 2008), "*Optical properties and aging of gasochromic WO_3 thin films*", he went to US Navy submarine school

Previous posdoctoral scholars supervised

- Yulan Fu, (september 2013- October 2016). She went back to an assistant professor position at Beijing Technological University, Beijing China.

- Abay Gadisa Dinku (Spring 2009-Fall 2014) He went to research assistant professor at NC State University.

- Eugene Donev (Fall 2012- Spring 2013), He went to assistant professorship at Sewanee, University of the South,TN.

- Mukti Aryal, (Fall 2009- Fall 2010), he went to work for startup at Rodlith, Inc. in San Jose CA, currently Process Development Engineer at Qorvo, Inc. Texas.

Honor thesis supervised

- Kai Shin, Materials Science major (April 10, 2015) "*Solar cell characterization*"

Current research team at UNC

- Qian Dong, 3rd year Materials Program, Ph.D. Student
- Timothy Gaverty, 5th year Materials Program, Ph.D sudent
- Cary Tippens, 5th year Materials Program, Ph.D. student
- Robert Call, 4th year Physics Program, Ph.D. student
- Taylor Moot, 3rd year Chemistry Program, Ph. D. Student, shared with Prof. James Cahoon UNC chemistry.
- Yukihiro Hara, full time posdoc joined group Nov. 2011
- Leila Alibabei, 1/3 posdoc shared with Prof. Thomas Meyer (Chemistry), joined on sept.8, 2011
- Shane Brogan, Materials Program, Masters student.
- 5 undergraduates, 1 from geology, 3 from physics, 1 from chemistry.

CURRENT AND PAST RESEARCH SUPPORT

Closed grants ($1,245,500)

- Eastman Corporation PI $38,000 (09/01/2014-07/31/2015)
- NSF Artificial butterfly wing structure PI ($150,000 total) 08/31/2012-08/31/2015

- DOE Energy Frontier Center Co-Pi in a 25 Co-PI collaboration ($17,600,000) ~$60,000/year to my group (five years grant 2009- 2014)
- NSF solar Co-PI (3 researchers $1,600,000.00 in total) ~$160,000/year 09/01/2009-08/31/2014
- UNC-Research Associate professor award, PI. $5,000 (2012)
- Research Corporation Scilog PI ($100,000 3 researchers) $33,000 (01/01/2011-12/31/2012) (no overhead allowed)
- DARPA- Surface Enhanced Raman Spectroscopy project (co-PI) $86,000/ year (12/01/2010-11/31/2011)
- ACS Petroleum Research Fund, PI $100,000, 07/31/2009-08/01/2011 (no overhead allowed)
- 2008 Junior Faculty Development Award, UNC faculty research, PI. $7,500.00 1/1/2008-12/31/2008
- Liquidia Technologies Research Support, PI. (2008) $4,000.00
- Photonic Light Trapping for Polymer Solar Cells US Army Research Office. PI. $42,000.00 8/20/2007-06/01/2008

Current grants ($1,474,085)

- Eastman Corporation PI $232,811 (01/05/2015-03/06/2017)
- DOE Energy Frontier Center phase II Co-Pi in a 16 Co-Pi collaboration lead by Thomas J. Meyer ($12,600,000) ~$70,000/year to my group (july 31 2014-August 1 2018)
- Research Corporation Scholar PI $100,000 (07/01/2014-6/31/2017) (no overhead allowed)
- Internal grant from MRSEC at UNC, PI, ($50,000 total) 09/01/2014-08/31/2017
- DOE Young Investigator award, PI, $811,274.00, 9/1/2011-12/31/2016

Additional past group support

- ORNL rapid access proposal accepted to conduct experiments at the Center for Nanophase Materials 8/2011-12/2011
- Yingchi Liu, 1 year *Carolina Energy fellowship* fall 2010- spring 2011
- Rudresh Ghosh 1 year *Carolina Energy Fellowship* fall 2010- spring 2011
- Kristen Alexander *GAANN fellowship* stipend and tuition 2010
- Emily Ray *NSF fellowship* stipend and tuition 8/01/2008-7/31/2013

