

Curriculum Vitae

JOHN MARK P. MARTIREZ

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Personal Information

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| Date of Birth | October 14, 1985 |
| Birthplace | Bohol, Philippines |
| Nationality | Filipino (US permanent resident) |
| Languages | English, Filipino |

Professional Appointments

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| May 2018 – current | Associate Research Scholar <i>Advisor: Prof. Emily A. Carter</i> Princeton University Princeton, New Jersey, United States |
| March 2015 – April 2018 | Postdoctoral Research Associate <i>Advisor: Prof. Emily A. Carter</i> Princeton University Princeton, New Jersey, United States |
| 2006 – 2008 | University Instructor University of the Philippines, Philippines |

Education

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|------|---|
| 2015 | Ph.D. in Chemistry <i>Advisor: Prof. Andrew M. Rappe</i> University of Pennsylvania Philadelphia, Pennsylvania, United States |
| 2006 | B.S. in Chemistry, <i>Magna cum Laude</i> University of the Philippines - Diliman Diliman, Quezon City, Metro Manila, Philippines |

Research Activities and Interests

I use state-of-the-art computational tools in fields where atomic-scale information delivers unparalleled chemical design principles. The main thrust of my work is using **first-principles density functional theory and embedded correlated wavefunction methods** to guide experimentalists in finding alternative and unconventional reaction pathways and catalysts for industrially relevant reactions. This includes computational investigations on manipulation of reactions via new or surface-modified heterogeneous catalysts and introduction of co-catalysts. The foundation of my work lay on the identification of key species and pathways in catalysis from first-principles quantum mechanics.

Patents

2. J. M. P. Martirez and E. A. Carter, Plasmonic Haber-Bosch catalysts based on surface-doped Au nanoparticles. **Provisional patent application no. 62/638,728** (filed on March 5, 2018)
1. J. M. P. Martirez, S. Kim, and A. M. Rappe, Synergistic Oxygen Evolving Activity of Non-Stoichiometric Surfaces. **United States Letters Patent No.: 9,469,908**. Issued October 18, 2016

Publications (* shared first authorship)

22. D. F. Swearer, H. Robatjazi, J. M. P. Martirez, M. Zhang, L. Zhou, E. A. Carter, P. Nordlander, and N. J. Halas, Controlling N₂O decomposition pathways by antenna-reactor photocatalyst design. **submitted** (2018)
21. L. Zhou, J. M. P. Martirez, C. Zhang, D. F. Swearer, S. Tian, H. Robatjazi, L. Henderson, E. A. Carter, P. Nordlander, and N. J. Halas, Light-driven methane dry reforming with single atomic site antenna-reactor plasmonic photocatalysts. **under review** (2018)
20. J. M. P. Martirez, and E. A. Carter, Unraveling Oxygen Evolution on Iron-Doped β -Nickel Oxyhydroxide: the Key Role of Highly Active Molecular-like Sites. **under review** (2018)
19. Z. Chen,* J. M. P. Martirez,* P. Zahl, E. A. Carter, and B. E. Koel, Self-Assembling of Formic Acid on the Partially Oxidized $p(2\times 1)$ Cu(110) Surface Reconstruction at Low Coverages. **The Journal of Chemical Physics**, *in press* (2018)

- Invited contribution to be featured in Special Topic on *Interfacial Electrochemistry and Photo(electro)catalysis*

18. A. J. Tkalych, J. M. P. Martirez, and E. A. Carter, Thermodynamic evaluation of trace-amount transition-metal ion doping in NiOOH films. **Journal of the Electrochemical Society**, **165**, F907-F913 (2018) DOI: 10.1149/2.0101811jes
17. J. M. P. Martirez, and E. A. Carter, Effects of the Aqueous Environment on the Stability and Chemistry of β -NiOOH Surfaces. **Chemistry of Materials**, **30**, 5205-5219 (2018) DOI: 10.1021/acs.chemmater.8b01866
16. A. J. Tkalych, J. M. P. Martirez, and E. A. Carter, Effect of transition-metal-ion dopants on the oxygen evolution reaction on NiOOH(0001). **Physical Chemistry and Chemical Physics**, **20**, 19525-19531 (2018) DOI: 10.1039/C8CP02849D
15. L. D. Chen, M. Bajdich, J. M. P. Martirez, C. M. Krauter, J. A. Gauthier, E. A. Carter, A. C. Luntz, K. Chan, and J. K. Nørskov, Understanding the apparent fractional charge of

