

**CORINNE E. PACKARD**  
University of Southern California  
Mork Family Department of Chemical Engineering & Material Science  
[cpackard@usc.edu](mailto:cpackard@usc.edu)

## EDUCATION

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**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**, Cambridge, MA  
Ph.D. in Materials Science & Engineering, September 2008. Conferred 2/18/2009  
Dissertation: “Nanomechanical studies of metallic glasses at ambient and elevated temperatures”  
Advisor: Prof. Christopher A. Schuh  
Program: Structural and Environmental Materials    Minor: Mathematics

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**, Cambridge, MA  
B.S. in Materials Science & Engineering, May 2004

## PROFESSIONAL EXPERIENCE

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**UNIVERSITY OF SOUTHERN CALIFORNIA**, Los Angeles, CA  
2024-present    Professor, Mork Family Dept. of Chemical Eng. & Material Science  
Responsibilities: Teaching and Research in fundamental and applied metallurgical and materials engineering, Service to the university

**COLORADO SCHOOL OF MINES**, Golden, CO  
2024-present    Research Professor, Dept. of Metallurgical & Materials Eng.  
2023-2024    Full Professor, Dept. of Metallurgical & Materials Eng.  
2017-2023    Associate Professor, Dept. of Metallurgical & Materials Eng.  
2010-2017    Assistant Professor, Dept. of Metallurgical & Materials Eng.  
Responsibilities: Teaching and Research in fundamental and applied metallurgical and materials engineering, Service to the university

**NATIONAL RENEWABLE ENERGY LABORATORY**, Golden, CO  
2010-2024    Joint Appointment  
Responsibilities: Fundamental and applied research in renewable energy

**JOURNAL OF MATERIALS SCIENCE**, Springer Nature  
2017-2020    Editor

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**, Cambridge, MA  
2008-2010    Post-doctoral Associate, Advisor: Prof. Vladimir Bulovic  
Responsibilities: Fundamental and applied research in flexible electronics

**AWARDS, HONORS, AND RECOGNITION**

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- **Invited speaker, Gordon Research Conference on Structural Nanomaterials 2022**  
One of only 22 speakers at an international conference held in Les Diablerets, Switzerland, with fewer than 50% of speakers from the U.S..
- Article in *Applied Physics Reviews* selected as “Featured Article” and highlighted with a “SciLight”, 2022
- Best poster award for presentation at the 49<sup>th</sup> IEEE Photovoltaic Specialists Conference, 2022
- 1<sup>st</sup> place poster award for presentation at the International Conference and Expo on Advanced Ceramics and Composites, 2021
- **Colorado School of Mines Faculty Excellence Award 2019**  
Highest annual award at Mines, given to a single faculty member, for demonstrated significant and meritorious achievement in teaching and scholarship during the immediately preceding calendar years
- **AIME Robert Lansing Hardy Award 2017**  
The Hardy Award annually recognizes a single young person in the broad fields of metallurgy and materials science for exceptional promise of a successful career. My award citation reads: “For exceptional promise in determining mechanical behavior of materials at diminishing length scales across the spectrum of metals, ceramics, and glasses.”
- **National Academy of Engineering U.S. Frontiers of Engineering Symposium 2016**  
Consists of 83 participants (invitation only) from academia, industry, and government
- **NSF Early Career Faculty Development Award 2014**  
Award description: “The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations.”-from nsf.gov
- **2014 TMS Structural Materials Division Young Leader Professional Development Award**  
Award description: “The TMS Young Leaders Professional Development Award was created to enhance the professional development of dynamic young people from TMS’s five technical divisions by helping them participate in Society activities, become better acquainted, make important contacts with TMS leaders, and network with prominent Society members.”- from tms.org
- Poster award for presentation at the 2013 Photovoltaic Module Reliability Workshop
- **Invited speaker, Gordon Research Conference on Thin Film Mechanical Behavior, 2012**  
One of only 19 speakers, ~70% of speakers from the U.S.
- Poster award for presentation at the 2012 Photovoltaic Module Reliability Workshop
- NSF ADVANCE Fellowship, Purdue Conference for Pre-Tenure Women 2010  
Description: Travel fellowship for participation in a workshop for career planning for pre-tenure women
- Ida M. Green MIT Institute Fellowship 2004

Description: 9-month fully supported fellowship for entering graduate student; maximum of two nominations per department per year

- National Science Foundation Graduate Research Fellowship Honorable Mention 2003, 2004

## RESEARCH ACCOMPLISHMENTS

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- **Developed and matured an independent research program** in fundamental and applied mechanics of materials, with focus on ceramics for solar energy, electronics, and aerospace.
- **Engineered fracture in photovoltaic semiconductors to enable dramatic cost reduction** through wafer reuse. Developed a low-cost electroplating-based process, scaled the technology to 4" wafer scale, achieved epitaxial growth of single junction devices with efficiencies of >23%, and acquired funding from DOE, DOD, AFRL, and industrial sponsors.
- **Identified complex deformation phenomena in rare-earth orthophosphate ceramics** including reversible, superelastic twinning behavior and shear-stress-induced reduction of the activation requirements for pressure-induced phase transformation. These phenomena have important implications for vibration damping and ceramic matrix composite performance for high-temperature aerospace applications.
- **Discovered and optimized new materials** to design for durability in transparent conducting oxides for photovoltaics and flexible electronics and metallic glass-based wear coatings. Established methods for high-fidelity, high-throughput mechanical property measurements, used on large-scale grants with multiple institutions.
- **Established an internationally approved protocol for inspection of fielded solar modules** through independent and collaborative work. The work has been widely cited, adopted, and adapted internationally for visual inspection of industrial and residential solar installations.
- **Early work established fundamental aspects of strain localization in amorphous metals.** Established a criterion for shear band formation and first to discover that sub-threshold, apparently elastic, mechanical cycling results in strength-increasing local structural changes.
- **Transformation of basic science research into science-guided technology development** in the areas of microelectronics, solar energy, and aerospace ceramics, resulting in 4 issued and 3 additional provisional US patents.
- **Projects/Funding** - Personal share of research funds: \$7M; Total research funds into Colorado School of Mines: \$10.8M; Involvement in \$34M funding into Mines and other institutions in total. Large scale collaborations with other institutions: NREL, SLAC. Funded industrial contracts with Spectrolab & Microlink, 2 of the 3 US suppliers of III-V solar cells. Notable grant awards: AFRL/ManTech's Manufacturing Science and Technology Program (PI), NSF CAREER, NSF MRI: ToF-SIMS acquisition (PI), ARPA-E (co-PI/Mines PI), NSF DMREF (co-PI), US DoEd GAANN (co-PI), NSF Nanotechnology in Undergraduate Education (NUE) (lead PI), DOE & AFRL awards via NREL subcontracts (Mines PI)

**PUBLICATIONS**

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**GOOGLE SCHOLAR CITATIONS** (Corinne E. Packard): **2811**, **H-index: 24**, **i10-index: 42**  
<https://scholar.google.com/citations?user=yHsbyDQAAAAJ&hl=en>

**WEB OF SCIENCE CITATIONS** (Packard, Corinne E.): **1357**, **H-index: 18**  
**Web of Science ResearchID: A-9606-2010**  
<https://www.webofscience.com/wos/author/record/1092798>

ORCID: 0000-0002-5815-8586  
<https://orcid.org/0000-0002-5815-8586>

Refereed Journals

(\*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding, %: Undergraduate researchers under my supervision)

1. Sharma, J.\*, Reynolds, B.\*, Crane, M.J., **Packard, C.E.**, “Revealing the pressure-induced phase transformation of xenotime TbPO<sub>4</sub> via in situ photoluminescence spectroscopy.” *Journal of Physical Chemistry Letters*, 15 (16), 4294-4300, 2024  
*Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1021/acs.jpcllett.4c00196>
2. McMahon, W.E., Braun, A.K.\*, Perna, A.N.\*, Coll, P.G., Schulte, K.L., Boyer, J.T., Neumann, A.N., Geisz, J.F., Warren, E.L., Ptak, A.J., Merkle, A.P., Bertoni, M.I., **Packard, C.E.**, Steiner, M.A., “In situ smooth of facets on spalled GaAs (100) substrates during OMVPE growth of III-V epilayers, solar cells, and other devices: The impact of surface impurities/dopants.” *Crystal Growth & Design*, 24 (8), 3218-3227, 2024  
*Contribution: participated in method design, assisted in analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1021/acs.cgd.3c01407>
3. Sharma, J.\*, **Packard, C.E.**, “Uncovering the Effects of Non-Hydrostaticity on Pressure-Induced Phase Transformation in Xenotime-Structured TbPO<sub>4</sub>.” *Solids*, 5(1), 110-122, 2024  
*Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.3390/SOLIDS5010008>
4. Braun, A.K.\*, Boyer, J.T., Schulte, K.L., McMahon, W.E., Simon, J., Perna, A.N.\*, **Packard, C.E.**, Ptak, A.J., “24% Single-Junction GaAs Solar Cell Grown Directly on Growth-Planarized Facets Using Hydride Vapor Phase Epitaxy.” *Advanced Energy Materials*, 14(3), 2392935, 2024  
*Contribution: conceived methods, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1002/AENM.202302035>

5. Boardman, S.\*, **Packard, C.E.**, “Linking flexural strength and strength-limiting flaws in additively manufactured alumina with print parameter variations.” *Journal of the American Ceramic Society*, 107 (2), 1185-1200, 2024 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1111/JACE.19493>
6. Perna, A.N.\*, Schulte, K.L., Simon, J., Braun, A.K.\*, Diercks, D.R., **Packard, C.E.**, Ptak, A.J., “Light-trapping structures fabricated in situ for ultrathin III-V solar cells.” *Journal of Applied Physics* 134, 135307, 2023 *Contribution: participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1063/5.0160559> Minor correction at  
<http://dx.doi.org/10.1063/5.0181050>
7. Boardman, S.\*, **Packard, C.E.**, “Strength of Additively Manufactured Alumina with Different Debinding and Sintering Heat Treatments.” *Journal of the American Ceramic Society*, 106 (7), 4076-4088, 2023 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1111/jace.19094>
8. Boyer, J.T., Braun, A.K.\*, Schulte, K.L., Simon, J., Johnston, S.W., Guthrey, H.L., Steiner, M.A., **Packard, C.E.**, Ptak, A.J., “Analysis of Crystalline Defects Caused by Growth on Partially Planarized Spalled (100) GaAs Substrates.” *Crystals* 13 (4), 681, 2023 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.3390/cryst13040681>
9. Braun, A.K.\*, Schulte, K. L., Simon, J., Ptak, A. J., **Packard, C. E.**, “Design of Planarizing Growth Conditions on Unpolished and Faceted (100)-Oriented GaAs Substrates Using Hydride Vapor Phase Epitaxy,” *Crystal Growth & Design*, 8, 2023 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1021/acs.cgd.2c01296>
10. Sharma, J. \*, Afful, H. Q.\*, **Packard, C. E.**, "Phase Transformation Pathway of DyPO4 to 21.5 GPa." *Crystals*, 13, 249, 2023 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.3390/cryst13020249>
11. Mangum, J.S., Rice, A.D., Chen, J.^, Chenenko, J. \*, Wong, E.W.K., Braun, A.K.\*, Johnston, S., Guthrey, H., Geisz, J.F., Ptak, A.J., **Packard, C.E.**, “High-efficiency solar cells grown on spalled germanium for substrate reuse without polishing.” *Advanced Energy Materials*, 2201332, 2022 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1002/aenm.202201332>

