Michael P. Zach — Scientist, Innovator, Researcher

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Highly motivated and creative innovator seeking high impact interdisciplinary discoveries to advance important missions. Interested in expanding capabilities for isotope enrichment and transmutations that will enable higher production, lower costs and higher enrichment of stable isotopes or specific activity of radioisotopes. Able to use general chemistry, inorganic, analytical and instrumental methods with an engineering approach for discovering and characterizing micro and nanomaterials. Research has focused on preservation and augmenting the supply of enriched stable isotopes and precision manufacturing of nuclear targets. Able to effectively control small amounts of matter into desired forms. Numerous awards, patents, and scientific journal publications, as well as external funding, have recognized excellence in innovation and creative engineering approaches to solve problems.

EMPLOYMENT AND ACADEMIC HISTORY

Oak Ridge National Laboratory - Enrichment Science and Engineering Division 2015 to present
Materials Processing Researcher, Stable Isotope Materials & Chemistry Group

- Our working group is responsible for the stewardship of the nation's strategic reserve inventory of stable isotopes. I develop new approaches to making nuclear targets with physical and chemical preparation of ingots, rods, wires, sheets, foils, thin films and particles. We do whatever it takes to transform precious materials into optimized forms that will make researchers project successful. I build upon traditional techniques and develop new capabilities as needed.
- I am the lead developer for feedstock materials and perform method development for isotope separation campaigns.
- Solve materials and physics related challenges associated with ionizing, separating, harvesting, and analysis of isotopes with the newly re-developed Electromagnetic Isotope Separator (EMIS).

University of Wisconsin-Stevens Point 2006 to 2015
Assistant (2006-2012) & Associate (2012-2015) Professor of Chemistry with tenure

- Held joint appointment as **Guest Faculty Researcher (2006-2015)** at Argonne National Laboratory.
- Projects included development of the Electroplate and Lift Lithography nanowire deposition technique //bit.ly/EPL_Animation , development of STEM educational tools //bit.ly/NF_Lab, and electrodeposition of superconducting nanocrystals.

Argonne National Laboratory 2004 to 2006
Glenn Seaborg Postdoctoral Fellow, with Dr. Wai Kwok in the Superconductivity & Magnetism Group.

- Projects included developing a combinatorial electrodeposition system, creating an ultra fast hydrogen sensor, creating polymer microspheres for encapsulating chemotherapy drugs and magnetic nanoparticles for targeted drug delivery.

University of California, Berkeley 2002 to 2004
Miller Postdoctoral Fellow worked with Prof. Jill Banfield in Earth and Planetary Sciences and Dr. Jonathan Trent at NASA/Ames Research Center.

- Explored the interactions between microbes and minerals and using biological structures towards patterning inorganic materials.
- Projects included developing electrochemical atomic layer epitaxy (ECALE), anchoring biological templates and building an automated bioreactor for extremophile microbes.

University of California, Irvine 1997 to 2002
M.S. (2000) & Ph.D. in Chemistry (2002) with Prof. Reginald Penner, University of Calfornia, Irvine

- Dissertation: “Controlling Size Dispersity, Morphology and Spatial Orientation of Nanostructures by Electrodeposition and Chemical Vapor Deposition on Highly Oriented Pyrolytic Graphite.”

- Defects on single crystal graphite surfaces were exploited to nucleate nanometer to micron sized structures such as nanoparticles, nanowires and thin films.
- Tested fast and sensitive nanowire hydrogen sensors.

