

# Dr. Charles A. Hirst

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## CURRICULUM VITAE

### Summary

Assistant Professor in the Department of Nuclear Engineering and Engineering Physics investigating the interplay between radiation damage, temperature, and stress in nuclear materials. Strong background coaching science communication for technical audiences.

### Education

- 2022–2024 University of Michigan, Ann Arbor, MI (USA)  
Postdoctoral Research Fellow. Supervisors: [Kevin Field](#) & [Gary Was](#).
- 2016–2022 Massachusetts Institute of Technology, Cambridge, MA (USA)  
PhD in Nuclear Science and Engineering. Supervisor: [Michael Short](#).
- 2011–2015 University of Oxford, Oxford (UK), *First Class Honors*  
MEng in Materials Science. Supervisor: [Michael Moody](#).

### Research Experience

- 2024–present University of Wisconsin-Madison, Madison, WI (USA)  
Nuclear Engineering and Engineering Physics Department (NEEP)  
Assistant Professor
- Investigating *in situ* ion irradiation mechanical testing (I<sup>3</sup>MT) at the UW Ion Beam Laboratory, including irradiation-tensile, -creep, and creep-fatigue experiments.
  - Investigating *in situ* ion irradiation differential scanning calorimetry (I<sup>3</sup>DSC) and *ex situ* DSC of nuclear materials.
  - Investigating thermal desorption spectroscopy (TDS) of implanted and irradiated surfaces for fusion plasma facing materials.
- 2022–2024 University of Michigan, Ann Arbor, MI (USA)  
Nuclear Engineering and Radiological Sciences Department (NERS)  
Postdoctoral Research Fellow
- Project: *Accelerated irradiation creep testing coupled with self-adaptive accelerated molecular dynamics for scalability analysis*. Supervisor: [Kevin Field](#).
  - Project: *The Neutron-Ion Handshake: Matching historical neutron and modern ion irradiations for forward projection of ARC structural material performance*. Supervisor: [Gary Was](#).

2016–2022 Massachusetts Institute of Technology, Cambridge, MA (USA)  
PhD Thesis title: ‘*Quantifying radiation damage through stored energy released during defect annealing in metals.*’ Supervisor: [Michael Short](#).

- Experimental and simulated annealing of neutron-irradiated Ti using differential scanning calorimetry and molecular dynamics.
- Simulated recovery of irradiated Al to determine parameter-space for statistically significant nanocalorimetry experiments.

2014–2015 University of Oxford, Oxford (UK)  
Master’s Thesis title: ‘*Atom probe tomography of unirradiated and proton irradiated Zircaloy fuel cladding.*’ Supervisor: [Michael Moody](#).

- Independently operated a Cameca Local Electrode Atom Probe 3000X HR and reconstructed data using the IVAS software.

## Scientific Contributions      Journal Publications

- 2025 5) R. C. Connick, **C. A. Hirst**, K. B. Woller, J. V. Logan, R. S. Kemp, M. P. Short, ‘*Measuring Very Low Radiation Doses in PTFE for Nuclear Forensic Enrichment Reconstruction*’ *Radiat. Phys. Chem.* 226 (2025) 112256 <https://doi.org/10.1016/j.radphyschem.2024.112256>
- 2024 L. Bonatti, S. Middlemas, **C. A. Hirst**, A. Navrotsky, ‘*Smaller and faster: a review of conventional and nanocalorimetry techniques for determining thermophysical properties of nuclear materials*’ *J Therm. Anal. Calorim.* (submitted)
- C. A. Hirst**, B. Kombaiah, I. L. Steigerwald, K. G. Field, M. P. Short, ‘*In situ TEM annealing of neutron-irradiated Ti reveals a mechanism for elevated temperature radiation damage recovery*’ *Scripta Mat.* (in prep)
- C. A. Hirst**, R. C. Connick, P. Cao, R. S. Kemp, M. P. Short, ‘*On the use of nanocalorimetry to measure radiation damage annealing in metals*’ *J. Nucl. Mater.* (in preparation)
- 2022 4) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, ‘*Revealing hidden defects through stored energy measurements of radiation damage*’ *Sci. Adv.* 8 31 (2022) eabn2733, <https://doi.org/10.1126/sciadv.abn2733>
- 3) **C. A. Hirst**, C. A. Dennett, ‘*Towards quantitative inference of nanoscale defects in irradiated metals and alloys*’ *Front. Mater.* 9 (2022) 888356, <https://doi.org/10.3389/fmats.2022.888356>
- 2020 2) M. Jiang, J. Kiyang, **C. A. Hirst**, C. C. Tasan, ‘*Effects of defect development during displacive austenite reversion on strain hardening and formability*’ *Metall. Mater. Trans. A* 51A (2020) 3832-3842, <https://doi.org/10.1007/s11661-020-05835-9>

