RAYMOND R. FULLON

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EDUCATION

RUTGERS UNIVERSITY, School of Engineering — June 2018
Ph.D. Materials Science and Engineering — New Brunswick, NJ
- Thesis: Investigation into the Active Sites for Two Dimensional Electrocatalysts
- GPA: 3.7 / 4.0

M.S. Materials Science and Engineering — January 2017

UNIVERSITY OF TEXAS AT AUSTIN, College of Natural Sciences — December 2012
B.S. Chemistry with Computation — Austin, TX
- University Honors
- GPA: 3.5 / 4.0

RESEARCH EXPERIENCE

Post-Doctoral Associate, The Nanomaterials and Devices Group, Rutgers University — July 2018 - Present
Advisor: Prof. Manish Chhowalla
- Developing processes to incorporate nitrogen into graphene, pattern it using electron beam lithography and control the nitrogen doping configuration

Graduate Research Assistant, Light to Energy Team (MPA-11), Los Alamos National Laboratory — Feb 2015 – Aug 2015
Advisors: Aditya Mohite; Gautam Gupta
- Utilized electron beam lithography to fabricate electronic devices on monolayer nanosheet samples of molybdenum disulfide (MoS_2) grown by chemical vapor deposition (CVD) towards electrical characterization
- Adapted standard electron beam lithography techniques in order to construct electrochemical microcells directly above the MoS_2 electronic devices allowing for discrete control of the area participating in the electrochemical reaction. Engineered the contact resistance of these devices using controlled local phase transformations.
- Measured the performance for the hydrogen evolution reaction (HER) of MoS_2 electrochemical microcells and correlated with the contact resistance, finding that as contact resistance decreases, catalytic performance increases
- Identified sulfur vacancies as the active site for the HER in MoS_2 nanosheets grown by CVD after comparing our electrochemical results with direct imaging of these defects in our MoS_2 samples from high angle annular dark-field scanning electron microscopy and density functional theory calculations

Ph.D. Student, The Nanomaterials and Devices Group, Rutgers University — 2013 – June 2018
Advisor: Prof. Manish Chhowalla
- Optimized solution based synthesis methods for chemically exfoliating two-dimensional materials, such as MoS_2 and graphene oxide (GO), into two-dimensional nanosheets which can then be dispersed into stable aqueous solutions, allowing for access to simple solution processing techniques
- Determined a high yield synthesis route towards high quality graphene from GO employing a simple and rapid microwave reduction method. Characterized the resultant microwave reduced graphene oxide (MWrGO) which exhibits high conductivity and high graphene character with few defects, which are typically found in GO.
- Devised a method to dope MWrGO with nitrogen using high temperature ammonia gas annealing. Studied nitrogen doped MWrGO for catalyzing the oxygen reduction reaction (ORR) towards use in fuel cells in practical acidic conditions. Analyzed the electrochemical data, calculating key benchmarks such as the electron number and percentage of H_2O_2 formed and confirmed the high activity of nitrogen doped MWrGO, emphasizing it a promising noble metal alternative.
- Fabricated all solution-processed photodetectors composed of two-dimensional nanosheets of metallic and semiconducting MoS_2 and organic/inorganic hybrid perovskites. The devices highlighted how tuning of the semiconducting and metallic phases of MoS_2 can yield exceptionally high photoresponsivity and external quantum efficiency values.

Undergraduate Researcher, Mullins Research Group, University of Texas at Austin 2012 - 2013
Advisor: Prof. C. Buddie Mullins

- Evaluated the changes in solar conversion efficiency as increasing quantities of selenium was added to a BiSI-based inorganic solar cell
- Synthesized rutile TiO_2 nanoplatelets via chemical bath deposition and investigated the effects of these nanostructures on photoelectrochemical water-splitting performance and on dye sensitized solar cell efficiency
- Investigated how niobium incorporation into TiO_2 microspheres, composed of many nanowires, can improve the water photo-oxidation photocurrent and photoconversion efficiency when used in dye sensitized solar cells
- Improved upon an array dispenser and scanner system for high-throughput testing of TiO_2 and hundreds of doped TiO_2 compositions for use in dye sensitized solar cells; ideal dopants were identified and tested in scaled-up devices