12. Metaferia, W., Chenenko, J.\*, **Packard, C.E.**, Wong, E.W.K., Ptak, A.J., Schulte, K.L., “(110)-oriented GaAs devices and spalling as a platform for low-cost III-V photovoltaics.” *IEEE Journal of Photovoltaics*, 12 (4), 962-967, 2022 *Contribution: participated in data analysis and interpretation, conceived and designed the work, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1109/JPHOTOV.2022.3161869>
13. Sarker, S., Tang-Kong, R., Schoeppner, R., Ward, L., Al Hasan, N., Van Campen, D.G., Takeuchi, I., Hattrick-Simpers, J., Zakutayev, A., **Packard, C.E.**, Mehta, A., “Discovering exceptionally hard and wear-resistant metallic glasses by combining machine-learning with high throughput experimentation.” *Applied Physics Reviews*, 9, 011403, 2022 *Contribution: participated in data analysis and interpretation, conceived and designed the work, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1063/5.0068207>  
*\* identified as ‘featured article’*
14. Cavalli, A., Alkurd, N.\*, Johnston, S., Diercks, D.R., Roberts, D.M., Ley, B.E.\*, Simon, J., Young, D.L., **Packard, C.E.**, Ptak, A.J., “Performance of III-V solar cells grown on reformed mesoporous Ge templates.” *IEEE Journal of Photovoltaics*, 12 (1), 337-343, 2022 *Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1109/JPHOTOV.2021.3120514>
15. Braun, A.K.\*, Theingi, S., McMahon, W.E., Ptak, A.J., **Packard, C.E.**, “Controlled spalling of (100)-oriented GaAs with a nanoimprint lithography interlayer for thin-film layer transfer without facet formation.” *Thin Solid Films*, 742, 139049, 2022 *Contribution: corresponding author, designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1016/j.tsf.2021.139049>
16. Schulte, K.L., Diercks, D., Guthrey, H. Young, M., **Packard, C.E.**, Simon, J., Ptak, A.J., “Inverted metamorphic GaInAs solar cell grown by dynamic hydride vapor phase epitaxy.” *Applied Physics Letters*, 119 (9), 092101, 2021 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1063/5.0061350>
17. Metaferia, W., Braun, A.K.\*, Simon, J., **Packard, C.E.**, Ptak, A.J., Schulte, K.L., “Control of surface morphology during the growth of (110)-oriented GaAs by Hydride Vapor Phase Epitaxy.” *Crystal Growth & Design*, 21 (7), 3916-3921, 2021 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1021/acs.cgd.1c00235>
18. Sharma, J.\*, Musselman, M.\*, Haberl, B., **Packard, C.E.**, “In situ synchrotron diffraction of pressure-induced phase transition in DyPO<sub>4</sub> under variable hydrostaticity.” *Physical Review B*, 103 (18), 184105, 2021 *Contribution: corresponding author, conceived and designed the*

work, participated in data analysis and interpretation, revised the manuscript, obtained funding.

<http://dx.doi.org/10.1103/PhysRevB.103.184105>

19. Chen, J.<sup>^</sup>, Cherenko, J.\*, **Packard, C.E.**, “Impacts of mode mixity on controlled spalling of (100)-oriented germanium.” *JOM*, 73 (6), 1607-1616, 2021 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1007/s11837-021-04639-5>  
**\* in special focus issue “100 Years of the Griffith Fracture Criteria”**
  
20. Chen, J.<sup>^</sup>, **Packard, C.E.**, “Controlled spalling-based mechanical substrate exfoliation for III-V solar cells: A review.” *Solar Energy Materials & Solar Cells*, 225, 111018, 2021 *Contribution: corresponding author, conceived the review, participated in data analysis and interpretation, drafted the manuscript, obtained funding.*  
<http://dx.doi.org/10.1016/j.solmat.2021.111018>  
**\*cited more than 20 times (Google Scholar)**
  
21. Schulte, K.L., Diercks, D.R., Guthrey H.L., Mangum, J.S., **Packard, C.E.**, Metaferia, W., Simon, J., Ptak, A.J., “Compositionally graded Ga<sub>(1-x)</sub>In<sub>(x)</sub>P buffers grown by static and dynamic hydride vapor phase epitaxy at rates up to 1 μm/min.” *Applied Physics Letters*, 118 (5), 052106, 2021 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1063/5.0040605>
  
22. Schulte, K.L., Diercks, D.R., Roberts, D.M., Dippo, P.C., **Packard, C.E.**, Simon, J., Ptak, A.J., “Effect of hydride vapor phase epitaxy growth conditions on the degree of atomic ordering in GaInP.” *Journal of Applied Physics*, 128, 025704, 2020 *Contribution: participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1063/5.0010680>
  
23. Wu, D.<sup>^</sup>, Chen, Y.<sup>^</sup>, Manna, S.\*, Talley, K.\*, Zakutayev, A., Brennecka, G.L., Ciobanu, C.V., Constantine, P., **Packard, C.E.**, “Characterization of elastic modulus across the (Al<sub>(1-x)</sub>Sc<sub>(x)</sub>)N system using DFT and substrate-effect-corrected nanoindentation.” *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, 65 (11) 2167-2175, 2018 *Contribution: corresponding author, conceived and designed the work, developed data analysis tools, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1109/TUFFC.2018.2862240>  
**\*cited more than 20 times**
  
24. Jain, N., Simon, J., Schulte, K.L., Friedman, D.J., Diercks, D.R., **Packard, C.E.**, Young, D.L., Ptak, A.J., “Tunable bandgap GaInAsP solar cells with 18.7% photoconversion efficiency synthesized by low-cost and high-growth rate hydride vapor phase epitaxy.” *IEEE Journal of Photovoltaics*, 8 (6) 1577-1583, 2018 *Contribution: participated in data analysis and interpretation, revised the manuscript.*

<http://dx.doi.org/10.1109/JPHOTOV.2018.2865172>

25. Jain, N., Crouse, D.\* , Simon, J., Johnston, S., Siol, S., Schulte, K., **Packard, C.**, Young, D.L., Ptak, A.J., “III-V solar cells grown on unpolished and reusable spalled Ge substrates.” *IEEE Journal of Photovoltaics*, 8 (5), 1384-1389, 2018 *Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1109/JPHOTOV.2018.2851283>
26. Musselman, M.A.\* , Wilkinson, T.M.\* , Haberl, B., **Packard, C.E.**, “In situ Raman spectroscopy of pressure-induced phase transformations in polycrystalline TbPO<sub>4</sub>, DyPO<sub>4</sub>, and GdxDy(1-x)PO<sub>4</sub>.” *Journal of the American Ceramic Society*, 101 (6), 2562-2570, 2018 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1111/jace.15374>
27. Crouse, D.\* , Simon, J., Schulte, K.L., Young, D.L., Ptak, A.J., **Packard, C.E.**, “Increased fracture depth range in controlled spalling of (100)-oriented germanium via electroplating.” *Thin Solid Films*, 649, 154-159, 2018 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1016/j.tsf.2018.01.031>
28. Wilkinson, T.M.\* , Wu, D.^ , Musselman, M.A.\* , Li, N., Mara, N., **Packard, C.E.**, “Mechanical behavior of rare-earth orthophosphates near the monazite/xenotime boundary characterized by nanoindentation.” *Materials Science & Engineering: A*, 691, 203-210, 2017 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1016/j.msea.2017.03.041>
29. Schulte, K.L., Simon, J., Mangum, J.\* , **Packard, C.E.**, Gorman, B.P., Jain, N., Ptak, A.J., “Development of GaInP solar cells grown by hydride vapor phase epitaxy.” *IEEE Journal of Photovoltaics*, 7, 4, 1153-1158, 2017 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1109/JPHOTOV.2017.2691659>  
**\*cited more than 20 times**
30. Wilkinson, T.M.\* , Musselman, M.A.\* , Boatner, L.A., Diercks, D.R., **Packard, C.E.**, “Indentation recovery in GdPO<sub>4</sub> and observation of deformation twinning.” *AIP Advances*, 6 (9), 095029, 2016 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1063/1.4964356>
31. Ndione, P.F., Zakutayev, A., Kumar, M.^ , **Packard, C.E.**, Berry, J.J., Perkins, J.D., Ginley, D.S., “Tuning the physical properties of amorphous In-Zn-Sn-O thin films using combinatorial sputtering.” *MRS Communications*, 6 (4), 360-366, 2016 *Contribution:*



*conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*

<http://dx.doi.org/10.1557/mrc.2016.57>

32. Zargari, S.\*, Wilkinson, T.M.\*, **Packard, C.E.**, Prasad, M., “Effect of thermal maturity on elastic properties of kerogen.” *Geophysics*, 81 (2), 2016 *Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1190/geo2015-0194.1>  
**\*cited more than 50 times**
33. Sweet, C.A.\*, Schulte, K.L., Simon, J.D., Steiner, M.A., Jain, N., Young, D.L., Ptak, A.J., **Packard, C.E.**, “Controlled exfoliation of (100) GaAs-based devices by spalling fracture.” *Applied Physics Letters*, 108 (1), 2016 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1063/1.4939661>  
**\*cited more than 50 times**
34. Kumar, N., Wilkinson, T.M.\*, **Packard, C.E.**, Kumar, M., “Design of low surface roughness-low residual stress-high optoelectronic merit a-IZO thin films for flexible OLEDs.” *Journal of Applied Physics*, 119, 2016 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1063/1.4953212>
35. Spataru, S., Hacke, P., Sera, D., **Packard, C.**, Kerekes, T., Teodorescu, R., “Temperature-dependency analysis and correlation methods of in-situ power-loss estimation for crystalline silicon modules undergoing potential-induced degradation stress testing.” *Progress in Photovoltaics*, 23,11, 2015 *Contribution: participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1002/pip.2587>  
**\*cited 50 times**
36. Wilkinson, T.M.\*, Zargari, S.\*, Prasad, M., **Packard, C.E.**, “Optimizing nano-dynamic mechanical analysis for high-resolution, elastic modulus mapping in organic-rich shales.” *Journal of Materials Science*, 50, 3, 2015 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1007/s10853-014-8682-5>  
**\* article featured on issue cover, cited more than 50 times**
37. Taylor, M.D.\*, Choi, K.S., Sun, X., Matlock, D.K., **Packard, C.E.**, Xu, L., Barlat, F., “Correlations between nanoindentation hardness and macroscopic mechanical properties in DP980 steels.” *Materials Science and Engineering: A*, 597, 2014 *Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1016/j.msea.2013.12.084>

**\*cited more than 100 times**

38. Chang, W., Wang, A., Murarka, A., Akselrod, G.M., **Packard, C.**, Lang, J.H., Bulovic, V., “Electrically tunable organic vertical-cavity surface-emitting laser.” *Applied Physics Letters*, 105, 7, 2014 *Contribution: methods development, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1063/1.4893758>

39. Diercks, D.R., Musselman, M. %, Morgenstern, A.\* , Wilson, T. %, Kumar, M.^ , Smith, K., Kawase, M., Gorman, B.P., Eberhart, M., **Packard, C.E.**, “Evidence for anisotropic mechanical behavior and nanoscale chemical heterogeneity in cycled LiCoO<sub>2</sub>.” *Journal of the Electrochemical Society*, 161, 11, 2014 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1149/2.0071411jes>