- ions in the aqueous electrochemical double layer. **Nature Communications**, **9**:3202 (2018) DOI: 10.1038/s41467-018-05511-y
14. R. B. Wexler, J. M. P. Martirez, and A. M. Rappe, Chemical Pressure-Driven Enhancement of the Hydrogen Evolving Activity of Ni₂P from Nonmetal Surface Doping Interpreted via Machine Learning. **Journal of the American Chemical Society**, **140**, 4678-4683 (2018) DOI: 10.1021/jacs.8b00947
 13. J. M. P. Martirez, and E. A. Carter, Prediction of a Low-Temperature N₂ Dissociation Catalyst Exploiting Near IR-to-Visible Light Nanoplasmonics. **Science Advances**, **3**, eaao4710 (2017) DOI: 10.1126/sciadv.aao4710
- Featured in **Chemical & Engineering News**: “Lowering the temperature on nitrogen splitting” by Sam Lemonick, January 3, 2018.
- Featured in **Princeton Engineering News**: “New process could slash energy demands of fertilizer, nitrogen-based chemicals” by John Sullivan, January 12, 2018
12. R. B. Wexler, J. M. P. Martirez, and A. M. Rappe, Active Role of Phosphorus in the Hydrogen Evolving Activity of Nickel Phosphide (0001) Surfaces. **ACS Catalysis**, **7**, 7718-7725 (2017) DOI: 10.1021/acscatal.7b02761
 11. J. M. P. Martirez, and E. A. Carter, Excited-State N₂ Dissociation Pathway on Fe-Functionalized Au. **Journal of the American Chemical Society**, **139**, 4390-4398 (2017) DOI: 10.1021/jacs.6b12301
 10. D. F. Swearer, H. Zhao, L. Zhou, C. Zhang, H. Robotjazi, J. M. P. Martirez, C. M. Krauter, S. Yazdi, M. J. McClain, E. Ringe, E. A. Carter, P. Nordlander, N. J. Halas, Heterometallic Antenna-Reactor Complexes for Photocatalysis. **Proceedings of the National Academy of Sciences U.S.A.**, **113**, 8916-8920 (2016) DOI: 10.1073/pnas.1609769113
 9. R. B. Wexler, J. M. P. Martirez, and A. M. Rappe, Stable Phosphorus Enriched (0001) Surfaces of Nickel Phosphides. **Chemistry of Materials**, **28**, 5365-5372 (2016) DOI: 10.1021/acs.chemmater.6b01437
 8. J. M. P. Martirez, and E. A. Carter, Thermodynamic Constraints in Using AuM (M= Fe, Co, Ni and Mo) Alloys as N₂ Dissociation Catalysts: Functionalizing a Plasmon-Active Metal. **ACS Nano** **10**, 2940-2949 (2016) DOI: 10.1021/acsnano.6b00085
 7. Y. Qi, J. M. P. Martirez, W. A. Saidi, J.J. Urban, W.S. Yun, J.E. Spanier and A. M. Rappe, Modified Schottky emission to explain thickness dependence and slow depolarization in BaTiO₃ nanowires. **Physical Review B**, **91**, 245431 (2015) DOI: 10.1103/PhysRevB.91.245431
 6. J. M. P. Martirez, S. Kim, E. H. Morales, B. T. Diroll, M. Cargnello, T. R. Gordon, C. B. Murray, D. A. Bonnell, and A. M. Rappe, Synergistic Oxygen Evolving Activity of a TiO₂-rich Reconstructed SrTiO₃(001) Surface. **Journal of the American Chemical Society**, **137**, 2939-2947 (2015) DOI: 10.1021/ja511332y
 5. C. Baeumer, D. Saldana-Greco, J. M. P. Martirez, A. M. Rappe, M. Shim, and L. W. Martin, Ferroelectrically Driven Spatial Carrier Density Modulation in Graphene. **Nature Communications**, **6**:6136 (2015) DOI: 10.1038/ncomms7136
 4. W. A. Saidi*, J. M. P. Martirez*, and A. M. Rappe, Strong Reciprocal Interaction between Polarization and Surface Stoichiometry in Ferroelectric Oxides. **Nano Letters**, **14**, 6711-6717 (2014) DOI: 10.1021/nl5035013
 3. N. Koocher, J. M. P. Martirez, and A. M. Rappe, Theoretical Model of Oxidative Adsorption of Water on a Highly Reduced Reconstructed Oxide Surface. **Journal of Physical Chemistry Letters**, **5**, 3408-3414 (2014) DOI: 10.1021/jz501635f

