



WILLIAM & MARY

CHARTERED 1693

College of William and Mary
Curriculum Vitae

PERSONAL INFORMATION

Kristin L. Wustholz

October 1, 2019

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EDUCATION

Ph.D. in Chemistry with Nanotechnology, University of Washington 2007
Dissertation: "Single-Molecule Orientations and Photophysics
in Dyed Salt Crystals"
Research Advisors: Profs. Philip J. Reid and Bart Kahr

M.S. in Chemistry, University of Washington 2004
Research Advisors: Profs. Philip J. Reid and Bart Kahr

B.A.S. in Chemistry and Philosophy, Muhlenberg College 2002
Research Advisors: Profs. Marsha Baar and Bruce Anderson

ACADEMIC POSITIONS

Class of 1964 Distinguished Associate Professor, College of William & Mary 2017 – present
Faculty Fellow in the Center for the Liberal Arts, College of William & Mary 2017 – present
Associate Professor of Chemistry, College of William and Mary 8/16 – present
Assistant Professor of Chemistry, College of William and Mary 8/10 – 8/16
Postdoctoral Fellow, Department of Chemistry, Northwestern University 1/8 – 7/10
Research Advisor: Professor Richard P. Van Duyne

HONORS, PRIZES, AND AWARDS

Alumni Fellowship Award, College of William and Mary 2016
Dean's Distinguished Lecturer, College of William and Mary 2013-2014
Coco Faculty Fellow, College of William and Mary 2013-2014
CIBA Young Scientist Travel Award 2011
American Chemical Society Award for Excellence in Postdoctoral Research 2009
University of Washington Initiatives Fund Graduate Fellowship 2006 – 2007
National Science Foundation (NSF) CMDITR Graduate Travel Grant 2006
NSF IGERT Graduate Fellowship 2006
NSF CMDITR Graduate Fellowship 2005
NSF REU Fellowship, University of Michigan 2001
Bob and Carolyn Buzzard Fellowship, Muhlenberg College 2001
Presidential Merit Scholarship, Muhlenberg College 1998 – 2002

Dana Associates Scholarship, Muhlenberg College
PennColor Corporation Chemistry Scholarship

1998 – 2002
1998

COURSES TAUGHT

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| Chem. 100: Light at the Museum | F '18, '19 |
| Chem. 103L: General Chemistry I Lab | F '19 |
| Chem. 201: Color, Light & Chemistry | F '17 |
| Chem. 301: Physical Chemistry I | F '10, '11, '12 |
| Chem. 302: Physical Chemistry II | S '13, '15, '16 |
| Chem. 303: Integrated Physical & Analytical Lab I | F '15 |
| Chem. 304: Integrated Physical & Analytical Lab II | S '15, '16, '18, '19 |
| Chem. 401/501: Advanced Physical Chemistry | F '13, '15; S '18, '19, '20 |
| Chem. 391: Physical Chemistry Lab I | F '10, '11, '12, '13 |
| Chem. 392: Physical Chemistry Lab II | S '11, '12, '13, '14 |
| Chem. 652: Topics in Physical Chemistry | F '12 |
| Chem. 191: Freshman Honors Research | F '10, S '13, S '16 |
| Chem. 291: Chemical Research | F '10 to present |
| Chem. 409: Senior Research | F '11 to present |
| Chem. 495: Senior Honors Research | F '12 – S '14, F '15 – S '16 |
| Chem. 695: M.S. Research | F '11 – S '12, F '13 to present |

FELLOWSHIPS AND GRANTS

Funded External Grants

Henry Dreyfus Teacher-Scholar Award, "Development of Stimulus-Responsive SERS Probes for Biosensing," 8/1/18 – 7/31/23, \$60,000.

National Science Foundation, "SusChEM: Interfacial Interactions and Electron Transfer in Dye-Sensitized Systems for Photovoltaics and Photocatalysis," 7/1/17 – 6/30/20, \$286,000.

Eppley Foundation for Research, "Conservation of our Cultural Heritage: Surface-Enhanced Raman Analysis of Fugitive Pigments in Historic Paintings," 1/1/16 – 12/31/16, \$20,100.

Jeffress Memorial Trust, "Identification of Artists' Materials in Early American Cultural Heritage Objects using Surface-Enhanced Raman Spectroscopy," 1/1/15 – 12/31/15, \$10,000.