**\*cited more than 20 times**

40. Rolston, J.S., Zilliox, S.H. %, **Packard, C.**, Mitcham, C., Zaharatos, B.\* , “Nanoethics and policy education: A case study of social science coursework and student engagement with emerging technologies.” *NanoEthics*, 8, 3, 2014 *Contribution: participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1007/s11569-014-0210-1>

41. Mitcham, C., Heller, L., Nan, W., Qin, Z., **Packard, C.**, Holles, C., Hudson, D., Rolston, J., “Nanotechnology ethics and policy education: Learning and sharing across boundaries.”, *Journal of Nano Education*, 5, 2013 *Contribution: participated in data analysis and interpretation, revised the manuscript, obtained funding.*  
<http://dx.doi.org/10.1166/jne.2013.1038>

42. Kumar, M.^ , Sigdel, A.K., Gennett, T., Berry, J.J., Perkins, J.D., Ginley, D.S., **Packard, C.E.**, “Optimizing amorphous indium zinc oxide film growth for low residual stress and high electrical conductivity.”, *Applied Surface Science*, 283, 2013 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1016/j.apsusc.2013.06.019>

**\*cited more than 20 times**

43. Periasamy, P.\* , Bradley, M.S., Parilla, P.A., Berry, J.J., Ginley, D.S., O’Hayre, R.P., **Packard, C.E.**, “Electromechanical tuning of nanoscale MIM diodes by nanoindentation.”, *Journal of Materials Research*, 28: 14, 2013 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1557/jmr.2013.171>

44. Ramalingam, S.\* **Packard, C.E.**, Reimanis, I.E., "In-situ diamond anvil cell–Raman spectroscopy and nanoindentation study of the pressure-induced phase transformation in pure

- and Zinc-doped  $\beta$ -eucryptite.", *Journal of the American Ceramic Society*, 96:6, 2013  
*Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
<http://dx.doi.org/10.1111/jace.12220>
45. Miller, D.C., Carloni, J.D. %, Johnson, D.K., Pankow, J.W., Gjersing, E.L., To, B., **Packard, C.E.**, Kennedy, C.E., Kurtz, S.R., "An investigation of the changes in poly(methyl methacrylate) specimens after exposure to ultra-violet light, heat, and humidity.", *Solar Energy Materials & Solar Cells*, 111, 2013 *Contribution: conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
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46. Yu, J., **Packard, C.E.**, Bulovic, V., "Subtractive contact-patterning of molecular organic films.", *Organic Electronics*, 13:10, 2012 *Contribution: data collection, participated in data analysis and interpretation, drafted the manuscript.*  
<http://dx.doi.org/10.1016/j.orgel.2012.05.012>
47. Ramalingam, S.\*, Reimanis, I.E., **Packard, C.E.**, "Determining activation volume for the pressure-induced phase transformation in  $\beta$ -eucryptite through nanoindentation.", *Journal of the American Ceramic Society*, 95:6, 2012 *Contribution: corresponding author, conceived and designed the work, participated in data analysis and interpretation, revised the manuscript.*  
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49. **Packard, C.E.**, Franke, O., Homer, E.R., Schuh, C.A., "Nanoscale strength distribution in amorphous versus crystalline metals.", *Journal of Materials Research*, 25:12, 2010  
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50. Trenkle, J.C., **Packard, C.E.**, Schuh, C.A., "Hot nanoindentation in inert environments.", *Review of Scientific Instruments*, 81, 073901, 2010 *Contribution: data collection, participated in data analysis and interpretation, revised the manuscript.*  
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51. **Packard, C.E.**, Homer, E.R., Al-Aqeeli, N., Schuh, C.A., "Cyclic hardening of metallic glasses under Hertzian contacts: Experiments and STZ dynamics simulations.",

*Philosophical Magazine*, 90: 10, 2010 *Contribution: data collection, participated in data analysis and interpretation, revised the manuscript.*

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52. **Packard, C.E.**, Murarka, A.%, Lam, E.W., Schmidt, M.A., Bulovic, V., “Contact-printed microelectromechanical systems.”, *Advanced Materials*, 22, 2010 *Contribution: methods development, data collection, participated in data analysis and interpretation, drafted the manuscript.*

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54. **Packard, C.E.**, Witmer L.M.,% Schuh, C.A., “Hardening of a metallic glass during cyclic loading in the elastic range.”, *Applied Physics Letters*, 92, 171911, 2008 *Contribution: methods development, data collection, participated in data analysis and interpretation, drafted the manuscript.*

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Published in Conference Proceedings (peer reviewed)

(\*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding, %: Undergraduate researchers under my supervision)

1. Mangum, J.S., Braun, A.K.\*, Perna, A.\*, Geisz, J.F., Ptak, A.J., **Packard, C.E.**, France, R.M., “Improving Performance of III-V Solar Cells Grown on Spalled Germanium with Ex Situ Substrate Planarization.” *2023 IEEE 50<sup>th</sup> Photovoltaics Specialist Conference*, 1-4, 2023

<http://dx.doi.org/10.1109/PVSC48320.2023.10359561>

2. Braun, A.K.\*, Steiner, M.A., **Packard, C.E.**, Ptak, A.J., “Planarization of Rough (100) GaAs Substrates via Growth by Hydride Vapor Phase Epitaxy.” *2021 IEEE 48<sup>th</sup> Photovoltaics Specialist Conference*, 1437-1439, 2021  
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3. Braun, A.K.\*, Theingi, S., Ptak, A.J., **Packard, C.E.**, “Facet suppression in (100) GaAs spalling via use of a Nanoimprint Lithography Release Layer.” *2021 IEEE 48<sup>th</sup> Photovoltaics Specialist Conference*, 1506-1509, 2021  
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4. Schulte, K.L., Diercks, D.R., **Packard, C.E.**, Simon, J., Ptak, A.J., “Effect of Doping Density on the Performance of Metamorphic GaInAs Solar Cells Grown by Dynamic Hydride Vapor Phase Epitaxy.” *2021 IEEE 48<sup>th</sup> Photovoltaics Specialist Conference*, 1100-1102, 2021  
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5. Metaferia, W., Chenenko, J.\*, **Packard, C.E.**, Ptak, A.J., Schulte, K.L., “(110)-Oriented GaAs Devices and Spalling as a Platform for Low-Cost III-V Photovoltaics.” *2021 IEEE 48<sup>th</sup> Photovoltaics Specialist Conference*, 1118-1120, 2021  
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7. Alkurd, N.\*, Cavalli, A., Ley, B.E.\*, Simon, J., Young, D.L., Ptak, A.J., **Packard, C.E.**, “Reformed Mesoporous Ge for Substrate Reuse in III-V Solar Cells.” *2019 IEEE 46<sup>th</sup> Photovoltaics Specialist Conference*, 0979-0982, 2019  
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8. McMahon, W.E., Simon, J.D., Young, M.S., Warren, E.L., Buencuerpo, J., Schulte, K.L., **Packard, C.E.**, Geisz, J.F., “Fabrication of Thin III-V Solar Cells on Ni Films using Electroless Ni Deposition.” *2019 IEEE 46<sup>th</sup> Photovoltaics Specialist Conference*, 3224-3226, 2019  
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9. Cavalli, A., Ley, B.\*, Johnston, S., Sulas, D., Simon, J., Schulte, K.L., **Packard, C.E.**, Young, D.L., Ptak, A.J., “GaAs solar cells grown on unpolished, spalled Ge substrates.” *IEEE 7<sup>th</sup> World Conference on Photovoltaic Energy Conversion (a joint conference of IEEE 45<sup>th</sup> Photovoltaics Specialist Conference, 28<sup>th</sup> PVSEC, and 34<sup>th</sup> EU PVSEC)*, 2771-2775, 2018  
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10. Jain, N., Simon, J., Schulte, K.L., Diercks, D.R., **Packard, C.E.**, Young, D.L., Ptak, A.J.,

“GaInAsP solar cells grown by hydride vapor phase epitaxy for one-sun & low-concentration III-V/Si photovoltaics.” *IEEE 44<sup>th</sup> Photovoltaic Specialists Conference*, 79-82, 2017  
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11. Diercks, D.R., Musselman, M.\* , Kumar, M.^, Gorman, B.P., **Packard, C.E.**, “Microscopy of chemical and mechanical heterogeneities in lithium cobalt oxide.”, *Microscopy & Microanalysis*, 21: S3, 2015  
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12. Sweet, C.A.\* , McNeely, J.E. % , Gorman, B., Young, D.L., Ptak, A.J., **Packard, C.E.**, Engineering controlled spalling in (100)-oriented GaAs for wafer reuse, *IEEE 42<sup>nd</sup> Photovoltaics Specialist Conference*, 15664601, 2015  
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14. Kurtz, S., Wohlgemuth, J., Hacke, P., Bosco, N., Kempe, M., Smith, R., **Packard, C.E.**, “The challenge to move from “One Size Fits All” to PV modules the customer needs.”, *26<sup>th</sup> European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC)*, 2011  
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15. Periasamy, P.\* , O’Hayre, R., Berry, J.J., Parilla, P.A., Ginley, D.S., **Packard, C.E.**, “A novel way to characterize metal-insulator-metal devices via nanoindentation.”, *Proceedings of the 2011 IEEE 37<sup>th</sup> Photovoltaic Specialist Conference*, #513, 2011  
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16. Murarka, A., **Packard, C.E.**, Yaul, F., Lang, J., Bulovic, V., “Micro-contact printed MEMS.”, *Proceedings of the 2011 IEEE 24<sup>th</sup> International Conference on MEMS*, 292-295, 2011  
<http://dx.doi.org/10.1109/MEMSYS.2011.5734419>

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(\*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding, %: Undergraduate researchers under my supervision)

1. Braun, A.K.\* , Boyer, J.T., McMahon, W.E., Schulte, K.L., Simon, J., **Packard, C.E.**, Ptak, A.J., “Morphology Control of Growth by Hydride Vapor Phase Epitaxy on Faceted GaAs Substrates Produced by Controlled Spalling for Low Cost III-V Devices.” *2023 International Conference on Compound Semiconductor Manufacturing Technology*, 2023  
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2. Diercks, D.R., Musselman, M. %, Kumar, M.^, Gorman, B.P., **Packard, C.E.**, “Microscopy of chemical and mechanical heterogeneities in Lithium Cobalt Oxide.” *Microscopy and Microanalysis*, 21, S3, 2015  
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3. Madeni, J.C., Campos-Bravo, P., Liu, S., **Packard, C.E.**, “Flow and microstructure of Co-based filler metals on stainless steel and intermetallic phases mechanical property determination by nanoindentation.”, *Brazing and Soldering 2012: IBSC Proceedings of the 5<sup>th</sup> International Conference*, ASM International, p. 414, 2012  
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4. **Packard, C.E.**, Ramalingam, S.\*, Reimanis, I.E., “Indentation study of the pressure-induced phase transformation in beta-eucryptite: a candidate material for new transformation-toughened ceramics.”, *Proceedings of the 2012 International Symposium on Plasticity and Its Current Applications*, 2012  
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#### Book Chapters