Undergraduate Student, Advanced Analytical Chemistry, University of Texas at Austin 2012

- Organized, proposed and performed an independent special research project using fluorimetry to investigate the nitrite content in canned cooked meat

TEACHING & WORK EXPERIENCE

The Nanomaterials & Devices Group 2016 – Present
Laboratory Manager

- Scheduled and led group meetings where recent research progress was presented and discussed among all group members
- Procured consumables and lab supplies in a timely manner. Set up and oversaw the installation of new laboratory equipment
- Implemented and performed maintenance and repairs on laboratory instrumentation while maintaining a clean and orderly laboratory environment
- Established laboratory safety rules for all researchers and processed hazardous waste disposal

Undergraduate Student Mentor 2013 – Present

- Trained nine individual undergraduate researchers in proper laboratory etiquette, practice and safety, including basic wet chemistry techniques and solution processing
- Developed students' scientific understanding and techniques towards individualized and independent research projects. Encouraged students to explore different applications within their project with training in electronic device fabrication and testing and electrochemical testing.

Research Intensive Summer Experience (RiSE) Student Mentor 2017

- Mentored a rising undergraduate senior during a full time summer research experience in the coordination of a research project involving the use of a metallic phase MoS_2 as a material for supercapacitors
- Supervised the student as she researched different possible approaches, ultimately fabricating and testing supercapacitors in monovalent and divalent cation electrolyte. Advised the student as she presented her work through a poster and oral presentation at the RiSE Summer Research Symposium.

Mechanical Properties of Materials 2017 – 2018
Teaching Assistant

- Supported professors during lectures and monitored in-class assessments and exams
- Graded assessments and exams and held special office hours to allow for returning of exams and provide individual feedback to students
- Facilitated the learning of over 350 students through management of a virtual learning environment, where lectures, homework assignments, quizzes and extra information were uploaded
- Systematically tracked grades and scores according to the syllabus in a spreadsheet, ultimately building a report for final grade submission
- Held weekly office hours to answer students' queries, concerns and offer suggestions for improving academic performance

Laboratory I 2014

Teaching Assistant

- Instructed and structured two lab classes with 12 students each
- Prepared and directed students in diverse laboratory experiments that involved good laboratory etiquette and safety, solution preparation, ceramics testing and experimental note taking.
- Reviewed and assigned grades to full scientific lab reports, providing feedback to enrich the students' understanding of the laboratory experiment.

New-Jersey Governor's School of Engineering & Technology: The Hydrogen Economy 2014

Laboratory Instructor

- Lead an interactive laboratory session for rising high school seniors in which the students synthesized graphene oxide aerogels and tested their electrical properties in differing conditions

LEADERSHIP & VOLUNTEERING

Rutgers Day 2015 - 2018

Team Leader

- Planned logistics and devised scientific demonstrations designed for a broad audience. Demonstrations showed how two dimensional materials can be used in real world applications such as electrochemistry for harvesting hydrogen and highly conductive and cost-effective materials for electronics.

Materials Science & Engineering – Graduate Student Association 2016 - 2017

Secretary

- Scheduled officer meetings and recorded notes of the proceedings of all conversations, which was made available to all officers
- Conducted all email and paper correspondence from the organization to our members

Engineers Week at Bartle Elementary School 2016

Team Leader

- Demonstrated how water currents can be used to generate electricity to light an LED in a classroom environment for two classes of elementary grade school children. The students participated in an interactive demo by increasing the rate of water flow which increases the voltage generated translating to a brighter LED.
- Formulated interactive activity for grade school children to demonstrate the effect of surface tension using soap and student designed boats made of polystyrene.