Muscarella Museum of Art, "SERS Studies of Synthetic Pigments in Copy of Tintoretto's *The Miracle of the Slave*" Honorarium, 2014-2015, \$1,000.

Research Corporation Multi-Investigator Cottrell College Science Award, "Developing Robust Systems for the Photogeneration of Hydrogen: A Combined Synthetic and Single-Molecule Spectroscopic Approach," co-PIs with W.R. McNamara (W&M Chemistry), 7/1/14 – 6/30/16, \$100,000 (\$75k award, \$25k departmental match, \$50k KW allocation).

Jeffress Memorial Trust Grant Renewal, "Identification of Artists' Materials in Early American Cultural Heritage Objects using Surface-Enhanced Raman Spectroscopy," 1/1/13 – 12/31/13, \$10,000.

American Chemical Society Petroleum Research Fund (ACS-PRF) Undergraduate New Investigator Award, "Probing Heterogeneous Electron Transfer Processes in Next-Generation Photovoltaics using Single-Molecule Spectroscopy," 9/1/11 – 8/31/13, \$50,000.

NASA Virginia Space Grant Consortium (VSGC) New Investigator Program, "Enhancing the

Electron Transfer Efficiency of Dye-Sensitized Solar Cells using Single-Molecule Microscopy,” 9/1/11 – 8/31/12, \$20,000 (\$10k award, \$10k institutional match).

Jeffress Memorial Trust, “Identification of Artists’ Materials in Early American Cultural Heritage Objects using Surface-Enhanced Raman Spectroscopy,” 7/1/11 – 6/30/13, \$25,000.

CIBA/YCC (Young Chemists’ Committee) Young Scientist Travel Award for ACS National Meeting, awarded 2/1/11, \$500.

Faculty sponsor for NASA VSGC Undergraduate STEM Research Scholarships: Jacquelyn Blake-Hedges (’13), 2011-2012, \$8,500; Kelly Kopera (’20), 2019-2020, \$8,500; Alana Ogata (’14), 2012-2013, \$8,500; John Rose (’16): 2014-2015, \$8,500; Natalie Wong (’14), 2013-2014, \$8,500. (\$10k total KW research allocation).

Internal Grants

William and Mary Faculty Summer Research Grant, “Surface-Enhanced Raman Studies of Pigment Mixtures in Historic Oil Paintings”, 2016, \$4,000.

William and Mary Faculty Summer Research Grant, “Probing Heterogeneous Electron Transfer Processes in Next-Generation Solar Cells using Single-Molecule Spectroscopy”, 2011, \$4,000.

SELECTED PUBLICATIONS

(W&M undergraduate students in bold, graduate students italicized)

Lynch, P.G.; *Richards, H.*; Wustholz, K.L. "Unraveling the Excited-State Dynamics of Eosin Y Photosensitizers Using Single-Molecule Spectroscopy," *J. Phys. Chem. A*, **2019**, *123* (13), 2592-2600. (Invited for virtual special issue "Young Scientists")

Farling, C. G.; **Fikse, K. M.**; Svoboda, S. A.; Wustholz, K. L. "Development of a quality assurance protocol for SERS-based identification of organic pigments in art," *Opt. Mater. Express*, **2019**, *9* (3), 1513-1519. (Invited original manuscript for themed issue on *Design, Manufacture, and Analysis of Photonic Materials for Historical and Modern Visual Arts*)

Burke, S. N.; **Farling, C. G.**; Svoboda, S. A.; Wustholz, K. L. Research with Undergraduates at the Intersection of Chemistry and Art: Surface-Enhanced Raman Scattering Studies of Oil Paintings. In *Raman Spectroscopy in the Undergraduate Curriculum*; Sonntag, M.D., Ed.; ACS Symposium Series 1305; American Chemical Society: Washington, DC, 2018; pp. 165-180.

Cassidy, J. P.; **Tan, J. A.**; Wustholz, K. L. “Probing the Aggregation and Photodegradation of Rhodamine Dyes on TiO₂,” *J. Phys. Chem. C*, **2017**, *121*(29), 15610–15618.

Tan, J. A.; **Garakyaraghi, S.**; **Tan, K. A.**; *Frano, K. A.*; **Crockett, H. M.**; **Ogata, A. F.**; Patterson, J. D.; Wustholz, K. L. "Contributions from Excited-State Proton and Electron Transfer to the Blinking and Photobleaching Dynamics of Alizarin and Purpurin," *J. Phys. Chem. C*, **2017**, *121*(1), 97-106.