PROFESSIONAL SERVICE

Within discipline

- Consultant for Palo Alto Research Center (XEROX)
- Consultant for Procter and Gamble, inc.
- Consultant for Liquidia Technologies
- Session chair SESAPS 2008 meeting, ACS inorganic chemistry 2011 meeting
- Reviewer, National Science Foundation, Singapore Science Foundation, Israel Science Foundation, Science Center program of the U.S. Department of State, and Indian Institute of Technology Madras
- Referee multiple research journals (PRB, Solid Thin Films, JAP, APL, Nanoletters, JMEMS, JPC, Transactions on Nanotechnology, ACS Applied Materials & Interfaces, New Journal of Physics)

- Member of the American Physical Society (APS), the American Chemical Society (ACS), the Materials Research Society (MRS) and the Optical Society of America (OSA).

Outreach

- Participant at with research group at *UNC-Science fair 2013,2014,2015.*
- Contributor to the *RECAP* program (***R**esearch **E**xperience in **C**hemistry, **A**stronomy and **P**hysics*) by hosting junior high-school students in his laboratory during the summer and provides a first time experiences for them in the area of solar cell development and photonic optics (2012,2013)

- Member (2009-2013) of the *American Physical Society committee in minorities* (APS-COM),
- Collaboration with *UNC Morehead Planetarium and Science Center (MPSC)* in Science-360 program entitled *"Emerging Photovoltaic Technologies", 2008.*

To UNC and Physics & Astronomy department

- Undergraduate adviser 2014-2015-2016
- Member of the Applied Science Faculty searches since 2013 to date. Peter Mucha, later Greg Forrest chairs.
- Administer self-study exam on optical materials to Materials Ph.D. program students Spring 2009, 2010, 2011,2013, 2015
- 2009, 2010 and 2011 selection committee for the Carolina Postdoctoral Program for Faculty
- Open House Event Organizer Fall 2009, Fall 2010
- Active supporter of undergraduate admissions office (4-5 lectures for prospective undergrads and parents per year in 2009-2015) lately within *Explore Carolina* campus events.
- Undergraduate recruitment committee chaired by Laurie McNeil 2009-2013 Instructor of undergraduate seminar SPLC390 with focus in physical and medical sciences 2008.
- Elected to serve in the University Faculty Council 2008-2011 in the Natural-Science Non-Tenure position 2008-2011
- Reviewer CASE and Applied Sciences admission committee 2008-2015
- Graduate admission committee 2007-2009
- Faculty responsible for Newcomers Seminar series for new P&A graduate students Fall 2007-2012
- Undergraduate mentoring (listing only when they joined those that stay in the group for longer than one year):

    - Miller, Chris Wayne, undergraduate fall 2015
    - Adam Kunesh, undergraduate fall 2015
    - Hannah Starr, undergraduate fall 2014
    - McKain Tompkins, undergraduate fall 2013
    - Christopher Miller, Undergraduate spring 2013
    - Rachel Thomas, Undergraduate spring 2013
    - Kai Shin, Undergraduate spring 2012
    - Kristina Vrouwenvelder- Undergraduate spring 2012
    - Jordan strongman- Undergraduate spring 2012
    - Sam Krustovski- Undergradaute spring 2012
    - Danielle Simmons- Undergraduate spring 2012

- Keving Hajeck- Undergraduate spring 2008-fall 2009
- Rishab Gada- Undergraduate fall 2010
- Hubert Turley- Undergraduate spring and fall 2010

- Ph.D. Committee member in thesis dissertations of the following students:
  - Li, Qiaoxi (PhD 2016)
  - Derek Vermeulen (PhD 2015)
  - Jing Zhou (PhD 2015)
  - Annie Jackson (PhD 2014)
  - Hanlin Luo (PhD 2014)
  - Myoung Ok (PhD 2013)
  - Justin Kirschbrown (PhD 2013)
  - R. K. Chetri (PhD 2013)
  - Courtey Hadsell (2013)
  - Brant West (PhD 2013)
  - Patrick MacMullin (PhD 2012)
  - William C. Rice (PhD 2012)
  - Zheng Ren (PhD 2012)
  - Dan Brosnan (master thesis 2011)
  - Robert J. Anderson (PhD 2011)
  - Shabana Sultana (PhD 2010)
  - Zhongqiao Ren (PhD 2010)
  - Greg Migilevski (PhD 2010)
  - Doo-Hyun Ko (PhD 2009 Chemistry)
  - Xiomara Calderon (PhD 2009)
  - Vicent Toups (PhD 2009)
  - David Bordelon (PhD 2009
  - Brian A. Collins (PhD 2009)
  - Benjamin A. Evans (PhD 2008)
  - Hakan Deniz (PhD 2007)

TEACHING STATEMENT.