University of Wisconsin--Stevens Point. 1994 to 1997 and 1983-1984
B.S. in ACS certified Chemistry w/polymer option (1997)
- 3.48 GPA, Chancellor's Leadership Award for tutoring services and developing scientific glass studio

M. P. Zach – Custom Designed Jewelry 1988 to 1997
Goldsmith, Gemologist, Store Owner
- Owned and operated a retail store 1988 to 1994 in Monroe, WI specializing in hand-crafted, one-of-a-kind designed gemstone, gold, silver, and platinum jewelry
- Won multiple design awards from the Wisconsin Jewelers Association
- Continued design and creation as concierge jeweler 1994 to 1997 on nights and weekends while full-time student

AWARDS AND SPECIAL RECOGNITIONS

ORNL Community Outreach Award for work with YoSTEM! 2020
//bit.ly/YoSTEM_Award
Recognition by US Department of Energy for role in Ru-96 campaign 2018
//bit.ly/DOE_Appreciation_Award and //bit.ly/Ru-96 (also see article on Fusion Reactor Wall Erosion in same newsletter)
R&D100 Award for NanoFab Lab … in a Box!™ 2014
//bit.ly/2014_RD100_Award
NASA TECH Briefs Create the Future Challenge 2014
//bit.ly/NFL-1stPlace
Invited demonstration of NanoFab Lab to **US House of Representatives** NUFO Science Exhibition 2014
//bit.ly/NUFO-USHouse_2014
Cover image for **NSF's 2012 Budget Request to Congress** 2012
//bit.ly/NSF_Cover_2012
Cover of **ACS-Materials and Interfaces**, April 27, 2011 2011
//bit.ly/ACS_Cover
NSF CAREER Award Civil, Mechanical and Manufacturing Innovation's Nanomanufacturing Prgm. 2010
//bit.ly/NSF_CAREER_Award_Nanomanufacturing
NSF and **Science** magazine International Science & Engineering Visualization Challenge (SciVis) 2009
//bit.ly/Microbe_vs_Mineral
Wisconsin Innovation Scholar Award from WiSys Technology Foundation for high level research 2008
//bit.ly/WI_Scholar_Award
R&D100 and **Micro/NANO25** 2006
//bit.ly/2006_RD100_Worlds_Fastest_Hydrogen_Sensor

PROFESSIONAL AFFILIATIONS

- International Nuclear Target Development Society
- Society of Manufacturing Engineers
- Society for Electroanalytical Chemistry (lifetime member)

PUBLICATIONS

1 Duran, J. D. *et al.* 13C surface characterization of midplane and crown collector probes on DIII-D. *Nuclear materials and energy* **34**, 101339 (2023). https://doi.org:10.1016/j.nme.2022.101339

2 Voyles, A. S. *et al.* Preparation and Characterization of Thin Arsenic Targets for Stacked-Target Experiments. (2021). https://doi.org:10.48550/arxiv.2106.05524

3 Zamperini, S. *et al.* Transport of tungsten to collector probes in DIII-D. *Nuclear materials and energy* **18**, 87-92 (2019). https://doi.org:10.1016/j.nme.2018.12.013

4 Unterberg, E. A. *et al.* Use of isotopic tungsten tracers and a stable-isotope-mixing model to characterize divertor source location in the DIII-D metal rings campaign. *Nuclear materials and energy* **19**, 358-363 (2019). https://doi.org:10.1016/j.nme.2019.02.028

5 Unterberg, E. A. *et al.* Localized divertor leakage measurements using isotopic tungsten sources during edge-localized mode-y H-mode discharges on DIII-D. *Nucl. Fusion* **60**, 16028 (2019). https://doi.org:10.1088/1741-4326/ab537b

6 Duran, J. D. *et al.* Multiple Analytical Approach to Isotopic Transport Analysis in Magnetic Fusion Devices. *Fusion science and technology* **75**, 493-498 (2019). https://doi.org:10.1080/15361055.2019.1610316

7 Zamperini, S. et al. Transport of tungsten to collector probes in DIII-D. *Nuclear Materials and Energy* **18** 87-92 (2019) https://doi:10.1016/j.nme.2018.12.013.