2. E. H. Morales*, J. M. P. Martirez*, W. A. Saidi, A. M. Rappe, and D. A. Bonnell, Coexisting Surface Phases and Coherent One-Dimensional Interfaces on BaTiO₃(001). **ACS Nano** **8**, 4465-4473 (2014) DOI: 10.1021/nn501759g
1. J. M. P. Martirez, E. H. Morales, W. A. Saidi, D. A. Bonnell, and A. M. Rappe, Atomic and Electronic Structure of the BaTiO₃ (001) ($\sqrt{5} \times \sqrt{5}$) *R*26.6° Surface Reconstruction. **Physical Review Letters** **109**, 256802 (1-5) (2012) DOI: 10.1103/PhysRevLett.109.256802

Students Mentored

Alexander J. Tkalych, *graduate*, Princeton University, Fall 2017 – Spring 2018
Robert B. Wexler, *graduate*, University of Pennsylvania, Summer 2014 – present (ongoing mentoring and collaborations)
Joseph Abbate, *undergraduate*, Princeton University, Fall 2015 – Spring 2016
Nicole Belonzi, *graduate*, University of Pennsylvania, Summer 2014
Nathan Z. Koocher, *undergraduate*, University of Pennsylvania, Fall 2011 – Fall 2014

Recent Referee Services (while at Princeton)

Grant Proposal Review
Centro Svizzero di Calcolo Scientifico (CSCS, Swiss National Supercomputing Centre)

Scientific Article Review
ChemCatChem, Small, The Journal of Chemical Physics, Advanced Functional Materials, ACS Nano, Nano Letters, ACS Catalysis, Nature Nanotechnology, The Journal of Physical Chemistry Letters, Angewandte Chemie

Courses Taught

Undergraduate-level general, analytical, physical, and organic chemistry laboratory courses, University of the Philippines, Diliman, Philippines, 2006-2008

Presentations

Talks

14. **Invited:** “Ab initio modeling of light-driven catalysis on surface-doped plasmonic metals” **SciX 2018**, Atlanta, Georgia USA (October 24, 2018)
13. **Invited:** “Quantum mechanical description of excited-state catalysis on metals for nanoplasmonics” **255th American Chemical Society National Meeting and Exposition**, New Orleans, Louisiana USA (March 19, 2018)
12. **Invited seminar:** “Surface phenomena on metals and metal oxides through the lens of first-principles quantum mechanics”, School of Chemical and Biomedical Engineering, **Nanyang Technological University, Singapore** (December 12, 2017)
11. “Quantum Mechanical Description of Excited-State Heterogeneous Catalysis Via Embedded Correlated Wavefunction Methods” **2017 American Institute of Chemical Engineers Annual Meeting**, Minneapolis, Minnesota, USA (October 31, 2017)
10. “Plasmon-induced excited-state heterogeneous catalysis on surface-doped metallic nanoparticles” **253rd American Chemical Society National Meeting and Exposition**, San Francisco, California, USA (April 2017)