One of the major responsibilities facing physical sciences professors is to provide solid background for students going into scientific, technological and medical careers. When I started teaching at UNC in 2006, I felt there was a nationwide somewhat downward trend in the interest of students for taking a physical science major. My perception is now that that trend has reversed, and the attention is up in physical and technological topics. The enrollment now in our mid-level Electromagnetic Theory PHYS 311/211 for example is 46 students, up 50% from the first time I taught it in 2011. Besides the rise in student interest and numbers, other things are also changing around the classroom: online tools are widespread, from videos to a plethora of "answer" sheets, inviting us to continually review how we perform the professor job.

Although I regard all those changes as overall very positive, after teaching over 10 years, I am convinced that our daily labor, even including all newer approaches and resources, remains a very limited impact activity. It might seem odd to say this, but I truly feel not much we do in the classroom makes a difference in the outcomes. This is because students do not need us to "provide knowledge" as information on any subject is nowadays easily accessible. What students really need is to assimilate it and make it their own… precisely the thing no one can do for someone else.

A few years ago I attended the workshop of the American Association of Physics Teachers, it was reassuring to see that consensus has been built around a fact that seems contrary to the classical teaching: we only learn when we actively seek knowledge, but not when facts are poured on us. However, it is still a question how can we assist them in their learning the best? I see my role as someone that can help out bridging the gap between the knowledge sources and the students own drive to seek that knowledge. It is my belief that no one way of discussing a topic fits everyone. My teaching philosophy has evolved thus to compel me to do my best to present as many angles and views of any given issue; do as much/many as possible examples and problem exercises while minimizing the classical lecture. As homework solutions are now easily available online, I also do apply constant quizzes in class time to keep the evaluation honest.

To help in particular undergraduate students in this -their- journey, besides the "many angles, many examples" approach, I think one needs to put significant time in spelling out "why all this matters at all?" This is because although their interest could be high in the final product, to appreciate the value of some learning some tools is not straightforward. ie. they all want to know why the sky is blue, but few of them wake up a morning wishing to know the significance of divergence theorem. Many students I have encountered indeed do not have a clear why the subjects are relevant. I have found that when science problems are put in a context familiar to the students, the interest to know grows. The challenge here is to hit the right level, one that does not discourage the student with overwhelming difficulty but invites him/her to desire seek the answers. Doing this in natural sciences like physics is convoluted with the intrinsic difficulties of mathematical education, which makes the whole thing a tough challenge when the students lack mathematical fluency.

Although very conscious of the limited impact one can have, I remain optimistic of the outcome of my work as a professor. I say this because I have indeed noticed that curiosity for the physical world is not in short supply, even when talking to non-science majors, I find that most students have desire to know how things work, to perhaps go on to solve physical world problems. There is in fact an abundance of able and willing students. Every semester, I get in touch with increasingly large fractions of students that clearly want to understand, definitely "get" it, and in a few instances amaze me with their own insights. I am not just talking about the "stars" of the

class. I have found plenty of cases of students that are able to clearly acquired greater understanding on the physical world as a result of their own dedication. Perhaps, there is the "Sweet spot" were our help as professor might have done a difference.

Finally, I believe the educational field in general is bound to have a reckoning with the extensive availability of knowledge via internet. The only part we can provide that is truly valuable and not available online is the real world experience of working in our research laboratories. I do believe the learning experience our students have working with us there is 100 times more valuable than the best classroom lectures they ever attend. Over the years, besides my graduate students and postdocs, I have had many undergrad students in my laboratory. I feel very proud of those that went deep into a challenge, develop skills to create something new, and I saw intellectually grow during the process. It is the professor privilege to have the chance to work with them and assist them in their own path. I greatly look forward to keep doing that.