8 Donovan, D. C. *et al.* Utilization of outer-midplane collector probes with isotopically enriched tungsten tracer particles for impurity transport studies in the scrape-off layer of DIII-D (invited). *Rev Sci Instrum* **89**, 10I115-110I115 (2018). https://doi.org:10.1063/1.5039347

9 Thomas, D. *et al.* Understanding tungsten divertor sourcing, SOL transport, and its impact on core impurity accumulation in DIII-D high performance discharges. *Europhysics Conference,* **45**, 2-6 (2018) https://www.osti.gov/servlets/purl/1489591

10 Doerner, R. P., Nishijima, D., Krasheninnikov, S. I., Schwarz-Selinger, T. & Zach, M. Motion of W and He atoms during formation of W fuzz. *Nucl. Fusion* **58**, 66005 (2018). https://doi.org:10.1088/1741-4326/aab96a

11 Nowotarski, J., Duran, J., Zach, M. & Donovan, D. *Transactions of the American Nuclear Society* **117** 370-373 (2017) https://www.osti.gov/servlets/purl/1456816

12 Holtrop, K. *et al.* The Design and Use of Tungsten Coated TZM Molybdenum Tile Inserts in the DIII-D Tokamak Divertor. *Fusion science and technology* **72**, 634-639 (2017). https://doi.org:10.1080/15361055.2017.1347456

13 Lukyanchuk, I. *et al.* Rayleigh instability of confined vortex droplets in critical superconductors. *Nature Physics* **11**, 21-25 (2015). https://doi.org:10.1038/nphys3146

14 Machovec, J. *et al.* Patterned Micro/ Nanowires by Electroplate and Lift Lithography on Reusable Ultrananocrystalline Diamond Template. *MRS Proc* **1478**, 8-13 (2012). https://doi.org:10.1557/opl.2013.193

15 Jones, D. *et al.* Electroplate-and-Lift (E&L) Lithography on Reusable, Patterned Ultrananocrystalline Diamond (UNCD) Templates for Rapid Prototyping of Micro- and Nanowires. *MRS Proc* **1412**, 14-19 (2012). https://doi.org:10.1557/opl.2012.664

16 Hohl, T. *et al.* Electrochemical Deposition of Bismuth Micro- and Nanowires Using Electroplate and Lift Lithography. *MRS Proc* **1477**, 1-6 (2012). https://doi.org:10.1557/opl.2012.1723

17 Grodek, C. *et al.* Deposition of Bronze Microwires on Ultrananocrystalline Diamond (UNCD) Electrodes. *MRS Proc* **1395**, 111-116 (2012). https://doi.org:10.1557/opl.2012.247

18 Seley, D. B. *et al.* Electroplate and Lift Lithography for Patterned Micro/Nanowires Using Ultrananocrystalline Diamond (UNCD) as a Reusable Template. *Acs Applied Materials & Interfaces* **3**, 925-930 (2011). https://doi.org:10.1021/am101226w

19 Photography. *Science (American Association for the Advancement of Science)* **327**, 954-955 (2010). https://doi.org:10.1126/science.327.5968.954

20 Rydh, A. *et al.* Magnetization of a few-fluxoid lead crystal. *Physica C-Superconductivity and Its Applications* **460**, 793-794 (2007). https://doi.org:10.1016/j.physc.2007.04.042

21 Xu, T. *et al.* Self-assembled monolayer-enhanced hydrogen sensing with ultrathin palladium films. *Applied physics letters* **86**, 203104-203104-203103 (2005). https://doi.org:10.1063/1.1929075

22 Zach, M. P., Newberg, J. T., Sierra, L., Hemminger, J. C. & Penner, R. M. Chemical Vapor Deposition of Silica Micro- and Nanoribbons Using Step-Edge Localized Water. *J. Phys. Chem. B* **107**, 5393-5397 (2003). https://doi.org:10.1021/jp034452k

23 Walter, E. C. *et al.* Metal nanowire arrays by electrodeposition. *Chemphyschem* **4**, 131-138 (2003). https://doi.org:10.1002/cphc.200390022