1. **Packard C.E.**, Wheeler J.M., Trenkle J.C., and Schuh C.A., Nanoindentation: High Temperature. In: Saleem Hashmi (editor-in-chief), *Reference Module in Materials Science and Materials Engineering*. Oxford: Elsevier; 2016. pp. 1-8.  
<http://dx.doi.org/10.1016/B978-0-12-803581-8.03389-0>
2. **Packard, C.E.**, Trenkle, J.C., Schuh, C.A., “Nanoindentation: High Temperature.” In: K.H.J. Buschow, R.W. Cahn, M.C. Flemings, B. Ilshner (print), E.J. Kramer, S. Mahajan, and P. Veyssiere (updates), Editor(s)-in-Chief, *Encyclopedia of Materials: Science and Technology*, Elsevier, Oxford, 2010, Pages 1-6  
<http://dx.doi.org/10.1016/B978-008043152-9.02224-7>

#### Reports (Peer Reviewed)

1. Jordan, D., Kempe, M., Miller, D., **Packard, C.**, Wohlgemuth, J., Kurtz, S., “Observed field failures and reported degradation rates.” NREL (National Renewable Energy Laboratory). 55 pp.; NREL Report No. PR-5200-59296, 2013  
<http://www.nrel.gov/docs/fy13osti/59296.pdf>
2. **Packard, C.E.**, Wohlgemuth, J.H., Kurtz, S.R., “Development of a visual inspection data collection tool for evaluation of fielded PV module condition.”, NREL Report No. TP-5200-56154, 2012  
<http://www.nrel.gov/docs/fy12osti/56154.pdf>  
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#### Reports (Not Reviewed)

1. Kontges, M., Kurtz, S., **Packard, C.**, Jahn, U., Berger, K.A., Kato, K., Friesen, T., Liu, H., Iseghem, M.V., “External report from International Energy Agency Photovoltaic Power Systems Programme: ‘Performance and reliability of photovoltaic systems subtask 3.2: Review on failures of PV modules.’” 132 pp. Report IEA-PVPS T13-01:2014

<https://repository.supsi.ch/9645/>

*\*cited >500 times since publication. I am one of the only two US authors. Used internationally as guidance for documenting and understanding in-field solar module failures.*

#### Archived Electronic Publications

(\*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding, %: Undergraduate researchers under my supervision)

1. Afful, H.\*, Sharma, J.\*, Braun, A.\*, Perna, A.\*, & **Packard, C. E.**, “Polymorphism in ceramic materials: a module developed for hands-on learning.” Colorado School of Mines Repository. <https://doi.org/10.25676/11124> 2022
2. Perna, A.\*, Braun, A.\*, Afful, H.\*, Sharma, J.\*, **Packard, C.E.**, “Materials fracture: a module developed for hands-on learning.” Colorado School of Mines Repository. <https://doi.org/10.25676/11124/14316> 2022
3. **Packard, C.E.** Training workshop: “Training workshop for participating in outreach at the Rocky Mountain Camp for Dyslexic Kids.” Workshop slides for professors and graduate students participating in STEM outreach to dyslexic children. 2019  
<https://hdl.handle.net/11124/174181>
4. Musselman, M.\*, Alkurd, N.\*, Ley, B.\*, Murugappan, X.%, Feldman, J.%, **Packard, C.E.**, Teaching module: “Ceramic materials in renewable energy: A module developed for hands-on learning.” Lesson plan for STEM outreach to dyslexic children. 2017  
<https://hdl.handle.net/11124/171186>
5. **Packard, C.E.**, Wilkinson, T.\*, McMullen, Z. %, Musselman, M.\* “Sintering ceramic materials: a module developed for hands-on learning” Lesson plan for STEM outreach to dyslexic children. 2015  
<http://hdl.handle.net/11124/169991>

#### Patents and Patent Applications

(\*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding)

1. US Patent Application “Control of surface morphology of spalled (110) III-V substrate surfaces.” Inventors: K.L. Schulte, J. Chenenko\*, **C.E. Packard**. Provisional Application No. 63/216,391 filed 6/29/2021, Application: filed 6/29/2022, Non-provisional Application No. 17/809,841
2. US Patent Application “Metallic glass coating material.” Inventors: A. Mehta, S. Sarker, **C.E. Packard**, R. Schoeppner^. Provisional Application No. 63/223,897 filed 7/20/2021, Application: filed 7/20/2022, Non-provisional Application No. 17/869,720
3. US Patent Application “Facet suppression in (100) GaAs spalling via use of a nanoimprint lithography release layer.” Inventors: A.J. Ptak, A.K. Braun\*, **C.E. Packard**. Provisional



Application No. 63/141,714 Provisional: filed 1/26/2021, Application: filed 1/26/2022, Non-provisional Application No. 17/585,096

4. US Patent #11,027,976 “Ferroelastic ceramic compositions, applications thereof, and related methods.” Inventors: T.M. Wilkinson\*, M. Musselman\*, **C.E. Packard**.
5. US Patent #8,963,262 “Method and Apparatus for forming MEMS device.” Inventors: V. Bulovic, **C.E. Packard**, V.C. Wood, A. Murarka, G. Akselrod.
6. US Patent #8,739,390 “Method for Microcontact Printing of MEMS.” Inventors: V. Bulovic, **C.E. Packard**, J.J.-H. Yu, A. Murarka, L. Kim.
7. US Patent #8,601,658 “Method for forming a MEMS capacitor array.” Inventors: V. Bulovic, **C.E. Packard**, J.J.-H. Yu, A. Murarka, L. Kim.

#### INVITED CONFERENCE PRESENTATIONS (INTERNATIONAL/SOCIETY)

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1. Packard, C.E., Ullrich, S., “Nanomechanical behavior of nanocrystalline spinel at elevated temperature.” MS&T/Materials Science & Technology Technical Meeting & Exhibition, Oct. 2022 (invited)
2. Packard, C.E., “Between a Rock and a Hard Place: Comparing Ceramics and Metals on the Basis of Thermal Stability of Structure and Mechanical Properties.” Gordon Research Conference on Structural Nanomaterials, Switzerland, May 2022 (invited)
3. Packard, C.E., “Controlled Spalling of Wafer-Scale, Single-Crystal Films of High-Quality, High-Value Semiconductors.” International Conference on Metallurgical Coatings & Thin Films, Apr. 2021 (invited)
4. Packard, C.E., “III-V Photovoltaic Substrate Reuse and Recycle Strategies for Reduced Cost and Improved Materials Utilization.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2021 (invited)
5. Packard, C.E., “Persistent, inelastic cycling behavior in rare earth orthophosphate ceramics.” MS&T/Materials Science & Technology Technical Meeting & Exhibition Oct. 2020 (invited)
6. Packard, C.E., “Analysis of fracture surface morphology in microscale Gallium Arsenide and Germanium films.” TMS/The Minerals, Metals & Materials Society Annual Meeting, March. 2019 (invited)
7. Packard, C.E., “Indentation size and microstructure effects on cyclic deformation in rare-earth phosphate ceramics.” MS&T/Materials Science & Technology Technical Meeting & Exhibition, Oct. 2018 (invited)

8. Packard, C. “Pressure-induced phase transformation in xenotime rare-earth orthophosphates.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Feb. 2017 (invited)
9. Packard, C.E., “Pressure-induced phase transformation in xenotime rare-earth orthophosphates.” MRS/Materials Research Society Fall Meeting, Nov. 2016 (invited)
10. Packard, C.E., “Investigation of pressure-induced phase transformation in REPO<sub>4</sub>’s by in-situ Raman spectroscopy.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Feb. 2016 (invited)
11. Packard, C.E., “Spalling microscale, single-crystal films of high-quality, high-value semiconductors.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Feb. 2016 (invited)
12. Packard, C.E., “Synthesis and characterization of mixed-cation rare-earth orthophosphates.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Feb. 2016 (invited)
13. Packard, C.E., Wilkinson, T.M.\*, Zargari, S.\*, Prasad, M., “Probing micro- and nano-scale elastic modulus variation in organic-rich shale—a naturally occurring composite.” Composites at Lake Louise, Canada, Nov. 2015 (invited)
14. Packard, C.E., “Pressure-induced transformation in rare-earth orthophosphates.” MS&T/Materials Science & Technology Technical Meeting & Exhibition, Oct. 2015 (invited)
15. Taylor, M.D.\*, Matlock, D.K., Packard, C.E., “Applicability of nanomechanical testing to commercially produced advanced high-strength steels.” MS&T/Materials Science & Technology Technical Meeting & Exhibition, Oct. 2012 (invited)
16. Packard, C.E., “Fielded PV module condition.” IEA PVPS/International Energy Agency Photovoltaic Power Systems Programme Task 13 Subtask 3 Meeting, held at EU PVSEC/European Photovoltaic Solar Energy Conference & Exhibition, Germany, Sept. 2012 (invited)
17. Packard, C.E., “Electromechanical tuning of nanoscale diodes by nanoindentation.” Thin Film and Small Scale Mechanical Behavior Gordon Research Conference, Jul. 2012 (invited)
18. Packard, C.E., “Tunable nanoscale diodes fabricated with nanoECR.” Hysitron Users’ Meeting held at the TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2012 (invited)
19. Ramalingam, S.\*, Reimanis, I., C.E. Packard, “Indentation study of the pressure-induced phase transformation in beta-eucryptite: a candidate material for new transformation-toughened ceramics.” International Symposium on Plasticity and Its Current Applications, Jan. 2012 (invited)

INVITED TALKS AT UNIVERSITIES AND ASSOCIATIONS

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1. Packard, C.E., "Behavior of Rare-Earth Orthophosphate Ceramics under Complex Stress States." Mork Family Department of Chemical Engineering & Materials Science, University of Southern California, Sept. 2022 (invited)
2. Packard, C.E., "How the Mechanics of Spalling Fracture Enable (and Inhibit) III-V Photovoltaic Substrate Reuse." Rocky Mountain Mechanics Seminar Series, University of Colorado Boulder, Feb. 2022 (invited)
3. Packard, C.E., "Visual Inspection of Fielded Modules." NREL HOPE/National Renewable Energy Laboratory Hands-On Photovoltaic Experience Workshop, July 2021 (invited)
4. Packard, C.E., "Controlled Spalling of Wafer-Scale, Single-Crystal Films of High-Quality, High-Value Semiconductors." Northwestern University, Mar. 2021 (invited)
5. Packard, C.E., "III-V Photovoltaic Substrate Reuse using Fracture." National Renewable Energy Laboratory, Feb. 2021 (invited)
6. Packard, C.E., "III-V Photovoltaic Substrate Reuse using Fracture." University of Southern California, Jan. 2021 (invited)
7. Packard, C.E., "III-V Photovoltaic Substrate Reuse using Fracture." Penn Engineering-Materials Science and Engineering Seminar, Sept. 2020 (invited)
8. Packard, C.E., "Controlled spalling of microscale, single-crystal films of high-quality, high-value semiconductors." Georgia Tech, Sept. 2018 (invited)
9. Packard, C.E., "Persistent, inelastic cycling behavior in rare earth orthophosphate ceramics." Center for Integrated Nanotechnologies (CINT) Annual Meeting, Sept. 2018 (invited)
10. Packard, C.E., "Controlled spalling of microscale, single-crystal films of high-quality, high-value semiconductors." Oxford University, United Kingdom, July 2018 (invited)
11. Packard, C.E., "Controlled spalling of microscale, single-crystal films of high-quality, high-value semiconductors." Erich Schmid Institute of the Austrian Academy of Sciences at Montanuniversitat Leoben, Austria, July 2018 (invited)
12. Gorman, B.P., Packard, C.E., invited talk at the Army Research Laboratory, Mar. 2018 (invited)
13. Packard, C.E., "Rare-earth orthophosphates under pressure." Rocky Mountain Chapter of ASM/American Society of Metals International, Oct. 2015 (invited)