9. **Invited:** “Modeling Surface Phenomena via First-Principles Quantum Mechanics” **Center for Functional Nanomaterials, Brookhaven National Laboratory**, Upton, New York, USA (January 19, 2017)
8. **Invited:** “Excited-State Heterogeneous Catalysis on Metallic Nanoparticles” **2016 MRS Fall Meeting and Exhibit**, Boston, Massachusetts, USA (November 28 – December 2, 2016)
7. “Excited State Dissociation Pathway for N₂ on Fe-substituted Plasmon-Active Au” **AFOSR MURI Meeting**, Rice University, Houston, Texas, USA (May 2016)
6. **Invited:** “Role of charge-transfer excitations in Au-Fe alloys for heterogeneous N₂ dissociation catalysis” **251st American Chemical Society National Meeting and Exposition** (Computers in Chemistry), San Diego, California, USA (March 13-17, 2016)
5. “Dual active-site catalyst based on a single element for synergistic water-splitting”, **9th International Workshop on Oxide Surfaces (IWOX- IX)**, Granlibakken Conference Center, Tahoe City, California, USA (January 2014) *on behalf of Prof. Andrew M. Rappe*
4. “Thermodynamic and Kinetic Exploration of Surface Phase Coexistence on an Oxide Surface”, **9th International Workshop on Oxide Surfaces (IWOX- IX)**, Granlibakken Conference Center, Tahoe City, California, USA (January 2014)
3. “Polarization Dependent Reconstructions of Ferroelectric Surfaces”, **APS March Meeting**, Boston, Massachusetts, USA (March 1, 2012)
2. “Hydration phase diagram for BaO terminated BaTiO₃”, **APS March Meeting**, Dallas, Texas, USA (March 22, 2011)
1. “Theoretical study on the diffusion of hydroxyl radical on BaO terminated BaTiO₃(001) surface”, **APS March Meeting**, Portland, Oregon, USA (March 18, 2010)

Posters

11. “Discovering and Understanding New Catalytic Materials for Sustainable Chemical Conversion via Quantum Mechanics” Princeton E-affiliates Partnership 2018 Retreat, New York City, New York, USA (June 13, 2018)
10. “Understanding heterogeneous photochemical conversion processes from first principles” AFOSR 2018 Molecular Dynamics and Theoretical Chemistry Program Review, Albuquerque, New Mexico, USA (May 23, 2018)
9. “Excited-State Heterogeneous Catalysis on Surface-Doped Plasmonic Nanoparticles” *Gordon Research Conference – Dynamics at Surfaces*, Salve Regina University, Newport, RI, USA (July 30 - August 3, 2017)
8. “Modeling Local Excited States on Surface Reactive Sites: An Exploration of Plasmon-Catalyzed CH₄ Dehydrogenation on Ru-functionalized Cu and N₂ Dissociation on Fe-functionalized Au” *AFOSR MURI Review Meeting*, Rice University, Houston, Texas, USA (December 7, 2016)
7. “Surface Functionalization of Plasmon-Active Au for Sustainable Ammonia Synthesis” *Andlinger Center Building Opening Celebration and Symposium*, Princeton University, Princeton, New Jersey, USA (May 2016)
6. “TiO-rich reconstructions of BaTiO₃(001) surface: The thermodynamics and kinetics of surface defect agglomeration leading to phase coexistence.” *Dynamics, Interactions, and Electronic Transitions at Surfaces (DIET14 workshop)*, Pacific Grove, California, USA (October 2014)
5. “Synergistic Oxygen Evolving Activity of a Dual Active-site Catalysts Based on a Single Element”, *Gordon Conference - Dynamics at Surfaces*, Salve-Regina University, Rhode Island, USA (August 2013)

4. “Strong Reciprocal Interaction between Polarization and Surface Stoichiometry in Ferroelectric Oxides”, *International Workshop on Interfaces at Bear Creek*, Bear Creek Mountain Resort and Conference Center, Pennsylvania, USA (October 2012)
3. “Connection between relaxation of metastable polarization and time evolution of surface ion coverage in BaTiO₃ nanowires”, *2011 Workshop on the Fundamental Physics of Ferroelectrics and Related Materials*, Gaithersburg, Maryland, USA (January 2011)
2. “First principle investigation of hydrogen transfer between surface adsorbed H₂O and OH on BaO (001) surface of thin film BaTiO₃”, *ACS National meeting*, Boston, Massachusetts, USA (August 2010)
1. “First principles investigation of surface dynamics involving OH on thin-film BaTiO₃ surfaces”, *22nd Annual Workshop on Electronic Structure Methods*, Austin, Texas, USA (June 2010)