Summer Camp 2014

Scientific Volunteer

- Directed scientific demonstrations aimed towards 7 – 8 year old children, where the basic principles of polymer chain entanglement was shown using increasing concentrations of jello and its effect on strength
- Aided in solar cell demonstration with 9 – 10 year old children, in which different applications of solar cells were discussed in an interactive experiment involving turning on LEDs and small fans and the fabrication of a solar powered miniature car

FELLOWSHIPS/SCHOLARSHIPS

- Ackermann Fellowship 2016 - 2017
- Graduate Assistance in Areas of National Need (GAANN) Fellowship 2013 - 2016
- Undergraduate Research Fellowship October 2012
- Non-Resident Tuition Exemption (NRTE) 2009 - 2012

SKILLS

Computer: Microsoft Office, Adobe Photoshop, Adobe Premiere Pro, and Adobe After Effects, AutoCAD
Programming: Java, Python, CSS, and HTML
Data Analysis: LabView, Origin, WiRE, Gwyddion, XEI, Chemdraw, PyMOL

Technical Skills

Spectroscopy	Characterization
• X-Ray Photoelectron Spectroscopy, • Photoluminescence Spectroscopy • UV-Vis, Infrared and Raman Spectroscopies	• Scanning Electron Microscopy • Atomic Force Microscopy • Electrical measurements
Electrochemistry	**Materials Synthesis & Processing**
• Linear sweep voltammetry • Cyclic voltammetry • Chronoamperometry • Electrochemical impedance spectroscopy	• Hydrothermal & solvothermal • Basic organic synthesis techniques • Chemical Vapor Deposition • Thermal and electron beam evaporation
Patterning	**Miscellaneous**
• Positive/negative resist electron beam lithography • Photolithography • Shadow / Optical Mask design	• Certificate of Fitness for Non-production Chemical Laboratory (C-14) • Advanced glovebox technique • Gas Chromatography equipped with a Thermal Conductivity Detector, Flame Ionization Detector and Mass Spectrometer • 500+ hours in a class 100 clean room environment

PUBLICATIONS

1. Jieun Yang*, Abdul Mohmad*, Yan Wang, **Raymond Fullon**, Xiuju Song, Fang Zhao, Ibrahim Bozkurt, Mathias Augustin, Elton Santos, Hyeon Suk Shin, Damien Voiry, Hu Young Jeong, Manish Chhowalla, "Ultrahigh current density niobium disulfide catalysts for hydrogen evolution," *Nature Materials (2018) submitted*
2. Yan Wang, **Raymond Fullon**, Muharrem Acerce, Christopher E. Petoukhoff, Jieun Yang, Chenggan Chen, Songnan Diu, Sin Ki Lai, Shu Ping Lau, Damien Voiry, Deirdre O'Carroll, Gautam Gupta, Aditya D. Mohite, Shengdong Zhang, Hang Zhou, Manish Chhowalla, "Solution-Processed MoS_2 Organolead Trihalide Perovskite Photodetectors," *Advanced Materials*. **29(4)**, (2017) doi:10.1002/adma.201603995
3. Damien Voiry, Jieun Yang, Jacob Kupferberg, **Raymond Fullon**, Calvin Lee, Hu Young Jeong, Hyeon Suk Shin, Manish Chhowalla, "High-quality graphene via microwave reduction of solution-exfoliated graphene oxide," *Science*. **353 (6306)**, 1413-1416 (2016) doi: 10.1126/science.aah3398
4. Damien Voiry, **Raymond Fullon**, Jieun Yang, Cecilia de Carvalho Castro e Silva, Rajesh Kappera, Ibrahim Bozkurt, Daniel Kaplan, Maureen J. Lagos, Philip E. Batson, Gautam Gupta, Aditya D. Mohite, Liang Dong, Dequan Er, Vivek B. Shenoy, Tewodros Asefa, Manish Chhowalla, "The role of electronic coupling between substrate and 2D MoS2 nanosheets in electrocatalytic production of hydrogen," *Nature Materials*. **15(9)**, 1003–1009 (2016) doi: 10.1038/nmat4660
5. Sean P. Berglund, Son Hoang, Ryan L. Minter, **Raymond R. Fullon**, C. Buddie Mullins, "Investigation of 35 Elements as Single Metal Oxides, Mixed Metal Oxides, or Dopants for Titanium Dioxide for Dye-Sensitized Solar Cells" *The Journal of Physical Chemistry C.* **117**, 25248-25258 (2013) doi: 10.1021/jp4073747
6. Son Hoang, Thong Q. Ngo, Sean P. Berglund, **Raymond R. Fullon**, Ryan R. Minter, John G. Ekerdt, and C. Buddie Mullins, "Improvement of dye sensitized solar cells with Nb-incorporated hierarchical TiO_2 micro-spheres," *ChemPhysChem* **14 (10)**, 2270-2276 (2013) doi: 10.1002/cphc.201201092
7. Son Hoang, Sean P. Berglund, **Raymond R. Fullon**, Ryan L. Minter, and C. Buddie Mullins, "Low temperature hydrothermal synthesis of vertically aligned TiO_2 nanoplatelet arrays for solar energy conversion applications," *Journal of Materials Chemistry A.* **1 (13),** 4307-4315 (2013) doi: 10.1039/c3ta01384g
8. Nathan T. Hahn, Alexander J. E. Rettie, Susanna K. Beal, **Raymond R. Fullon**, and C. Buddie Mullins, "n-BiSI thin films: Selenium doping and solar cell behavior," *The Journal of Physical Chemistry C*. **116 (47)**, 24878-24886 (2012) (47), 24878–24886. doi: 10.1021/jp3088397