14. Packard, C.E., “Residual Stress and Mechanical Properties in Transparent Conducting Oxide Contacts for Photovoltaics.” University of Colorado-Boulder Mechanical Engineering Graduate Seminar, Oct. 2013 (invited)
15. Packard, C.E., “New capabilities in nanoscale mechanical characterization at Mines.” Meeting of the Rocky Mountain chapter of ASM/American Society of Metals International, Nov. 2010 (invited)
16. Packard, C.E., “Microcontact printing approaches for optoelectronics and MEMS using organic small molecules.” Chemistry Department seminar series, Colorado School of Mines, Oct. 2010 (invited)
17. Packard, C.E., “New capabilities in nanoscale mechanical characterization.” Materials Research seminar series, Colorado School of Mines, Oct. 2010 (invited)
18. Packard, C.E., “Understanding the initiation of failure in metallic glasses through nanomechanical testing.” Yale University, Apr. 2010 (invited)
19. Packard, C.E., “Understanding the initiation of failure in metallic glasses through nanomechanical testing.” California Institute of Technology, Feb. 2010 (invited)
20. Packard, C.E., “Opportunities and experimental challenges in high temperature nanoindentation.” Hysitron User Group Meeting, Feb. 2009 (invited)
21. Packard, C.E., “New nanoindentation–based methods for studying plasticity in metallic glasses.” Northeastern University, Oct. 2008 (invited)

#### CONTRIBUTED PRESENTATIONS

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(speaker underlined, \*: Mines Graduate Students, ^: Post-doctoral associates under my supervision and funding, %: Undergraduate researchers under my supervision)

1. Boardman, S.\*, **Packard, C.E.**, “Defect Populations and Their Linkage to Strength Distribution Parameters in Additively Manufactured Alumina.” TMS Specialty Congress 2024, Jun. 2024
2. Afful, H.\*, **Packard, C.E.**, “Uncovering Superelastic Energy Dissipation in Monazite Ceramics via Elevated Temperature Nanoindentation.” TMS Specialty Congress 2024, Jun. 2024
3. Yoo, N.\*, Collins, S., Forcade, G.P., McMahon, W.E., Young, M., Goldsmith, J., **Packard, C.E.**, Steiner, M.A., “Full Wafer Spalling and Cell Processing of Devices Grown on GaAs(100) Substrates.” 2024 IEEE 52<sup>nd</sup> Photovoltaics Specialist Conference, Jun. 2024

4. Forcade, G.P., McMahon, W.E., Yoo, N.\*, Neumann, A.N., Young, M., Goldsmith, J., Hinzer, K., **Packard, C.E.**, Steiner, M.A., “Planarizing Spalled GaAs(100) Surfaces by MOVPE Growth.” 2024 IEEE 52<sup>nd</sup> Photovoltaics Specialist Conference, Jun. 2024  
**\*Best Student Presentation Award Finalist**
5. Mangum, J.S., Braun, A.K.\*, Perna, A.\*, Geisz, J.F., Ptak, A.J., **Packard, C.E.**, France, R.M., “Improving Performance of III-V Solar Cells Grown on Spalled Germanium with Ex Situ Substrate Planarization.” 2023 IEEE 50<sup>th</sup> Photovoltaics Specialist Conference, Jun. 2023.
6. McMahon, W.E., Braun, A.K.\*, Perna, A.N.\*, Coll, P.G., Schulte, K.L., Boyer, J.T., Neumann, A.N., Geisz, J.F., Warren, E.L., Ptak, A.J., Merkle, A.P., Bertoni, M.I., **Packard, C.E.**, Steiner, M.A., “In-Situ Smoothing of Facets on Spalled GaAs(100) Substrates During OMPVE Growth of III-V Solar Cells.” 2023 IEEE 50<sup>th</sup> Photovoltaics Specialist Conference, Jun. 2023.
7. Braun, A.K.\*, Boyer, J.T., Schulte, K.L., Simon, J., Johnston, S.W., Steiner, M.A., **Packard, C.E.**, Ptak, A.J., “Effect of Surface Morphology on GaAs Solar Cells Grown on Planarized Spalled (100) GaAs Substrates.” 2023 IEEE 50<sup>th</sup> Photovoltaics Specialist Conference, Jun. 2023.
8. Braun, A.K.\*, Boyer, J.T., McMahon, W.E., Schulte, K.L., Simon, J., **Packard, C.E.**, Ptak, A.J., “Morphology Control of Growth by Hydride Vapor Phase Epitaxy on Faceted GaAs Substrates Produced by Controlled Spalling for Low Cost III-V Devices.” 2023 International Conference on Compound Semiconductor Manufacturing Technology, May 2023.
9. Packard, C.E., Ptak, A.J., “Wafer reuse via controlled spalling for lowering space photovoltaic cell cost.” Space Power Workshop, Apr. 2023.
10. Sharma, J.\*, Haberl, B., Packard, C. E. “Between Two Diamonds: Probing Pressure-Induced Mechanical and Optical Dynamics in Rare Earth Orthophosphates.” Rocky Mountain Solid State Chemistry Workshop, Jan. 2023. **\*Selected for best poster award**
11. Boardman, S.V.\*, Packard, C.E., “Influence of post-processing heat treatments on the mechanical properties of high-purity alumina made via lithography-based ceramic manufacturing.” International Conference on Additive Manufacturing, Oct. 2022 **\*Invited talk**
12. Afful, H.\*, Packard, C.E., “Investigating Superelasticity in Europium Orthophosphate (EuPO<sub>4</sub>) using nanoindentation.” 2022 Gordon Research Conference/GRC on Solid State Studies in Ceramics, Aug. 2022
13. Sharma, J.\*, Haberl, B., Packard, C.E., “Between Two Diamonds: Probing Pressure-Induced Mechanical and Optical Dynamics in Rare Earth Orthophosphates.” 2022 Gordon Research Conference/GRC on Solid State Studies in Ceramics, Aug. 2022
14. Perna, A.N.\*, Braun, A.K.\*, Schulte, K.L., Simon, J., Packard, C.E., Ptak, A.J., “Ultrathin

III-V solar cells with light-trapping structures fabricated in situ using an HVPE reactor.” 49<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2022

*\*Selected for best poster award*

15. Braun, A.K.\*, McMahon, W.E., Perna, A.N.\*, Schulte, K.L., Packard, C.E., Ptak, A.J., “Planarizing HVPE Growth on GaAs Substrates Produced by Controlled Spalling.” 49<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2022
16. Mangum, J.S., Rice, A.D., Chen, J.^, Chenenko, J.\* , Wong, E., Braun, A.K.\* , Johnston, S., Guthrey, H., Geisz, J.F., Ptak, A.J., Packard, C.E., “High-efficiency solar cells grown on spalled germanium without polishing.”, 49<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2022
17. Schulte, K.L., Diercks, D.R., Guthrey, H.L., Mangum, J.S., Packard, C.E., Simon, J., Ptak, A.J., “Rapid Growth of GaInP Graded Buffers and Metamorphic Devices Grown by HVPE” 2022 MRS/Materials Research Society Meeting (Virtual), May 2022
18. Braun, A.\*, McMahon, W., Packard, C.E., Ptak, A., “GaAs overgrowth of a faceted surface using HVPE towards planarization of rough substrates.” MRS/Materials Research Society Spring Meeting, May 2022
19. Schulte, K.L., Diercks, D.R., Guthrey, H.L., Mangum, J.S., Packard, C.E., Simon, J., Ptak, A.J., “High growth rate GaInP graded buffers and metamorphic devices grown by hydride vapor phase epitaxy.” 22<sup>nd</sup> American Conference on Crystal Growth and Epitaxy and 20<sup>th</sup> US Workshop on Organometallic Vapor Phase Epitaxy, Aug. 2021
20. Braun, A.K.\*, Steiner, M.A., Packard, C.E., Ptak, A.J., “Planarization of Rough (100) GaAs Substrates via Growth by Hydride Vapor Phase Epitaxy.” 48<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2021
21. Braun, A.K.\*, Theingi, S., Ptak, A.J., Packard, C.E., “Facet suppression in (100) GaAs spalling via use of a Nanoimprint Lithography Release Layer.” 48<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2021
22. Schulte, K.L., Diercks, D.R., Packard, C.E., Simon, J., Ptak, A.J., “Effect of Doping Density on the Performance of Metamorphic GaInAs Solar Cells Grown by Dynamic Hydride Vapor Phase Epitaxy.” 48<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2021
23. Metaferia, W., Chenenko, J.\* , Packard, C.E., Ptak, A.J., Schulte, K.L., “(110)-Oriented GaAs Devices and Spalling as a Platform for Low-Cost III-V Photovoltaics.” 48<sup>th</sup> IEEE Photovoltaic Specialists Conference, June 2021
24. Chen, J.^, Packard, C.E., “Fracture-Based Reuse of Single Crystal Wafers for High-Efficiency Photovoltaics.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2021

25. Sharma, J.\*, Musselman, M.\*, Haberl, B., Packard, C.E., “In-situ synchrotron diffraction of DyPO<sub>4</sub> pressure-induced phase transformation under variable hydrostaticity.” International Conference and Expo on Advanced Ceramics and Composites, Jan. 2021  
*\*Selected for 1<sup>st</sup> place poster award*
26. Boardman, S.V., Packard, C.E., “Stereolithographic 3D Printing of Silicon Nitride Ceramics.” GRC/Gordon Research Conference Solid State Studies in Ceramics, August 2019
27. Cavalli, A., Ley, B.\*, Alkurd, N.\*, Johnston, S., Sulas, D., Simon, J., Schulte, K.L., Packard, C.E., Young, D.L., Ptak, A.J., “III-V solar cells on spalled and porous Ge for substrate reuse.”, 19th International Conference on Crystal Growth and Epitaxy (ICCGE-19), July 2019
28. Alkurd, N.\*, Cavalli, A., Ley, B.E.\*, Simon, J., Young, D.L., Ptak, A.J., Packard, C.E., “Reformed Mesoporous Ge for Substrate Reuse in III-V Solar Cells.” IEEE 46<sup>th</sup> Photovoltaics Specialist Conference, June 2019
29. Packard, C.E., “Training workshop for participating in outreach at the Rocky Mountain Camp for Dyslexic Kids.” Colorado School of Mines Dyslexic Camp Training Workshop, May 2019
30. Sweet, C.A.\*, Crouse, D.\*, Ley, B.\*, Packard, C.E., “Limitations and applicability of LEFM to spalling fracture in single crystal semiconductors.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2018
31. Jain, N., Simon, J., Schulte, K.L., Diercks, D.R., Packard, C.E., Young, D.L., Ptak, A.J., “GaInAsP solar cells grown by hydride vapor phase epitaxy for one-sun & low-concentration III-V/Si photovoltaics.” IEEE 44<sup>th</sup> International Photovoltaic Specialists Conference, June 2017
32. Schulte, K.L., Simon, J., Mangum, J., Packard, C.E., Gorman, B., Jain, N., Ptak, A.J., “GaInP solar cells grown by hydride vapor phase epitaxy.” IEEE 44<sup>th</sup> International Photovoltaic Specialists Conference, June 2017
33. Jain, N., Crouse, D.\*, Simon, J., Johnston, S., Siol, S., Schulte, K., Packard, C., Young, D.L., Ptak, A.J., “III-V solar cells grown on reusable spalled Ge substrate.” IEEE 44<sup>th</sup> International Photovoltaic Specialists Conference, June 2017
34. Musselman, M.\*, Wilkinson, T.\*, Haberl, B., Packard, C., “High-pressure phase transformation to monazite structure in xenotime rare-earth orthophosphates.” MS&T/Materials Science & Technology Technical Meeting & Exhibition Oct. 2017
35. Wu, D.<sup>^</sup>, Talley, K.\*, Manna, S.\*, Chen, Y.<sup>^</sup>, Zakutayev, A., Ciobanu, C., Constantine, P., Brennecka, G., Packard, C.E., “Characterization and Modeling of Elastic Modulus across the (Al, Sc)N System.” Composites at Lake Louise, Canada, Dec. 2017
36. Wu, D.<sup>^</sup>, Talley, K.\*, Manna, S.\*, Zakutayev, A., Constantine, P., Brennecka, G., Packard,

