EZRA L. CATES

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Education

- ***Yale University, 2013-2014***
  Postdoctoral Appointment, Chemical and Environmental Engineering

- ***Georgia Institute of Technology, 2013***
  Ph.D. in Environmental Engineering
  Thesis: "Development of Pr^{3+}-doped Visible-to-UVC Upconversion Materials for Antimicrobial Technologies"
  Advisor: Prog. Jaehong Kim

- ***University of North Carolina - Asheville (UNC-A), 2007***
  B.S. in Environmental Studies, with honors

Appointments

- Clemson University, Associate Professor, Environmental Engineering, **2020-**
- Clemson University, Assistant Professor, Environmental Engineering, **2014-2020**
- Yale University, Postdoctoral Associate, Chemical and Environmental Engineering, **2013-2014**

Research Interests

- Light-activated materials for sustainable technology
- Photocatalytic advanced oxidation for drinking water treatment and wastewater reuse
- Destructive treatment systems for per/polyfluorinated substances
- Vacuum ultraviolet sources and applications
- UVC disinfection and biofouling prevention

Awards and Honors

2021	UV Technology Paper of the Year, International Ultraviolet Society
2020	Best Feature Article of 2019, *Environmental Science & Technology*
2019	Early Career Award, Environmental Protection Agency STAR Program
2013	Best Student Paper, American Chemical Society National Meeting, Division of Environmental Chemistry
2011	Best Environmental Technology Article of 2011, *Environmental Science & Technology*

2010 Best Student Paper, American Chemical Society National Meeting, Division of Environmental Chemistry
2008 Georgia Power Fellowship in Environmental Engineering
2005 North Carolina Beautiful Fellowship in Pollution Control

Publications

1. Qanbarzadeh, M., L. DiGiacomo, E. Bouteh, M.M. Mason, B. Wang, M.S. Wong, **E.L. Cates**. **2023. "**An Ultraviolet/Boron Nitride Photocatalytic Process Efficiently Degrades Poly-/Perfluoroalkyl Substances in Complex Water Matrices". ***Environmental Science & Technology Letters*** 10 (8) 705.

2. Bentel, M.J., M.M. Mason, **E.L. Cates**. **2023.** "Synthesis of petitjeanite $Bi_3O(OH)(PO_4)_2$ photocatalytic microparticles: "Effect of synthetic conditions on crystal structure and activity towards degradation of aqueous perfluorooctanoic acid (PFOA)." ***ACS Applied Materials & Interfaces*** 15 (17), 20854.

3. Bouteh, E., M.J. Bentel, **E.L. Cates**. **2023** "Semiconductor-hydrophobic material interfaces as a new active site paradigm for photocatalytic degradation of perfluorocarboxylic acids". ***Journal of Hazardous Materials*** 453, 131437.

4. Torkzadeh, H., **E.L. Cates. 2021** "Biofilm growth under continuous UVC irradiation: Quantitative effects of growth conditions and growth time on intensity response parameters". ***Water Research***, 206:117707.
5. Yu, W., J. Chen, M. Ateia, **E.L. Cates**, M.S. Johnson. **2021** "Do Gas Nanobubbles Enhance Aqueous Photocatalysis? Experiment and Analysis of Mechanism". ***Catalysts***, 11(4) 511.
6. Torkzadeh, H., K.R. Zodrow, W.C. Bridges, **E.L. Cates**. **2021** "Quantification and modeling of the response of surface biofilm growth to continuous low intensity UVC irradiation". ***Water Research***, 193: 11689.
7. Qanbarzadeh, M., D. Wang, M. Ateia, S. P. Sahu, **E.L. Cates. 2021**. "Impacts of reactor configuration, degradation mechanism, and water matrices on perfluorocarboxylic acid treatment efficiency by the UV/$Bi_3O(OH)(PO_4)_3$ photocatalytic process. ***ACS E&T Engineering***, *in press*