ORAL & POSTER PRESENTATIONS

1. **Raymond Fullon** and Manish Chhowalla, "Investigation into the active sites for two dimensional electrocatalysts", Oral Ph.D. Dissertation Defense at *Rutgers University, New Brunswick, NJ*, June 2018
2. **Raymond Fullon**, "Two Dimensional Nanomaterials", Guest lecture contributed for "Introduction to Nanomaterials and Nanotechnology" at the *U.S. Army Picatinny Arsenal, Wharton, NJ*, September, 2017
3. **Raymond Fullon** and Manish Chhowalla, "Electrocatalytic behavior and photovoltatic applicability of two dimensional materials", Oral Ph.D. Thesis Proposal at *Rutgers University, New Brunswick, NJ*, January 2017

4. **Raymond Fullon**, Damien Voiry, Jieun Yang, Cecilia Silva, Rajesh Kappera, Ibrahim Bozkurt, Daniel Kaplan, Tewodros Asefa, and Manish Chhowalla, "Fabrication of Electrochemical Microcells on Two-Dimensional MoS_2 Using Electron Beam Lithography", Poster contribution in the 2D Layers and Heterostructures beyond Graphene—Theory, Preparation, Properties and Devices symposium presented at *Materials Research Society Fall Meeting, Boston, MA*, November 2016
5. **Raymond Fullon**, Damien Voiry, Jieun Yang, Cecilia Silva, Rajesh Kappera, Ibrahim Bozkurt, Daniel Kaplan, Maureen Joel Lagos, Philip Batson, Gautam Gupta, Aditya Mohite, Liang Dong, Dequan Er, Vivek Shenoy, Tewodros Asefa, and Manish Chhowalla, "The Role of Electronic Coupling between Substrate and 2D MoS_2 Nanosheets in Electrocatalytic Production of Hydrogen", Poster contribution in the Catalytic Materials for Energy and Sustainability symposium presented at *Materials Research Society Fall Meeting, Boston, MA*, November 2016
6. **Raymond Fullon**, Son Hoang and C. Buddie Mullins, "Ta-Doped TiO_2 Nanoplatelets for Photoelectrochemical Water Splitting", Oral Presentation for Physical Chemistry II, *University of Texas at Austin, Austin, TX*, November 2012
7. **Raymond Fullon**, Son Hoang and C. Buddie Mullins, "Metal Oxides for Photoelectrochemical Water Oxidation", Oral Presentation at the Undergraduate Research Focus Group, *University of Texas at Austin, Austin, TX*, December 2012
8. **Raymond Fullon**, "Quantification of Nitrite Ions in Spam through Fluorescence Quenching", Oral Presentation for Advanced Analytical Chemistry, *University of Texas at Austin, Austin, TX*, May 2012