- C., "Investigating the Mechanical and Piezoelectric Properties of Combinatorially Deposited (Al, Sc)N Thin Films Using Nanoindentation Techniques." MRS/Materials Research Society Spring Meeting Apr. 2017
37. Wilkinson, T.\* , Wu, D.^, Musselman, M.\* , Packard, C., "Cataloging Anomalous Nanoindentation Behavior and Mechanical Properties in Rare-Earth Orthophosphate Ceramics." 41<sup>st</sup> International Conference and Expo on Advanced Ceramic and Composites Jan. 2017
38. Wilkinson, T.M.\* , Musselman, M.A.\* , Packard, C.E., "Cataloging anomalous nanoindentation behaviors and mechanical properties in rare-earth orthophosphate ceramics." MRS/Materials Research Society Fall Meeting, Nov. 2016
39. Wilkinson, T.M.\*, Wu, D.^, Musselman, M.A.\* , Packard, C.E., "Anomalous nanoindentation behaviors, mechanical properties, and the role of processing in rare-earth orthophosphates." Gordon Research Conference on Solid-State Studies in Ceramics, Aug. 2016
40. Musselman, M.\*, Wilkinson, T.M.\* , McMullen, Z.D.%, Packard, C.E., "In situ Raman spectroscopy of pressure-induced transformation in xenotime rare-earth orthophosphates." MRS/Materials Research Society, Dec. 2015  
*\*Selected as a poster award finalist*
41. Diercks, D.R., Musselman, M. %, Morgenstern, A. %, Wilson, T. %, Kumar, M.^, Smith, K., Kawase, M., Gorman, B.P., Eberhart, M., Packard, C.E., "Experimental and computational investigation of fracture in LiCoO<sub>2</sub> battery cathode material." MRS/Materials Research Society, Dec. 2015
42. Sweet, C.A.\* , Gorman, B., Simon, J., Young, D.L., Ptak, A.J., Packard, C.E., "Epitaxial lift-off of thin-film (100) GaAs by controlled spalling." MRS/Materials Research Society, Dec. 2015
43. Packard, C.E., Moskal, B., "A module for teaching ceramic processing to children with dyslexia." MRS/Materials Research Society, Dec. 2015  
*\*Invited to record for MRS On-Demand*  
<http://www.prolibraries.com/mrs/?select=speaker&speakerID=78341>
44. Wilkinson, T.M.\* , Musselman, M.A.\* , McMullen, Z.D.%, Packard, C.E., "Mechanical behavior and properties of REPO<sub>4</sub> studied by nanoindentation." Composites at Lake Louise, Canada, Nov. 2015.
45. Kumar, N., Wilkinson, T.M.\* , Packard, C.E., Kumar, M., "Study of surface roughness and residual stress in a-IZO thin films for next generation flexible organic light emitting diodes." 2<sup>nd</sup> International Conference on Emerging Technologies (Jaipur, India), Oct. 2015



46. Diercks, D.R., Musselman, M. %, Kumar, M.^, Gorman, B.P., Packard, C.E., "Microscopy of chemical and mechanical heterogeneities in Lithium Cobalt Oxide." Microscopy and Microanalysis, Aug. 2015
47. Musselman, M.A.\* , Wilkinson, T.M.\* , Packard, C.E., "Controlling pressure-induced transformation in rare earth orthophosphates." International Conference on Exotic Forms of Silicon, Jul. 2015.
48. Packard, C.E., Rolston, J.S., "Ethics in NanoScience: An interactive workshop." REMRSEC REU/Renewable Energy Materials Research Science and Engineering Center Research Experiences for Undergraduates Professional Development Series, Jun. 2015
49. Sweet, C.A.\* , McNeely, J.E. %, Gorman, B., Young, D.L., Ptak, A.J., Packard, C.E., "Engineering controlled spalling in (100)-oriented GaAs for wafer reuse." IEEE 42<sup>nd</sup> Photovoltaics Specialist Conference, Jun. 2015
50. Packard, C.E., "Panel Discussion: What it means to do research in a national laboratory setting" member of panel, Spring REMRSEC/Renewable Energy Materials Research Science and Engineering Center Post Doc/Graduate Student Luncheon, Mar. 2015
51. Wilkinson, T.M.\*, Zargari, S.\* , Prasad, M., Packard, C.E., "High resolution mechanical property mapping in oil shales." GRC/Gordon Research Conference: Thin Films & Small Scale Mechanical Behavior, Jul. 2014
52. Packard, C.E., "CAREER: Controlling pressure-induced transformation in rare earth orthophosphates." ACerS-NSF/American Ceramics Society-National Science Foundation Ceramic Materials PI Workshop, Jun. 2014
53. Sweet, C.A.\* , Simon, J.D., Young, D.L., Ptak, A.J., Packard, C.E., "Effect of material choice on spalling fracture parameters to exfoliate thin PV devices." IEEE 40<sup>th</sup> Photovoltaics Specialist Conference, Jun. 2014
54. Sweet, C.\*, Simon, J., Young, D.L., Ptak, A.J., Packard, C.E., "Rapid release of thin, flexible GaAs devices by controlled spalling." MRS/Material Research Society, Mar. 2014
55. Packard, C.E., Gorman, B.P., Smith, K., Eberhart, M.E., "Li-ion electrode mechanical properties." Battery and Energy Storage Research Workshop, Colorado Collaboratory, Aug. 2013
56. Packard, C.E., "Nanomechanical origins of pressure-induced phase transformation in aluminosilicate ceramics." ACerS-NSF/American Ceramics Society-National Science Foundation Ceramic PI Workshop, Jun. 2013
57. Reimanis, I., Ciobanu, C., Packard, C., Ramalingam, S.\* , Narayanan, B.\* , and Misture, S., "Thermomechanical behavior in beta-eucryptite and its composites." (Invited), PAC RIM meeting of the American Ceramic Society, Jun. 2013

58. Kumar, M.<sup>^</sup>, Sigdel, A.K., Gennett, T., Berry, J.J., Perkins, J.D., Ginley, D.S., Packard, C.E., "Low residual stress/high electrical conductivity for mechanically reliable flexible contacts." 8<sup>th</sup> International Symposium on Transparent Oxide and Related Materials for Electronics and Optics, May 2013
59. Reimanis, I., Ciobanu, C., Packard, C., Ramalingam, S.\* , Narayanan, B.\* , "Pressure-induced phase transformations in ceramics." (Invited), Department of Energy Office of Basic Energy Sciences Principal Investigators Meeting, Mar. 2013
60. Packard, C.E., "Electromechanical tuning of nanoscale MIM diodes by nanoindentation." TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2013
61. Packard, C.E., Wohlgemuth, J.H., Kurtz, S.R., "Development of a visual inspection checklist for evaluation of fielded PV module condition." Photovoltaic Module Reliability Workshop 2013, Feb. 2013  
*\* Poster presentation recognized with an award*
62. Ndione, P.F., Zakutayev, A., Kumar, M.<sup>^</sup>, Sigdel, A.K., Parilla, P.A., Packard, C.E., Gennett, T., Berry, J.J., Ginley, D.S., Perkins, J.D., "Tuning the properties of amorphous In-Zn-Zn-O using combinatorial sputtering." MRS/Materials Research Society, Nov. 2012
63. Kim, Y., Bulusu, A., Cowan, S., Kumar, M.<sup>^</sup>, Olson, D., Berry, J.J., Packard, C.E., Graham, S., "Interfacial adhesion in organic photovoltaic devices." MRS/Materials Research Society, Nov. 2012
64. Ramalingam, S.\*, Packard, C., Reimanis, I.E., "Doping effects on the behavior of  $\beta$ -eucryptite." ECI Conference- Nonstoichiometric Compounds V, Sept. 2012
65. Ramalingam, S.\*, Packard, C.E., Reimanis, I.E., "Doping effects on pressure-induced phase transformation of  $\beta$ -eucryptite" Solid State Studies in Ceramics, Gordon Conference, Aug. 2012.
66. Ramalingam, S.\*, Reimanis, I., Packard, C., "Pressure-induced phase transformation in  $\beta$ -eucryptite to impart toughening in ceramics" International Conference on Strength of Materials, Bangalore, India, Aug. 2012
67. Ramalingam, S.\*, Packard, C.E., Reimanis, I.E., "Effect of doping on the thermal and mechanical behavior of  $\beta$ -eucryptite" 4th International Congress on Ceramics, Chicago, Jul. 2012.
68. Madeni, J.C., Campos, P., Packard, C.E., Liu, S., "Flow and microstructural evolution of Co-based filler metals on Stainless Steel and intermetallic phases mechanical property determination by nanoindentation." International Brazing and Soldering Conference, Apr. 2012

69. Holles, C., Heller, L., Delbourne, J., Schneider, J., Hudson, D., Packard, C., “Nano-STEP: Nano-Science, Technology, Ethics, and Policy.” Engineering Education and Centers (EEC) Annual Awardees Conference, Mar. 2012
70. Ramalingam, S.\*, Reimanis, I.E., Packard, C.E., “Determining activation volume for the pressure-induced phase transformation in  $\beta$ -eucryptite through nanoindentation.” Sao Carlos Advanced School on Materials Science & Engineering, Mar. 2012
71. Klafehn, G.W.\* , Packard, C.E., “Humidified nanoindentation.” TMS/The Minerals, Metals & Materials Society Annual Meeting, Mar. 2012
72. Packard, C.E., “Accelerating reliable transparent conductor development by mechanical property screening.” Center for Revolutionary Solar Photoconversion Winter Meeting, Feb. 2012
73. Ramalingam, S.\*, Reimanis, I.E., Packard, C.E., “Utilizing pressure-induced transformations for toughening of ceramics.” 36<sup>th</sup> International Conference and Expo on Advanced Ceramics and Composites, Jan. 2012
74. Packard, C.E., Wohlgemuth, J.H., Kurtz, S.R., “Development of a visual inspection checklist for evaluation of fielded PV module condition.” Photovoltaic Module Reliability Workshop 2012, Jan. 2012  
*\*Poster presentation recognized with an award*
75. Packard, C.E., Akselrod, G.M., Bulovic, V., “Tuning emission from an organic molecular film microcavity using a MEMS deformable mirror.” 8<sup>th</sup> International Conference on Electroluminescence and Organic Optoelectronics, Oct. 2010
76. Packard, C.E., Aidala, K.E., Yu, J., Bulovic, V., “Scalable, high resolution patterning of organic small molecule films.” MRS/Materials Research Society, Feb. 2010
77. Packard, C.E., Bulovic, V., “Exploiting delamination to fabricate microcontact-printed MEMS.” TMS/The Minerals, Metals & Materials Society Annual Meeting & Exhibition Mar. 2010
78. Packard, C.E., Yu, J., Kim, L., Bulovic, V., “Microcontact printing-based patterning techniques for OLED displays and other microelectronic devices.” Organic Microelectronics & Optoelectronics Workshop V ACS/IEEE/MRS, Jul. 2009
79. Packard, C.E., Murarka, A., Bulovic, V., “Direct patterning of metallic MEMS through microcontact printing.” MRS/Materials Research Society, Feb. 2009
80. Schuh, C.A., Packard, C.E., and Al-Aqeeli, N., “Cyclic hardening in metallic glasses.” TMS/The Minerals, Metals & Materials Society Annual Meeting & Exhibition Mar. 2009