8. **Cates, E.L.,** M. Qanbarzadeh, S. Sahu. **2021** "Comment on "Enhanced photocatalytic degradation of perfluorooctanoic acid using carbon-modified bismuth phosphate composite: Effectiveness, material synergy, and roles of carbon*".* ***Chemical Engineering Journal***. 404:127060
9. **Cates, E.L.,** H. Torkzadeh. **2019**. "Can incorporation of UVC LEDs into showerheads prevent opportunistic respiratory pathogens? – Microbial behavior and device design considerations. ***Water Research***. 168, 115163
10. Loeb, S.K., P.J. Alvarez, J.A. Brame, **E.L. Cates**, W. Choi, J. Crittenden, D.D. Dionysiou, Q. Li, G. Li-Puma, X. Quan, D.L. Sedlak, T.D. Waite, P. Westerhoff, J.H. Kim. **2019**. "The Technology Horizon for Photocatalytic Water Treatment: Sunrise or Sunset?". ***Environmental Science & Technology***, 53(6), 2937-2947.
11. Hodges, B. C., **E. L. Cates**, J.H. Kim. **2018**. "Challenges and prospects of advanced oxidation water treatment processes using catalytic nanomaterials." ***Nature Nanotechnology.*** 13(8): 642-650.
12. S.P. Sahu, M. Qanbarzadeh, M. Ateia, H. Torkzadeh, A.S. Maroli, **E. L. Cates**. **2018**. "Rapid Degradation and Mineralization of Perfluorooctanoic Acid by a New Petitjeanite $Bi_3O(OH)(PO_4)_2$ Microparticle Ultraviolet Photocatalyst." ***Environmental Science & Technology Letters****. 5* (8), 533-538.

13. Sahu, S.P., S.L. Cates, H.I. Kim, J.H. Kim, **E.L. Cates**. **2018**. "The myth of visible light photocatalysis using lanthanide upconversion materials". ***Environmental Science and Technology***. 52(5) 2973-2980.
14. Sahu, S.P., **E.L. Cates**. **2017.** "Radiocatalytic Efficiency and Mechanisms of Bismuth Complex Oxides". ***Journal of Physical Chemistry C.*** 121 (19) 10538–10545**.**
15. **Cates, E.L. 2017**. "Photocatalytic Water Treatment: So Where are We Going with This?" ***Environmental Science & Technology***. (Viewpoint). 51(2): 757-758.
16. Johnson, T.A., E.A. Rehak, S.P. Sahu, D.A. Ladner, and **E.L. Cates (Corresponding author). 2016. "**Bacteria Inactivation via X-ray-Induced UVC Radioluminescence: Toward in Situ Biofouling Prevention in Membrane Modules." ***Environmental Science & Technology***. 50(21): 11912-19921.
17. **Cates, E. L.** and F. Li. **2016**. "Balancing intermediate state decay rates for efficient Pr^{3+} visible-to-UVC upconversion: the case of β-$Y_2Si_2O_7$:Pr^{3+}." ***RSC Advances.*** 6(27): 22791-22796.