- 2018 1) A. Harte, R. Prasath Babu, **C. A. Hirst**, T. Martin, P. Bagot, M. Moody, P. Frankel, J. Romero, L. Hallstadius, E. Darby, M. Preuss, '*Understanding irradiation-induced nanoprecipitation in Zr alloys using parallel TEM and APT*' J. Nucl. Mater. 510 (2018) 460-471, <https://doi.org/10.1016/j.jnucmat.2018.08.033>

### **Invited Presentations**

- 2024 9) **C. A. Hirst**, M. Warwick, W. Peterson, B. Arms, A. Chavira, F. Gao, K. G. Field, '*Accelerated Irradiation Creep Testing Coupled with Self-adaptive Accelerated Molecular Dynamics Simulations*', Invited seminar at the AMMT & ART Materials Program Review (USA), Argonne National Laboratory, Fremont IL, May 2024
- 8) **C. A. Hirst**, M. Warwick, W. Peterson, B. Arms, K. G. Field, '*In Situ Ion Irradiated Creep & Mechanical Testing at the Michigan Ion Beam Laboratory*', Invited talk at the Nuclear Science User Facilities (NSUF) Annual Program Review (Virtual), April 2024
- 7) **C. A. Hirst**, M. Warwick, W. Peterson, B. Arms, K. G. Field, '*Accelerated irradiation creep testing of structural materials for advanced reactors*', Invited talk at the Nuclear Science User Facility (NSUF) Users Organization Annual Meeting Orlando, FL (USA), March 2024
- 2023 6) **C. A. Hirst**, '*Advancing nuclear materials development through coupled extremes testing and characterization of defects' energetics*', Invited seminar at the University of Wisconsin-Madison (USA), May 2023
- 5) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Quantifying radiation damage in neutron-irradiated Ti through stored energy measurements*' Invited talk at the UKAEA, Culham (UK), April 2023
- 4) **C. A. Hirst**, '*Accelerating nuclear materials science through simultaneous environments and coupled characterisation*', Invited presentation at the University of Manchester (UK), March 2023
- 2022 3) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Revealing hidden defects through stored energy measurements of radiation damage*' Invited talk to the MIDAS programme (UK), October 2022
- 2) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Exploring the evolution of irradiation-induced defects through their energetic signatures*' Invited talk at MS&T 2022, Pittsburgh, PA (USA), October 2022
- 2021 1) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Revealing hidden defects through stored energy measurements of radiation damage*' Invited talk at MS&T 2021, Columbus, OH (USA), October 2021