81. Schuh, C.A., Homer, E.R., and Packard, C.E., “Collective dynamics of shear transformation zones in amorphous metals.” MRS/Materials Research Society, Dec. 2008
82. Trenkle, J.C., Packard, C.E., and Schuh, C.A., “Optimizing high temperature nanoindentation in inert atmospheres.” MRS/Materials Research Society, Dec. 2008
83. Packard, C.E., and Schuh, C.A., “Probing the nanoscale strength distribution in metallic glasses.” TMS/The Minerals, Metals & Materials Society Annual Meeting & Exhibition Mar. 2008
84. Packard, C.E., and Schuh, C.A., “Condition to initiate shear bands around a stress concentration in metallic glass.” MRS/Materials Research Society, Dec. 2007
85. Schuh, C.A., and Packard, C.E., “Statistics of shear band activation in metallic glasses.” TMS/The Minerals, Metals & Materials Society Annual Meeting & Exhibition Mar. 2006
86. Packard, C.E., and Schuh, C.A., “Statistical analysis of the first shear band event during nanoindentation of metallic glass.” MRS/Materials Research Society, Dec. 2005

## TEACHING

**Colorado School of Mines Courses**

(MTGN: Program Code for Department of Metallurgical & Materials Engineering,  
MLGN: Program Code for Interdisciplinary Materials Science Program)

<u>Course Number</u>	<u>Course Title</u>  % responsible	<u>Term</u> ( <u>Fall</u> , <u>Spring</u> ) & <u>Year</u>	<u>Type (Lab</u> , <u>Lect</u> , <u>Rec</u> , <u>Ind Study</u> )	<u>Credit Hours</u>	<u># of Students</u>
MTGN 352	Metallurgical and Materials Engineering Kinetics  100%	S2011	Lect.	3.0	37
		S2012			42
		S2013			31
MTGN 498/598	Nano-mechanical Measurements  100%	F2011	Lect.	3.0	12
		F2015			9
MTGN 202	Engineering Materials  100%	F2013	Lect.	3.0	45
MLGN 592	Advanced Materials Kinetics & Transport  100%	F2012	Lect.	3.0	29
		S2014			20
		S2015			26

		S2016			24
		S2017			32
		S2018			39
		S2019			33
		S2020			38
		S2021			32
		S2022			38
MTGN 350/450	Statistical Process Control and Design of Experiments  50% in 2016 100% 2017+	F2016	Lect.	3.0	57
		F2017			44
		F2020			102
		F2021			65
		F2022			51
		F2023			52
MLGN 599	Introduction to Epitaxy  100%	S2021	Ind. Study	3.0	2
MTGN 498/598	Thin Film Deposition and Mechanics  100%	S2023	Lect.	3.0	18
		S2024			18

**Colorado School of Mines Course Development** (most recent listed first)

- Developed new course, Thin Film Deposition & Mechanics, including lectures, guest lectures, in-class activities, and assignments
- Redeveloped the undergraduate, required course, MTGN450/350 Statistical Process Control and Design of Experiments, to apply modern pedagogical methods and use statistical analysis tools. Three times weekly chalkboard lectures and traditional daily homework and comprehensive exams were replaced by a Tell-Show-Do-Apply pedagogical framework. I developed low-stakes concept readiness questions, in-class Practicum session assignments, and authentic assessments, frequently linked to laboratory courses in the department curriculum, for demonstration of mastery at the completion of each unit. Practicum sessions were developed over the course of 2 years, now consisting of a weekly Friday session for guided and self-directed use of modern software tools for statistical analysis and Design of Experiments (Matlab and Minitab).
- Transitioned MTGN450/350 to Open Education Resources (OER) through obtaining a Zero Textbook Cost (ZTC) grant in 2020 for replacement of an expensive, dated textbook. I used the grant funds to extend Mines' Minitab license so that students could download the program on their personal computers (prior to Tech Fee covering this for all students). The

course has run with no supplemental cost to the students since then, saving each student \$120-215/year.

- Taught an Independent Study course, MTGN599 Introduction to Epitaxy, for two graduate students who perform epitaxial materials growth at the National Renewable Energy Laboratory. An NREL researcher was included in weekly scientific discussions as part of the course.
- Developed MTGN498/598 special topics class on Nanomechanical Measurements, including lectures, in-class activities, and assignments
- Redeveloped MLGN592, including adoption of new textbook (Balluffi, Allen, & Carter, *Kinetics of Materials*) as part of the redevelopment of the core curriculum of the Materials Science Program. Created new lectures, assignments, and assessments.

## MENTOR AND ACADEMIC SPONSOR

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### Current

#### Students Advised (ongoing)

Student Name- <i>Thesis Title</i>	Faculty Role (Advisor or Coadvisor)	Degree Sought
Savannah Ullrich- <i>“Mechanical Properties and Deformation of Nanocrystalline Magnesium Aluminate Spinel at Elevated Temperature by Nanoindentation”</i>	Advisor	Ph.D.
Henry Quansah Afful- <i>“Damping by Elastic Twinning in Rare-Earth Orthophosphates”</i>	Advisor	Ph.D.
Nicholas Yoo- <i>“Development of Germanium Controlled Spalling Processes”</i>	Coadvisor	Ph.D.

#### Post-Doctoral Researchers Advised (current contracts)

Post-Doc Name/Years/Project	Faculty Role (Advisor or Coadvisor)
Dr. Michael Walden/2023-present/Spalling modeling & development	Advisor

### Former

#### Students Advised (completed degrees)

Student Name- <i>Thesis Title</i> Employment	Faculty Role (Advisor or Coadvisor)	Degree & Year
Grant Klafehn- <i>“Creating a Variable Humidity, Variable Temperature Environment for the Mechanical Testing of PEM Fuel Cell Electrolytes via Nanoindentation”</i> Entrepreneur	Advisor	M.S. 2011
Cassi Sweet- <i>“Short-Term Failure and Degradation in Concentrator Photovoltaics”</i>	Advisor	M.S. 2012

Module Development Engineer @ Intel		
Taylor Wilkinson- <i>“High Resolution Mechanical Property Mapping in Oil Shales”</i> Senior Development Scientist @ Corning	Advisor	M.S. 2013
Cassi Sweet- <i>“Spalling Fracture in (100) Gallium Arsenide”</i> Module Development Engineer @ Intel	Advisor	Ph.D. 2016
Matthew Musselman- <i>“In Situ Raman Spectroscopy of Pressure-Induced Phase Transformations in DyPO<sub>4</sub> and Gd<sub>x</sub>Dy<sub>(1-x)</sub>PO<sub>4</sub>”</i> Materials & Process Engineer @ Ball Aerospace	Advisor	M.S. 2017
Taylor Wilkinson- <i>“Characterization of Ferroelasticity in Rare-Earth Orthophosphates by Nanoindentation”</i> Senior Development Scientist @ Corning	Advisor	Ph.D. 2017
Dustin Crouse- <i>“Controlled Spalling in (100)-Oriented Germanium by Electroplating”</i> Senior Application Development Engineer @ 3D Systems	Advisor	M.S. 2017
Brett Ley- <i>“Wafer-Scale Controlled Spalling and Reuse of (100)-Oriented Germanium”</i> SIMS Senior Analyst @ EAG Laboratories	Advisor	M.S. 2019
Noor Alkurd- <i>“Demonstration of Functional III-V Photovoltaic Cell via Processing of Porous Ge Substrates”</i> Field Process Engineer @ Lam Research	Advisor	Ph.D. 2019
Jason Chenenko- <i>“The Role of Offcut and Spall Direction in Surface Morphology of Spalled (110) GaAs”</i> Materials Scientist @ NASA Langley Research Center	Advisor	M.S. 2021
Allison Perna- <i>“Surface Texturing and Anisotropic Growth Evolution in Hydride Vapor Phase Epitaxy”</i> Planning Ph.D. research	Advisor	M.S. 2023
Sarah Boardman- <i>“Understanding the Influence of Process Parameters on the Mechanical Properties of Alumina Formed Through Lithography-Based Additive Manufacturing”</i> Senior Engineer- Raytheon Technologies Research Center	Advisor	Ph.D. 2023
Anna Braun- <i>“Study of Fracture Morphology During (100) GaAs Spalling and Overgrowth Behavior on Spalled GaAs Facets by Hydride Vapor Phase Epitaxy” **NSF GRFP Fellowship</i> Research Scientist @ SRI International	Advisor	Ph.D. 2023
Jai Sharma- <i>“Elucidating Pressure-Induced Phase Transformations in Xenotime Rare Earth Orthophosphates” **DoD NDSEG Fellowship</i> Post-doctoral researcher @ Colorado School of Mines	Advisor	Ph.D. 2023

**Post-Doctoral Researchers Advised (completed contracts)**

Post-Doc Name/Years/Project Employment	Faculty Role (Advisor or Coadvisor)
Dr. Mukesh Kumar/2011-2013/Thin Film Oxide Characterization Associate Professor @ Indian Institute of Technology, Ropar	Advisor
Dr. Jason Fish/2014/Rare Earth Orthophosphate Synthesis Product Engineer @ Excelitas Technologies Corp.	Advisor
Dr. Dong Wu/2016-2017/Thin Film Piezoelectric Discovery Assistant Professor @ Wuhan Institute of Technology	Advisor
Dr. Yachao Chen/2018/Thin Film Piezoelectric Discovery Teaching Assistant Professor @ Kansas State University	Advisor
Dr. Rachel Schoepner/2017-2019/Metallic Glass Discovery Cleanroom Manager @ California NanoSystems Institute (UCSB)	Advisor
Dr. George Burton/2020/III-V Interface Characterization Materials Research Engineer @ NIST	Advisor
Dr. Jie Chen/2019-2021/Germanium Spalling Development Engineer @ Applied Optoelectronic Inc.	Advisor
Dr. Jai Sharma/2023-2024/Spalling process development Detector Test Engineer @ BAE Systems, Inc.	Advisor