RESEARCH STATEMENT

I think my motivation to do scientific research originates from two of our most inner human impulses – deep rooted curiosity for our world and a no less fundamental ambition to control and benefit from it–. However, in contrast to most scientific and engineering fields which gravitate to close to one of those poles, I think the professional path of a materials scientist necessarily demands a fine balance of those drivers. Consistent with this ethos, my research interests revolve around material problems of large potential impact on society and where improvements in material understanding and processing seem essential to make progress. In particular, my work has and will continue to focus at the intersection between *electromagnetic radiation and nanostructured materials*. Beyond its well established footprint in telecommunications, the physics of light manipulation and control with/within nanoscale materials is nowadays a rendezvous point for solar energy harvesting, chemical sensors, and photonic structures with a variety of potential science-fiction like applications. In this research statement I describe the current three legs, all targeting an effective control of materials and light length scales, that comprise the ongoing work within my research group: **Nanostructured solar photovoltaic and photochemical cells, photochemical sensors, and bio-inspired color-tunable systems.** In the following lines I will provide a brief synopsis of their particular motivation, progress and how I envision they will evolve within the next few years.

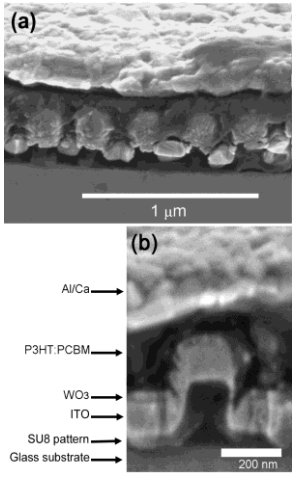

Fig. 1 Nanostructured OPV device. (a) Whole view of the cross-section. (b) Detail of the structure .

Nanostructured Photovoltaic/Photoelectrochemical Cells: Sunlight is the most abundant and sustainable source of energy available. However, exploiting its concentrated fossil forms has negative environmental and geopolitical consequences. Such omissions make them appear as the "cheapest" way to supply the world with energy. Despite this uphill situation, an economic upheaval in direct solar energy conversion technology seems possible. The price of solar panels has fallen steadily for 40 years and the onset of chinese manufacturing caused prices to undergo an even stronger decline. This current development is showing that a new technology can only have a chance of being disrupting if its costs are lower than silicon's and performs with commercial module photon conversion efficiencies (PCE) > 15 % (> 20 % laboratory). We advocate that sustainable energy research cannot be blind to these realities.

Clearly abundant and low cost materials are the only ones with a chance to surpass silicon's cost trajectory. *This is why we are committed to a bet on alternative systems: namely organic, hybrid, and quantum dot solar cells.* The key adversative problem –light absorption vs. carrier transport–, present in all types of alternative photovoltaic materials is for most part being addressed on by improving the intrinsic characteristic of PV-active materials. As it has been proven by organic bulk heterojunction progress, the problem is surmountable by separating the absorption and transport issue, the key is identifying the correct length scales that need to be addressed. My group is working on a program that pursues the conception and study of solar cell nanostructure at multiple length scales. *The objective of this effort is to accomplish efficient light capturing by a photonic arrangement of nanostructures while at the same time significantly reducing the effective path carriers need to travel to reach contacts.* We started in 2008 with polymer solar cell enhancements (Fig. 1).

This photonic nanostructure can also be shown be an ideal to exploit the deep IR absorption on colloidal quantum dot (CQD) systems which are ~10% efficiencies but hold a promise of reaching higher levels with the right electro-photonic design. I have a vetted design for that purpose and we have started to make CQDs devices in December 2013, very recently my group had overcome some of the nanofabrication challenges (fig 2). I think we can reach 15% efficiency without materials parameters improvements, perhaps even higher if processes such as the hybrid passivation methods are employed. I am certain this integrated approach is the best route to make the best of low cost material.