24 Zach, M. P., Inazu, K., Ng, K. H., Hemminger, J. C. & Penner, R. M. Synthesis of molybdenum nanowires with millimeter-scale lengths using electrochemical step edge decoration. *Chemistry of Materials* **14**, 3206-3216 (2002). https://doi.org:10.1021/cm020249a

25 Zach, M. P. *Controlling size dispersity, morphology and spatial orientation of nanostructures by electrodeposition and chemical vapor deposition on highly oriented pyrolytic graphite*, ProQuest Dissertations Publishing, (2002). https://www.proquest.com/docview/251632000

26 Walter, E. C. *et al.* in *Physical Chemistry of Interfaces and Nanomaterials* Vol. 4807 *Proceedings of the Society of Photo-Optical Instrumentation Engineers (Spie)* (eds J. Z. Zhang & Z. L. Wang) 83-92 (2002).

27 Walter, E. C. *et al.* Sensors from electrodeposited metal nanowires. *Surface and Interface Analysis* **34**, 409-412 (2002). https://doi.org:10.1002/sia.1328

28 Walter, E. C., Ng, K., Zach, M. P., Penner, R. M. & Favier, F. Electronic devices from electrodeposited metal nanowires. *Microelectronic Engineering* **61-2**, 555-561 (2002). https://doi.org:10.1016/s0167-9317(02)00582-8

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30 Zach, M. P. & Penner, R. M. Electrodeposition of molybdenum nanowires. *Abstracts of Papers of the American Chemical Society* **221**, U350-U350 (2001).

31 Zach, M. P., Ng, K. H., Favier, F. & Penner, R. M. Metal nanowires by electrodeposition. *Abstracts of Papers of the American Chemical Society* **222**, U106-U107 (2001).

32 Zach, M. P., Inazu, K., Hemminger, J. C. & Penner, R. M. Electrochemical Deposition of Molybdenum Nanowires for Use as Sensors. *Microscopy and microanalysis* **7**, 464-465 (2001). https://doi.org:10.1017/S1431927600028397

33 Markowitz, P. D., Zach, M. P., Gibbons, P. C., Penner, R. M. & Buhro, W. E. Phase Separation in Al x Ga1-x As Nanowhiskers Grown by the Solution−Liquid−Solid Mechanism. *J. Am. Chem. Soc* **123**, 4502-4511 (2001). https://doi.org:10.1021/ja0025907

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35 Liu, H., Favier, F., Ng, K., Zach, M. P. & Penner, R. M. Size-selective electrodeposition of meso-scale metal particles: a general method. *Electrochimica Acta* **47**, 671-677 (2001). https://doi.org:10.1016/s0013-4686(01)00747-2

36 Favier, F., Walter, E. C., Zach, M. P., Benter, T. & Penner, R. M. Hydrogen Sensors and Switches from Electrodeposited Palladium Mesowire Arrays. *Science* **293**, 2227-2231 (2001). https://doi.org:10.1126/science.1063189

37 Zach, M. P., Ng, K. H. & Penner, R. M. Molybdenum Nanowires by Electrodeposition. *Science* **290**, 2120-2123 (2000). https://doi.org:10.1126/science.290.5499.2120

38 Zach, M. P. & Penner, R. M. Nanocrystalline nickel nanoparticles. *Advanced Materials* **12**, 878-883 (2000). //bit.ly/Ni_particles

39 Markowitz, P. D., Buhro, W. E., Penner, R. M. & Zach, M. Possible compositional modulation in AlXGa(1-X)As nanowhiskers grown by the SLS process. *Abstracts of Papers of the American Chemical Society* **219**, U833-U833 (2000).

40 Zach, M. P. & Penner, R. M. Nanoscale introduction of nucleation sites for electrochemical/chemical synthesis of metal metal oxide semiconductor nanocrystals on HOPG substrates. *Abstracts of Papers of the American Chemical Society* **217**, U610-U610 (1999).