## Conference Presentations

- 2024
- 15) **C. A. Hirst**, A. Penders, Z. Zhang, A. Flick, L. Clowers, V. Pauly, F. Naab, C. Dennett, M. P. Short, L. Garrison, G. Was, '*Accelerating ion irradiation sample throughput via lateral gas implantation gradients*', Talk at TOFE 2024, Madison, WI (USA), July 2024
- 14) **C. A. Hirst**, M. Warwick, W. Peterson, B. Arms, K. G. Field, '*Accelerated irradiation creep testing of structural materials for advanced reactors*', Talk at TMS 2024, Orlando, FL (USA), March 2024
- 2023
- 13) **C. A. Hirst**, R. Connick, P. Cao, R. S. Kemp, M. P. Short, '*Energy: a path forward to connect radiation damage simulations and experiments*' Talk at TMS 2023, San Diego, CA (USA), March 2023
- 12) **C. A. Hirst**, D. Shklover, S. Humphry-Baker, M. P. Short, '*Exploring irradiation-induced phase evolution in WC*' Talk at TMS 2023, San Diego, CA (USA), March 2023
- 2022
- 11) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Uncovering new mechanisms behind the high-temperature recovery of radiation damage in Ti*' Talk at NuMat 2022, Ghent (Belgium), October 2022
- 10) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Quantifying radiation damage through stored energy released during defect annealing in metals*' Poster at MRS Spring 2022, Honolulu, HI (USA), May 2022
- 9) **C. A. Hirst**, F. Granberg, B. Kombaiah, P. Cao, S. Middlemas, R. S. Kemp, J. Li, K. Nordlund, M. P. Short, '*Revealing hidden defects via stored energy measurements of radiation damage*' Talk at TMS 2022, Anaheim, CA (USA), March 2022
- 2020
- 8) **C. A. Hirst**, F. Granberg, P. Cao, S. Middlemas, G. Zheng, R. S. Kemp, J. Li, M. P. Short, '*Can we measure radiation damage through the energy stored in defects?*' Talk at NuMat 2020 (Virtual) October 2020
- 7) **C. A. Hirst**, P. Cao, J. Li, R. S. Kemp, M. P. Short, '*Direct measurement of radiation damage through the energy stored in defects*' Talk at TMS 2020, San Diego, CA (USA), March 2020
- 2019
- 6) **C. A. Hirst**, P. Cao, J. Li, R. S. Kemp, M. P. Short, '*Developing a method to measure radiation damage in metals using calorimetry*' Talk at the Mettler Toledo Flash DSC Conference, Zurich (Switzerland), November 2019
- 5) **C. A. Hirst**, P. Cao, J. Li, R. S. Kemp, M. P. Short, '*Developing a method to measure radiation damage using stored energy: simulations and experiments*' Talk at MiNES 2019, Baltimore, MD (USA), October 2019

- 2018
- 4) **C. A. Hirst**, R. C. Connick, K. P. So, P. Cao, R. S. Kemp, M. P. Short *'Developing a method to quantify radiation damage using stored energy'* Talk at NuMat 2018, Seattle, WA (USA), October 2018
  - 3) **C. A. Hirst**, R. C. Connick, K. P. So, P. Cao, R. S. Kemp, M. P. Short *'Developing a method to quantify radiation damage in materials using stored energy fingerprints'* Talk at ICONE 2018, London, (UK), July 2018
  - 2) **C. A. Hirst**, R. C. Connick, K. P. So, P. Cao, R. S. Kemp, M. P. Short *'Quantifying radiation damage using stored energy fingerprints'* Talk at TMS 2018, Phoenix, AZ (USA), March 2018
- 2017
- 1) **C. A. Hirst**, R. C. Connick, K. P. So, P. Cao, R. S. Kemp, M. P. Short *'Quantifying radiation damage using stored energy fingerprints'* Talk at the Mettler Toledo Flash DSC Conference, Zurich (Switzerland), November 2017

## Proposals

### Awarded

- 2024
- 6) Co-PI, *'In situ ion irradiation testing facilities for the investigation of nuclear materials under mechanical and thermal extremes'*, DOE NEUP-GSI, DE-FOA-0003040, 2024
- 2023
- 5) PI, *'Investigating the effect of solute segregation on defect recovery kinetics in reactor-irradiated Ti'* DOE NSUF-RTE, Project 23-4571, 2023
  - 4) Co-PI, *'Mechanism Driven Evaluations of Sequential and Simultaneous Irradiation-Creep-Fatigue Testing'* DOE NEUP-CINR, DE-FOA-0002732, 2023
  - 3) Co-PI, *'Increasing the Sensitivity of Passive SiC Thermometry Through Nanocalorimetry Experiments'* DOE NSUF RTE, Project 23-4676, 2023
  - 2) Co-PI, *'Quantifying the effect of simultaneous vs. sequential irradiation on creep performance of additively manufactured austenitic stainless steel'* DOE NSUF-RTE, Project 23-4654, 2023
- 2021
- 1) PI, *'Verifying Wigner energy measurements by in-situ TEM annealing of neutron-irradiated Ti'* DOE NSUF-RTE, Project 21-4238, 2021

### Awaiting Decision

- 2024
- 2) PI, *'In situ ion irradiation mechanical testing to inform physics-based modeling of irradiation creep mechanisms in Grade 91'* DOE, NEUP-CINR DE-FOA-0003309, 2024
  - 1) Co-PI, *'Sample preparation facilities to enable high quality in situ ion irradiation mechanical testing experiments'* DOE, NEUP-GSI DE-FOA-0003312, 2024