Roark, B.; **Tan, J. A.**; Invanina, A.; Chandler, M.; Castaneda, J.; Kim, H. S.; Jawahar, S.; Viard, M.; Talic, S.; Wustholz, K. L.; Yingling, Y. G.; Jones, M.; Afronin, K. "Fluorescence Blinking as an Output Signal for Biosensing," *ACS Sensors*, **2016**, *1* (11), 1295-1300.

Tan, J. A.; **Rose, J. T.**; *Cassidy, J. P.*; **Rohatgi, S. K.**; Wustholz, K. L. “Dispersive Kinetics of Rhodamines on TiO₂: Impact of Structure and Driving Force on Single-Molecule Photophysics,” *J.*

Phys. Chem. C, **2016**, *120*, 20710-20720.

Roh, J.-Y.; Matecki, M. K.; Svoboda, S. A.; Wustholz, K. L. "Identifying Pigment Mixtures in Art using SERS: A Treatment Flowchart Approach," *Anal. Chem.* **2016**, *88*, 2028-2032.

Blake-Hedges, J. M.; Greenspan, S. H.; Kean, J. A.; McCarron, M. A.; Mendonca, M. L.; Wustholz, K. L. "Plasmon-Enhanced Fluorescence of Dyes on Silica-Coated Silver Nanoparticles: A Single-Nanoparticle Spectroscopy Study," *Chem. Phys. Lett.* **2015**, *635*, 328-333.

Mayhew, H. E.; Frano, K. A.; Svoboda, S. A.; Wustholz, K. L. "Using Raman Spectroscopy and Surface-Enhanced Raman Scattering to Identify Colorants in Art: an Experiment for an Upper-Division Chemistry Laboratory," *J. Chem. Educ.* **2015**, *92* (1), 148-152.

Frano, K. A.; **Mayhew, H. E.;** Svoboda, S. A.; Wustholz, K. L. "Combined SERS and Raman Analysis for the Identification of Red Pigments in Cross-Sections from Historic Oil Paintings," *Analyst*, **2014**, *139*, 6450-6455.

Wong, N. Z.; Ogata, A. F.; Wustholz, K. L. "Dispersive Kinetics from Single Emitters on TiO₂ Nanoparticle Films," *J. Phys. Chem. C*, **2013**, *117* (41), 21075-21085.

Mayhew, H. E.; Fabian, D. M.; Svoboda, S. A.; Wustholz, K. L. "Surface-Enhanced Raman Spectroscopy Studies of Yellow Organic Dyestuffs and Lake Pigments in Oil Paint," *Analyst*, **2013**, *138* (16), 4493-4499. (Invited original manuscript for themed issue on *Molecular analysis for art, archaeometry and conservation*)

Oakley, L. H.; Fabian, D. M.; Mayhew, H. E.; Svoboda, S. A.; Wustholz, K. L. "Pretreatment Strategies for SERS Analysis of Indigo and Prussian Blue in Aged Painted Surfaces," *Anal. Chem.* **2012**, *84*, 8006-8012.

Oakley, L. H.; Dinehart, S. A.; Svoboda, S. A.; Wustholz, K. L. "Identification of Organic Materials in Historic Oil Paintings Using Correlated Extractionless Surface-Enhanced Raman Scattering and Fluorescence Microscopy," *Anal. Chem.* **2011**, *83*, 3986-3989.

Kleinman, S. L.; Ringe, E.; Valley, N.; Wustholz, K. L.; Phillips, E.; Scheidt, K.; Schatz, G. C.; Van Duyne, R. P. "Single-Molecule Surface-Enhanced Raman Spectroscopy of Crystal Violet Isotopologues: Theory and Experiment," *J. Am. Chem. Soc.* **2011**, *133*, 4115-4122.

Kosuda, K. M.; Bingham, J. M.; Wustholz, K. L.; Van Duyne, R. P. "Nanostructures and Surface-Enhanced Raman Spectroscopy," In: *Comprehensive Nanoscience and Technology*, T. Odom, G. Wiederrecht, Eds., vol. 3, pp. 263-301, Oxford: Academic Press (2011).

Kleinman, S. L.; Bingham, J. M.; Henry, A.-I.; Wustholz, K. L.; Van Duyne, R. P. "Structural and Optical Characterization of Single Nanoparticles and Single-Molecule SERS," *Proc. SPIE* **2010**, *7757*, 77570J1-10.