PATENTS

A.V. Sumant, M.P. Zach, A.D. Marten. **United States Patent, 9,903,033; 10,900,137** "Nanowire and microwire fabrication technique and product" 2018, 2021

M.P. Zach. **United States Patents 8,236,386, 8,652,615** "Nanowire and microwire fabrication technique and product" 2012, 2014

M.P. Zach. **United States Patent 8,058,627** "Addressable transmission electron microscope grid" 2011

T. Xu, M.P. Zach, Z. Xiao. **United States Patents 7,171,841, 7,389,671** "Ultrafast and ultrasensitive hydrogen sensors based on self-assembly monolayer promoted 2-dimensional palladium nanoclusters" 2007, 2008

R.M. Penner, M.P. Zach, F. Favier. **United States Patents 6,843,902; 7,220,346; 8,070,930** "Methods for fabricating metal nanowires" 2005, 2007, 2011

PRESENTATIONS

OUTREACH

FUNDING AWARDS

After 2015 at ORNL

- Laboratory Equipment upgrades, Crystal Bar 3687T1EQ, 48 Ton press 3687T2EQ, Tabletop SEM 3687T3EQ, Denton Furnace upgrade 3687T4EQ Powder Spheroidization, 3641RTAR
- QIS Si-28 Recovery R&D,
- Charged Particle Target Development for Th-229, 3641NPTD
- LDRD/SEED Nuclear Battery, 3X179NB2
- Core R&D Materials Conversion, 3641MCON

Thirty-four successful applications (of 58 submitted) for a total of $1,026,486 all prior to 2015.

- These were submitted while at an undergraduate-only institution. ($912,413 was external to UW-System).
- Most of the funding created opportunities for students and postdocs who performed the research and allowed their travel to research with top scientists at Argonne National Laboratory, Cornell Center for Nano Fabrication and University of Texas at Dallas.

Nine additional peer-reviewed proposals (of 10 submitted) granted access to Argonne National Laboratory's Center for Nanoscale Materials for use of facilities and consultation with their scientists.

EXTRACURRICULAR ACTIVITIES

- 200+ presentations made at 171 locations within the last 17 years to schools, universities, community groups and professional conferences – listing available by request
- Founded EChem Nanowires Educational Foundation, Inc. a 501(c)(3) non-profit organization dedicated to helping develop STEAM (Science, Technology, Engineering, Arts and Mathematics) opportunities for

students especially those in rural, inner-city and tribal schools. Closed foundation in 2016 due to complications in licensing technology from University of Wisconsin.

REFERENCES

Reginald M. Penner Thesis advisor **Associate Dean and Chancellor's Professor of Chemistry** 2137 Natural Sciences II University of California, Irvine Irvine, CA 92697 RMPenner@uci.edu (949) 824-8572	**Anirudha Sumant** Scientific collaborator to develop Electroplate and Lift Lithography **Materials Scientist, Center for Nanoscale Materials** Argonne National Laboratory 9700 S. Cass Ave. Argonne, IL 60439 Sumant@anl.gov (630) 252-4854	**Kristine Andrews** Mentor for government relations **UW-System Administration, Associate Vice President for Federal and Corporate Relations** 1764 Van Hise Hall 1220 Linden Drive Madison, WI 53706 kandrews@uwsa.edu (608) 263-3362
Wai Kwong-Kwok Postdoctoral mentor at Argonne Group Leader **Superconductivity and Magnetism Group** Argonne National Laboratory 9700 S. Cass Ave. Argonne, IL 60439 WKwok@anl.gov (630) 252-5539	**Brian Egle** Direct supervisor and current collaborator **Oak Ridge National Laboratory** One Bethel Valley Rd, MS-6329 Oak Ridge, TN 37831-6329 EgleB@ORNL.gov (865)574-0437	**Alan Tatum** Former direct supervisor **Oak Ridge National Laboratory** One Bethel Valley Rd, MS-6368 Oak Ridge, TN 37831-6329 TatumBA@ORNL.gov (865)574-4759