18. Moor, K. J., **Cates, E.L.**, Kim, J.H. **2016**. "Porous Silicon's Photoactivity in Water: Insights into Environmental Fate." ***Environmental Science & Technology.*** 50(2): 756-764.
19. **Cates, E. L.** and J.H. Kim. **2015**. "Bench-scale evaluation of water disinfection by visible-to-UVC upconversion under high-intensity irradiation." ***Journal of Photochemistry and Photobiology B.*** 153: 405-411.
20. **Cates, E. L. 2015**. "Comment on "Intimate Coupling of Photocatalysis and Biodegradation for Degrading Phenol Using Different Light Types: Visible Light vs UV Light"." ***Environmental Science & Technology*** 49(21): 13075-13076.
21. **Cates, E.L.**, A.P. Wilkinson, J.H. Kim. **2015**. "Visible-to-UVC upconversion efficiency and mechanisms of $Lu_7O_6F_9$:Pr^{3+} and Y_2SiO_5:Pr^{3+} ceramics". ***Journal of Luminescence,***160(2015) p. 202-209.
22. Park, G.W., M. Cho, **E.L. Cates**, J.H. Kim, D. Lee, B.T. Oh, J. Vinjé. **2014**. "Evaluation of fluorinated TiO_2 as an ambient light-activated antimicrobial surface for control of human norovirus". ***Journal of Photochemistry and Photobiology B.*** 140(0): 315-320.
23. Cates, S.L., **E.L. Cates**, M. Cho, J.H. Kim. **2014**. "Synthesis and characterization of visible-to-UVC upconversion antimicrobial ceramics". ***Environmental Science & Technology***, 48(4) p. 2290-2297.
24. **Cates, E.L**., J.H. Kim. **2013.** "Upconversion under polychromatic excitation: Y_2SiO_5:Pr^{3+},Li^+ converts violet, cyan, green, and yellow light into UVC." ***Optical Materials***, 35(12) p. 2347-2351.
25. **Cates, E.L.**, S.L. Chinnapongse, J.H. Kim, J.H. Kim. **2012**. "Engineering light: Advances in wavelength conversion materials for energy and environmental technology (Critical Review)". ***Environmental Science & Technology***, 46(22) p. 12316-12328.
26. **Cates, E.L.**, A.P. Wilkinson, J.H. Kim. **2012**. "Delineating mechanisms of upconversion enhancement by Li^+ doping in Y_2SiO_5:Pr^{3+}". ***Journal of Physical Chemistry C***, 116(23) p. 12772-12778.
27. **Cates, E.L.**, M. Cho, J.H. Kim. **2011**. "Converting visible light into UVC: Microbial inactivation by Pr^{3+}-activated upconversion materials". ***Environmental Science & Technology***, 45(8) p. 3680 – 3686. **"Best Environmental Technology Article of 2011"**
28. Cho, M., **E.L. Cates**, and J.H. Kim. **2011** "Inactivation and surface interactions of MS-2 bacteriophage in a TiO_2 photoelectrocatalytic reactor". ***Water Research***, 45(5) p. 2104 – 2110.

29. **Cates, E.L.**, S. Patch, J. Cox, M. Westphal, J. Calabria. **2009**. "Field evaluation of a proprietary stormwater treatment system: Removal efficiency and relationships to peak flow, season, and dry time". ***ASCE Journal of Environmental Engineering***, 135(7) p. 511-517.

Patents

1. Cates, E.L. “Materials and methods for reducing biofouling in water treatment membrane systems”. U.S. Patent 10023481B2

Funding

1. DoD SERDP Program, ER18-599, $200,000 limited scope + $1,011,507 follow-on. “Pilot Scale Assessment of a Deployable Photocatalytic Treatment System Modified with $BiPO_4$ Catalyst Particles for PFAS Destruction in Investigation-Derived Wastewaters”. 2018-2024.
2. NASA EPSCoR Program (co-investigator), 521365-CM, $700,535. “Peroxide-Producing Microbial Fuel Cells for Space Life Support Systems Applications”. 2019-2023
3. Environmental Protection Agency STAR Program, Early Career Award, RD839630, $458,469. “The BOHP/UV Process for Destruction of PFAS in Leachate and Groundwater: Tandem mechanistic advancement and pilot demonstration”. Aug. 2019 – July 2022.
4. NSF EAGER Program, CBET - 1551534, $64,214. “UVC microbial inactivation within model water treatment membrane modules via X-ray-driven radioluminescence”. Sep. 2015 – 2016.

Memberships

- American Chemical Society, Division of Environmental Chemistry
- Association of Environmental Engineering and Science Professors
- International Ultraviolet Association
- International Water Association
- American Water Works Association

Affiliations

- Center for Optical Materials Science and Engineering Technologies
- Clemson Water-Energy Consortium

Consulting

- Source tracking of PFAS contamination. SC State Attorney General. 2023-
- Design of UVC sterilization device. Global Center for Medical Innovation. 2015

Teaching

- EES 4010, Introduction to Environmental Engineering and Science
- EES 4840, Municipal Solid Waste Management
- EES 8030, Physicochemical Operations in Water and Wastewater Treatment Systems

Service

- Editorial Board Member, *UV Solutions*, Publication of the International Ultraviolet Society. 2018-
- Associate Editor, Journal of Hazardous Materials Advances, 2021-2022
- Member, Awards Committee, Association of Environmental Engineering and Science Professors, 2019-2021
- Moderator, “Electromagnetic Radiation in Water Treatment and Transformations” Symposium. AEESP biannual conference. Summer 2015
- Co-organizer, “Innovative Materials and Technologies for Water Purification” Symposium. American Chemical Society National Meeting. Division of Environmental Chemistry Spring 2016, Spring 2017