Wustholz, K. L.; Henry, A.-I.; McMahon, J. M.; Freeman, R. G.; Valley, N.; Piotti, M. E.; Natan, M. J.; Schatz, G. C.; Van Duyne, R. P. "Structure-Activity Relationships in Nanoparticle Gold Dimers and Trimers for Surface-Enhanced Raman Spectroscopy" *J. Am. Chem. Soc.* **2010**, *132*, 10903-10910.

Wustholz, K. L.; Henry, A.-I.; Bingham, J. M.; Kleinman, S. L.; Freeman, R. G.; Natan, M. J.; Van Duyne, R. P. "Exploring single-molecule SERS and single-nanoparticle plasmon

microscopy,” *Proc. SPIE* **2009**, 7394, 7394031-73940310.

Barbon, A.; Bott, E. D.; Brustolon, M.; Fabris, M.; Kahr, B.; Kaminsky, W.; Reid, P. J.; Wong, S. M.; Wustholz, K. L.; Zanré, R. “Triplet States of the Non-Linear Optical Chromophore DCM in Single Crystals of Potassium Hydrogen Phthalate and Their Relationship to Single-Molecule Dark States,” *J. Am. Chem. Soc.* **2009**, *131*, 11548-11557.

Wustholz, K. L.; Brosseau, C. L.; Casadio, F.; Van Duyne, R. P. “Surface-Enhanced Raman Spectroscopy of Dyes: from Single Molecules to the Artists’ Canvas,” *Phys. Chem. Chem. Phys.* **2009**, *11*, 7350-7359; Cover article.

McMahon, J.; Henry, A.-I.; Wustholz, K. L.; Natan, M.; Freeman, G.; Van Duyne, R. P.; Schatz, G. C. “Gold Nanoparticle Dimer Plasmonics: Finite Element Method Calculations of the Electromagnetic Enhancement to Surface-Enhanced Raman Spectroscopy,” *Anal. Bioanal. Chem.* **2009**, *394*, 1819-1825.

Dieringer, J. A.; Wustholz, K. L.; Masiello, D. J.; Camden, J. P.; Kleinman, S. L.; Schatz, G. C.; Van Duyne, R. P. “Surface-Enhanced Raman Excitation Spectroscopy of a Single Rhodamine 6G Molecule,” *J. Am. Chem. Soc.* **2009**, *131*, 849-854.

Bullard, T.; Wustholz, K. L.; Bott, E. D.; Robertson, M.; Reid, P. J.; Kahr, B. “Role of Kinks in Dyeing Crystals: Confocal Luminescence Microscopy from Single Molecules to Square Centimeters,” *Cryst. Growth Des.* **2009**, *9*, 982-990.

Wustholz, K. L.; Sluss, D. R. B.; Kahr, B.; Reid, P. J. “Single-Molecule Microscopy Studies in Dyed Composite Materials,” *Int. Rev. Phys. Chem.* **2008**, *27*, 167-200.

Wustholz, K. L.; Bott, E.D.; Kahr, B.; Reid, P. J. “Memory and Spectral Diffusion in Single-Molecule Emission,” *J. Phys. Chem. C* **2008**, *112*, 7877-7885.

Wustholz, K. L.; Bott, E. D.; Isborn, C. M.; Li, X.; Kahr, B.; Reid, P. J. “Dispersive Kinetics from Single Molecules Oriented in Single Crystals of Potassium Acid Phthalate,” *J. Phys. Chem. C* **2007**, *111*, 9146-9156.

Wustholz, K. L.; Kahr, B.; Reid, P. J. “Single-Molecule Orientations in Dyed Salt Crystals,” *J. Phys. Chem. B* **2005**, *109*, 16357-16362.

Invited Talks

“Elucidating the Excited-State Dynamics of Eosin Y Photosensitizers: Aggregates to the Single-Molecule Limit,” Chemistry Department, Pennsylvania State University, State College, PA, 2/27/20.

“New Statistical Tools to Connect Single-Molecule Blinking to Physical Models,” Chemistry Department, Temple University, Philadelphia, PA, 2/4/20.

“Elucidating the Excited-State Dynamics of Eosin Y Photosensitizers using Single-Molecule Spectroscopy,” Inter-American Photochemical Society Meeting, Sarasota, FL, 1/2-1/5/20.