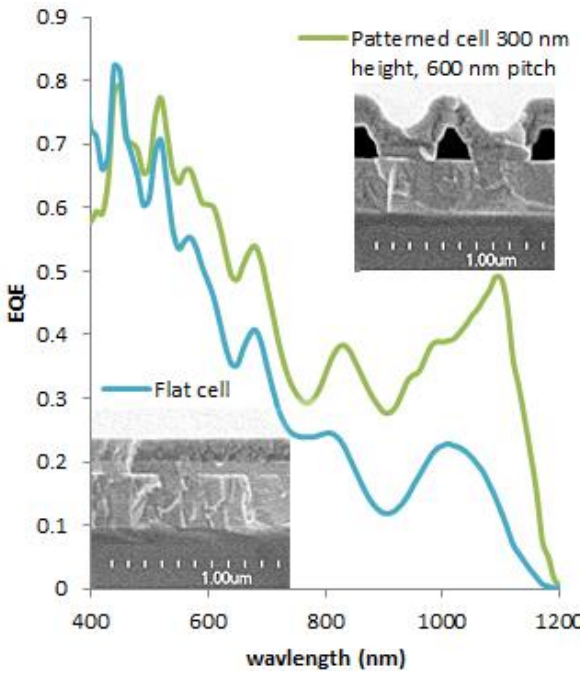

Fig. 2 External quantum efficiency (EQE) in pattern vs. flat PbS quantum dot solar cells. Devices made by Yukihiro Hara and Qian Dong at Lopez laboratory UNC 2015.

In a related effort, we have applied the unique nanostructure that pulse laser deposition can provide to the growth of columnar porous oxide structures to study and improve dye sensitized photoelectrochemical cells (DSPEC). We are seeking to maximize surface area (for chromophore and catalyst attachment) while enhancing transport of charges to the collection contacts, thus reshaping photoanode/photocathode structures. In a DSPEC device, the photoelectrode is surface loaded with light-absorbing dye that can pass photo-excited electrons to the electrode, and a molecular catalyst that mediates the water oxidation reaction and is activated by the oxidized dye. Proton reduction at a dark electrode completes the cell. For these devices, the semiconductor should have a wide bandgap and a conduction band edge energetically lower than the excited state of the dye. However, it should also have a conduction band potential that is more negative than the hydrogen reduction potential if water splitting is to be realized without an applied bias.

High conduction band oxides such as SrTiO3, Ta_2O_5 or Na_2O_5 are significantly less studied oxide semiconductors for dye-sensitized applications compared to TiO_2. They are less favored because nanocrystalline TiO_2-based DSSCs have been proven to be extremely efficient at transporting electrons giving rise to high photocurrent densities and high photoconversion efficiencies. Additionally, commonly used inorganic dyes that are functionalized with carboxylate or phosphonate anchors tend to adsorb better onto TiO_2. Despite some of its inferior properties, $SrTiO_3$ for instance has been noted to present a conduction band potential more capable of unbiased proton reduction. For this reason, doped and undoped $SrTiO_3$, grown by a variety of physical and chemical methods, has gained interest for use in direct excitation photoelectrochemical cells. In my group, we have grown $SrTiO_3$ films utilizing pulsed laser deposition (PLD) and processed them under different annealing conditions to evaluate their properties as potential DSPEC photoanodes. Pulsed laser deposition can tailor film properties by easily varying material doping, and controlling the sample's surface area (see figure 3). These photoanodes are studied using spectroscopic techniques, flat-band potential measurements, transient absorption, and linear sweep voltammetry. Correlation of results from these

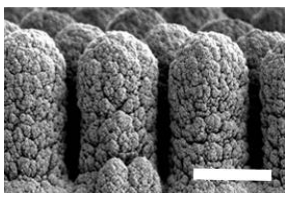
Fig 3 a) ITO pillars coated with high surface area oxide. Scale bar 1.0 μm.

experiments grants insight to the dye-film interactions and the effects of changes in the film synthesis. In collaboration with Dr. Jim Cahoon, our shared student pursues another analog project in the photocathode side, where the goal is to develop a deep valence band oxide for water oxidation. Currently her project is centered in $Pb_xTi_{1-x}O_3$. This line of work is now funded by DOE and the UNC-DOE-Energy Frontier Center.