## Advising

- University of Wisconsin-Madison, Madison, WI (USA)
- 2024  
*Smeet Patel*, graduate student in Nuclear Engineering & Engineering Physics. *In situ* ion irradiation mechanical testing of structural alloys.  
*Dylan Kohler*, graduate student in Nuclear Engineering & Engineering Physics. Thermal desorption spectroscopy of plasma facing materials.
- 2023  
University of Michigan, Ann Arbor, MI (USA)  
*Ian Steigerwald*, undergraduate student in Nuclear Engineering and Radiological Sciences. Machine learning analysis of Ti annealing.  
*Lauryn Kortman*, undergraduate student in Nuclear Science and Engineering (MIT). Molecular dynamics of YBCO irradiation.
- 2022  
*Mackenzie Warwick*, graduate student in Nuclear Engineering and Radiological Sciences. Ion-irradiation creep experiments of 316L.  
*Wyatt Peterson*, graduate student in Nuclear Engineering and Radiological Sciences. Ion-irradiation creep-fatigue experiments.  
Massachusetts Institute of Technology, Cambridge, MA (USA)  
*Erick Liang*, undergraduate student in Nuclear Science and Engineering. Molecular dynamics of displacement cascades in Ti.  
*Claudia Miklavic*, undergraduate student in Nuclear Science and Engineering. Nanocalorimetry of recovery in cold-worked Cu.
- 2021  
*Paula Amadeo*, undergraduate student in Materials Science and Engineering. Nanocalorimetry of ion-beam deposited W.  
*Diana Shklover*, undergraduate student in Nuclear Science and Engineering. Multi-modal characterization of irradiated WC.

## Science Communication

- 2019–2022  
Massachusetts Institute of Technology, Cambridge, MA (USA)  
[Communication Lab Fellow](#), Nuclear Science & Engineering.
- Over 150 hours 1-on-1 coaching students & post-docs to improve their communication in presentations, posters & journal articles.
  - Authored several online CommKit articles: [Abstract](#), [Slide Design](#), [Delivery and Q&A](#), [Virtual Presentations](#).

## Teaching Experience

- 2024  
University of Wisconsin-Madison, Madison, WI (USA)  
Instructor, 'EP 271 [Engineering Problem Solving I](#)'
- Teaching a blended learning course with twice weekly Team Labs solving engineering problems using Maple and Python.

- 2023 University of Michigan, Ann Arbor, MI (USA)  
Guest Lecturer, 'NERS 521 *Radiation Materials Science I*'
- Independently taught two lectures on atomic displacement theory, NRT-dpa, the Kinchin-Pease model, and stopping powers.
- 2020 Massachusetts Institute of Technology, Cambridge, MA (USA)  
Teaching Assistant, '*Intro to Nuclear Engineering & Ionizing Radiation*'.
- Independently taught three lectures on radiation damage in metals, held weekly recitations and office hours.
  - Received stellar reviews (6.5/7.0) and outstanding comments.
- Teaching & Learning Lab: *Subject Design & Teaching Practice*.
- Created a syllabus using backward-design. Developed a unit-level assessment plan using student-centered learning outcomes.
  - Designed and delivered a lesson plan featuring active learning, scaffolding, and goal-directed practice.

## Awards

- Massachusetts Institute of Technology, Cambridge, MA (USA)
- 2020 *School of Engineering: Exponent Fellowship*  
Awarded in recognition of an outstanding academic record, exceptional background, and promising future.
- 2019 *Best Team Project* at the Oak Ridge National Laboratory  
Modelling, Experimentation, Validation (MeV) Summer school.
- University of Oxford, Oxford (UK)
- 2015 *RA Knox Memorial Prize*  
For outstanding achievement in Final Examinations.
- 2014 *Gibbs Prize for best overall performance in Part I*  
For achieving the highest mark in Final Examinations.
- 2013 *TATA Steel - Armourers & Brasiers' Company Prize*  
For best Team Design Project.
- 2012 *Rolls Royce - Armourers & Brasiers' Company Prize*  
For achieving one of the highest marks in Preliminary Examinations.

## Professional Memberships

- 2020–present Member – The Materials Society (TMS) Nuclear Materials Committee  
Member – TMS Nuclear Materials Subcommittee on Programming
- 2019–present Member – American Nuclear Society (ANS)
- 2018–present Member – The Materials Society (TMS)
- 2011–present Member – Institute of Materials, Minerals and Mining (IOM<sup>3</sup>)