“Elucidating the Excited-State Dynamics of Eosin Y Photosensitizers using Single-Molecule Spectroscopy,” Chemistry Department, Lehigh University, Bethlehem, PA, 10/29/19.

“Stimuli-Responsive pH Sensing using EC-SERS,” Chemistry Department, Saint Mary’s University, Halifax, NS, Canada, 5/21/19.

“Stimuli-Responsive SERS Probes for Biosensing,” Chemistry Department, Saint Mary’s University, Halifax, NS, Canada, 3/2/18.

Keynote Speaker, “Investigating Fugitive Pigments in Art: from Identification to Photodegradation Mechanism,” Southeast Regional Meeting of the American Chemical Society (SERMACS), Charlotte, NC, 11/9/17.

“Heterogeneous Electron-Transfer Kinetics of Sensitizers on TiO₂: Insights from Single-Molecule Spectroscopy,” Department of Chemistry, University of North Carolina at Charlotte, Charlotte, NC, 10/12/17.

“Elucidating the excited-state proton and electron transfer processes in substituted anthraquinone dyes using single-molecule spectroscopy,” American Chemical Society (ACS) National Meeting, Washington, DC, 8/22/17.

“Undergraduate research at the interface of analytical chemistry and art conservation: SERS Studies of organic pigments in oil paintings,” ACS National Meeting, Washington, DC, 8/20/17.

“Collaboration at the Interface of Chemistry and Art Conservation: Surface-Enhanced Raman Spectroscopy of Pigments in Historic Oil Paintings,” Bridgewater College, Virginia ACS Meeting, Bridgewater, VA, 10/14/16.

“Dispersive Electron-Transfer Kinetics of Dyes on TiO₂: Insights from Single-Molecule Spectroscopy,” NC Photochem 2016, North Carolina State University, Raleigh, VA, 10/1/16.

“Probing the Photochemistry of Fugitive Organic Pigments,” Gordon Research Conference on Scientific Methods in Cultural Heritage Research, Newry, ME, 7/31/16 – 8/5/16.

“Finding Fugitive Pigments in Art,” Keynote Speaker, Colonial Athletic Association Conference, Williamsburg, VA, 4/16/16.

“Organic Pigments in Transatlantic 18th c. Oil Paintings: A Surface-Enhanced Raman Spectroscopy Study,” invited lecture with S. A. Svoboda, Virginia Association of Museums 2016 Conference, Williamsburg, VA, 3/12/16 – 3/15/16.

“Collaboration at the Interface of Chemistry and Art Conservation: Surface-Enhanced Raman Spectroscopy of Pigments in Historic Oil Paintings,” Department of Chemistry, Virginia State University, ACS Local Meeting, Petersburg, VA, 1/22/16.

“Detection of Natural and Synthetic Organic Colorants in Historic Oil Paintings using Surface-Enhanced Raman Spectroscopy,” Invited symposium speaker for ‘Raman in Cultural Heritage’ session, SciX 2015 Conference, Providence, RI, 9/27/15 – 10/2/15.

“Dispersive Electron-Transfer Kinetics from Single Emitters on TiO₂ Nanoparticle Films,” Department of Chemistry, Pennsylvania State University, University Park, PA, 4/11/14, cancelled due to travel concerns during late pregnancy.

“Collaboration at the Interface of Chemistry and Art Conservation: SERS Studies of Pigments in Historic Oil Paintings,” PittCon Conference 2014, Chicago, IL, 3/2/14.

“The Fugitive Color Red,” William and Mary Town & Gown lecture series, Williamsburg, VA,

2/13/14.

“Identification of Fugitive Organic Colorants in Historic Oil Paintings using Surface-Enhanced Raman Spectroscopy,” Department of Chemistry, Old Dominion University, Norfolk, VA, 10/10/13.

“Identification of Organic Colorants in Historic Oil Paintings using Surface-Enhanced Raman Spectroscopy,” Department of Molecular Biology and Chemistry, Christopher Newport University, Newport News, VA, 9/14/12.

“Pigments, Dyes and Chemical Fingerprints in Art Conservation,” ACS Webinar (Extreme Chemistry Series), <http://acswebinars.org/wustholz>, 5/31/12.

“Pigment Identification in Paintings: Collaborative Research at the Interface of Chemistry and Art Conservation,” Playing to the Galleries and Engaging New Audiences: The Public Face of Conservation; Meeting at the Colonial Williamsburg Foundation, Williamsburg, VA, 11/15/11.