Photochemical sensors. Another area where nanoscale features is having a revolutionary effect is sensor technology. Since the advent of laser and photon detection technologies has allowed Raman spectroscopy to become a practical tool to study analytes in bulk quantities. Today, under favorable circumstances, using surface Raman enhancement (SERS), this technique is capable of single molecule detection which represents a $\sim 10^{14}$ enhancement factor. This has prompted a renewed interest in Raman for a variety of applications ranging from security, chemical identification, environmental monitoring and healthcare. Although considerable progress has been made in elucidating the mechanisms behind this signal boost, SERS enhancements have not been reproduced at will in specific controlled locations in a low cost and reliable SERS substrate. This standing problem is hardly surprising since theoretical and computational calculations have shown that the dominant field enhancements are specifically localized to the crevices between metal nanoparticles. Our goal in this area is to address experimentally those theoretical predictions and create those SERS substrates. This project started long ago in my group, and has continue under different students. In contrast to what other groups have done in the past, we are directing the metal nanoparticles to form only particle-dimers with controlled size, location and interparticle distance by macroscopic mechanical means (fig 4). My current goal is to arrive to definitive methods to achieve such nanofabrication on large scale and high quality reproducibility. Connected to the nanopatterning of the substrate, we have applied this expertize to work with Eastman Chemical in several applied problems from their thin film division. As a result, nanopatterning for mechanical film tailoring has been funded in the past few years by Eastman Chemical Corporation.

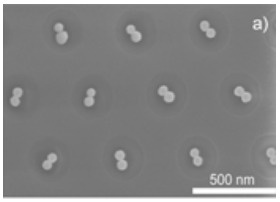

Fig. 4 a) Array of gold nanoparticle dimmers fabricated with our novel technique.

Bio-inspired color-tunable systems. Tremendous progress has been made in display devices and virtual reality methods over the years, yet the primary representation remains "through the window"—we look, feel, or move using a computer interface that acts as a portal into a simulated world. Even with the best projection systems light emitting devices offer very limited simulations of the real world. There is a real need to explore novel material concepts in texture and color control to create *physical manifestations of virtual objects*. The major challenge for this revolution is the need of a new type of pixel that can change color and texture in a flexible substrate. To that end we are also working to comprehensively address the full opto-mechanical requirements to build structurally active designs to enable efficient color and texture surface control. It is important to point out that we are neither proposing that such technology would displace light emitting diode displays any time soon, nor other rigid and/or liquid-based architectures in development for the e-book reader market. What we are proposing here is fundamentally different, a technology that because based on intrinsically soft

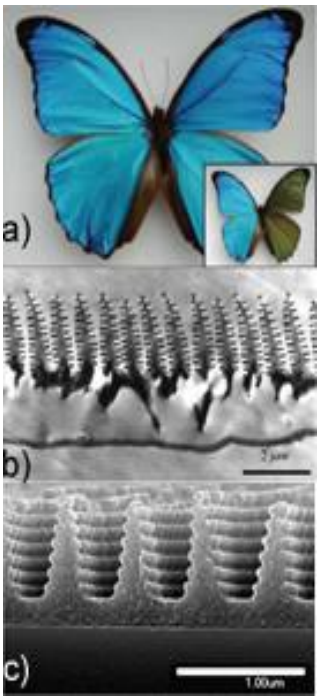

Fig. 5 a) Morpho butterfly, b) wing photonic structure, c) nanofabricated in elastomer.

components can really reproduce color and texture. It could have important implications in adaptive optics, camouflage, and the overall integration of visual and tactile experience in, for example, a truly sci-fi chameleonic skin.

Natural nanoarchitectures such as the cuttlefish or butterfly wing offer a different 'blueprint' for realizing active structural color compatible with soft and flexible surfaces. We are pursuing a technology based on *soft materials* to implement a *controllable and flexible structural coloration* scheme inspired by the butterfly wing structure (fig 5). If successful, it will allow a *low cost nano-replication of structured color pixel that will be tunable and will not consume energy to retain a state*. The structure shown in fig.5-c is created in a *single* step out of a master we have made. This work has been funded until recently by the National Science Foundation IGERT program and UNC-MERSC lead by Dr. Sergei Sheiko.