### Undergraduate Researchers Advised (completed contracts)

Student	Dates	Notable Outcomes
Anthony Martinez*	Spring 2011-Fall 2013	
Joseph Carloni	Summer 2011	<ul style="list-style-type: none"> <li>• Author- paper- <i>Solar Energy Mat. &amp; Solar Cells</i></li> <li>• Poster Award</li> <li>• Author- poster-Washington, D.C. NSF National REU Conference</li> <li>• Pursued graduate school at Cornell University</li> </ul>
Rebecca Reitz	Summer 2011	<ul style="list-style-type: none"> <li>• Pursued graduate school at UC Santa Barbara</li> </ul>
Stephanie Gomez	Summer 2012	
James Gorman	Summer 2012	
Matthew Musselman	Summer 2012-May 2014	<ul style="list-style-type: none"> <li>• Author- paper- <i>J. Electrochem. Soc.</i></li> <li>• Author- conference proceeding- <i>Microscopy &amp; Microanalysis</i></li> <li>• Author- presentation- MRS</li> <li>• Pursued M.S. at Mines</li> </ul>
Kayla Raddant-Rankin	Fall 2012-Spring 2013	
Raymond Oberbroeckling	Fall 2012	
Elizabeth McClure	Summer 2013	<ul style="list-style-type: none"> <li>• Author-Presentation- NREL SULI</li> <li>• Pursued graduate school at Rochester Institute of Technology</li> </ul>
Skylar Zilliox*	Summer 2013-Summer 2014	<ul style="list-style-type: none"> <li>• Author- paper- <i>Nanoethics</i></li> <li>• Author- paper- <i>Teaching Ethics</i></li> </ul>



Tim Wilson*	Summer 2013	<ul style="list-style-type: none"> <li>• Author-Paper- <i>J. Electrochem. Soc.</i></li> <li>• Author- Presentation- MRS</li> <li>• Pursued graduate school at Mines</li> </ul>
Joshua McNeely	Spring 2014-Fall 2014	<ul style="list-style-type: none"> <li>• Author- Conference Proceeding &amp; poster- <i>IEEE PVSC</i></li> </ul>
Chloe Castenada	Summer 2015	<ul style="list-style-type: none"> <li>• Admission to NREL SULI Program</li> <li>• Pursued graduate school at Rhode Island School of Design</li> </ul>
Will Major	Summer 2015-Fall 2015	
Zachary McMullen	Summer 2015-Spring 2016	<ul style="list-style-type: none"> <li>• Author- Poster- MRS</li> <li>• Poster selected as award finalist</li> <li>• Pursued NT-M.S. at Mines</li> <li>• Author- Poster- Composites at Lake Louise</li> <li>• Author- Article on E-print server</li> </ul>
Benjamin Warren	Fall 2015	<ul style="list-style-type: none"> <li>• Pursued graduate school at Mines and Universite de Bordeaux</li> </ul>
Connor Dugan	Spring 2015	<ul style="list-style-type: none"> <li>• Pursued graduate school at CSU</li> </ul>
Jacob Tavenner	Fall 2015-Spring 2016	<ul style="list-style-type: none"> <li>• Pursued Ph.D. at Mines</li> </ul>
Ryan Plessinger	Fall 2015-Summer 2016	
Ryan Matheisen	Fall 2016-Spring 2017	
Anna Braun	Summer 2016	<ul style="list-style-type: none"> <li>• NREL SULI</li> <li>• NSF Graduate Fellowship</li> <li>• Pursued Ph.D. at Mines</li> </ul>
Majid Muhammad	Fall 2019-Spring 2020	
Kayla Andis	Fall 2021-Spring 2022	<ul style="list-style-type: none"> <li>• Presented at MURF conference</li> </ul>
Kathleen Mah	Fall 2021-Spring 2022	
Adjoa Sakwa	Fall 2022-Spring 2023	

### **Ph.D. and M.S. Thesis Committee Membership** (students not advised or co-advised by me)

Served on 33 Graduate Student Committees in departments & programs including:  
 Materials Science, Metallurgical & Materials Engineering, Chemical Engineering,  
 Petroleum Engineering, Mechanical Engineering, Chemistry & Geochemistry, Mining  
 Engineering

### PROFESSIONAL SERVICE

#### **Highlighted National/International Service**

- Chair, American Ceramic Society Members Services Committee 2024-2026
- Member of the Organizing Committee for Accelerating Discovery for Mechanical Behavior of Materials 2024/TMS Specialty Congress 2024, 2023-2024
- Invited member of the External Advisory Board for the Erich Schmid Institute of Materials Science of the Austrian Academy of Sciences 2022 - 2025
  - Deputy Chair
- Editor for the *Journal of Materials Science* 2017 - 2020
- Elected Leader of TMS Nanomechanical Behavior of Materials Committee 2015 - 2019
  - Elected to Vice Chair in 2015 for 2-year term, followed by ascension to Chair in 2017 for a 2-year term, followed by 2 years of informal Past Chair advisory role
- Appointed Leader on behalf of NREL to an International Energy Task Force 2012 - 2013

- Represented the U.S. on behalf of NREL (one of only two U.S. members) and joined representatives from Germany, Switzerland, Austria, Japan, China, and France for the International Energy Agency's Task 13 (Performance and Reliability of Photovoltaic Systems) Activity 3.2 (Collecting Failures and Adapting Test Methods to Failure Mechanisms for PV Modules)

*Other National/International Service*

**Membership in Professional Societies**

- The Minerals, Metals and Materials Society (TMS)
- American Ceramic Society (ACerS)
- Materials Research Society (MRS)
- TMS Technical Committees-
  - Mechanical Behavior of Materials Committee, 2009 - present
  - Nanomechanical Materials Behavior Committee, 2008 – present, Chair, 2017 - 2019
- Symposium organizer for TMS Annual Meeting 2013- *Fatigue and Fracture of Thin Films and Nanomaterials*
- American Ceramic Society- Member Services Committee, appointed, 2021- present
- Materials Research Society
  - MRS Outstanding Early Career Investigator Award Subcommittee, 2022 - 2023
  - Reviewer, Fall 2015 Annual Meeting Graduate Student Awards
  - Symposium organizer for Fall 2015 Annual Meeting- *Strength and Failure at the Micro- and Nano-scale: From Fundamentals to Applications*
- Gordon Research Conference: 2022 GRC on Solid State Studies in Ceramics
  - Organizer, Power Hour Session (supports prof. development for women), 2022
- Reviewer for a wide variety of journals in materials, mechanics, physics, and cross-disciplinary topics:
  - *ACS Nano, Small, Experimental Mechanics, Acta Materialia, JOM, Journal of Materials Research, Applied Physics Letters, Applied Surface Science, Ceramics International, Journal of Applied Physics, Thin Solid Films, Geology, Journal of Photovoltaics, IET Renewable Power Generation, Electrochemistry Communications, Metallurgical Transactions, Review of Scientific Instruments, International Journal of Materials, Journal of Physical Chemistry, Journal of Vacuum Science & Technology,* and others
- Reviewer for National Laboratories, and National & International Agencies
  - National Laboratories: Center for Integrated Nanotechnologies, NREL
  - National & International Agencies: NSF CMMI, NSF MRI, NSF DMR Ceramics, Army Research Office, CRDF Global, Austrian Academy of Sciences, Austrian Science Fund

UNIVERSITY SERVICE (USC)

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**University Service**

- Member, Advisory Board, Core Center for Excellence in Nanoscale Imaging (2024-present)

DEPARTMENT SERVICE (USC)

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**Department Service**

- Member, Graduate Applicant Review Committee (2024-present)

UNIVERSITY SERVICE (MINES)

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**Highlighted University Service**

- Dept. Representative (Appointed), Campus Undergraduate Council (2016 – 2023)
- Champion of Shared Experimental Facilities across campus
  - Member, Research Advisory Committee (2022 - 2023)
    - Presidential appointment- Advise and make recommendations to the Vice President for Research and Tech Transfer.
  - Member, Cleanroom Advisory Council (2022 - 2024)
  - Member, Mines' Shared Instrumentation Facility (SIF) Board (2021- 2024)
    - Vice President for Research & Technology Transfer appointment
  - Co-Director of the International Center for Multiscale Characterization (2017-2024)
    - The Center formally established legal interoperability of research facility use between Mines and NREL
  - Proposal Writer and Supporter of NSF Major Research Instrumentation acquisitions
    - PI or co-PI on 4 proposals, writing support and internal reviews on 3 proposals
    - Successful TOF-SIMS acquisition and management, leading to >\$400K in revenue
  - Member, Shared Instrumentation Facility Microscope Manager Search Committee (Summer 2022)

**Additional Campus-wide Service**

- Member, Materials Science Program (Dec. 2015 - 2024)
- Member, Nexus (Mines/NREL) (Affiliated Faculty) (2019 - 2024)
- Member, Undergraduate Council Steering Committee (2021 - 2022)
- Member, Dean of Energy & Materials Programs Search Committee (2021)
- Member, Mines' Faculty Awards Committee (2020, 2021)
- Member, REMRSEC (NSF MRSEC) Executive Board (2011 - 2019)
- Department Representative, Research Council (appointed) (2012 - 2017)
  - Led sub-committee to establish an undergraduate research program (2012)
- Member, Ad-hoc Graduate Dismissal Appeal Committee (2014)
- Faculty Advisor, Energy Minor Student Club (2010 - 2012)
- Served on 49 Graduate Student Committees (16 (my students) + 33 others)

DEPARTMENT SERVICE (MINES)

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**Highlighted Department Service**

- Leadership in Undergraduate Education Administration
  - Chair (Appointed), Metallurgical & Materials Engineering (MME) Undergraduate Affairs Committee (2016 - 2023)

- Planned monthly meetings, reviewed & updated undergraduate catalog, conducted strategic activities & advisement per Dept. Head direction
- Negotiated, proposed, and secured the first major changes to the MME Undergraduate program in more than 2 decades. Integrated all program changes, course additions, and course deletions in the Undergraduate Catalog over the course of a multi-year transition
- Executed the proposal and adoption of a 2<sup>nd</sup> departmental undergraduate degree program in Ceramic Engineering in 2022
- Reconciled both departmental BS program with the Mines@150 Core Curriculum update and streamlined course requirements for a reduction of 10 credit hours, without sacrificing in-major instructional content
- Dept. Representative (Appointed), Campus Undergraduate Council (2016 – 2023)
- Member, Undergraduate Council Steering Committee (2021 - 2022)

#### Additional Departmental Service

- Member, MME Undergraduate Affairs Committee (Aug. 2011 - 2024)
- Founder & Faculty Advisor, Women in Metallurgy, Materials & Nuclear (WiMMN-graduate women's group) (2013 - 2023)
- Member, Faculty Search Committees (2011 - 2012, 2012 - 2013, 2013 - 2014, 2021 - 2022)
- Associate Chair, Faculty Search Committee (appointed)- Chem. Proc. (2015 - 2016)
- Member, MME Ceramics Curriculum Committee (2022)
- Member, MME Ceramics Engineering Degree Committee (2023 - 202)
- Member, MME Departmental Committees- Finance (2021 - 2022), Faculty Awards (2021 - 2022), Strategic Planning (2019 – 2021, 2023), Graduate Affairs (2010 - 2011)

#### Faculty Mentoring Activities

- Formal faculty mentor for 2 Assistant Professors: Nicole Smith (Mining Engineering), Jonah Klemm-Toole (Metallurgical & Materials Engineering)
  - Met with mentees 1-2 times annually to discuss preparations for tenure and annual reviews
  - Reviewed annual reviews and mid-tenure package
  - Provided informal advising ~5 times a year, as needed (advising on committee service, departmental activities, awards, proposals, etc.)

#### Outreach Activities

- Founder & Faculty Advisor for Women in Metallurgy, Materials & Nuclear (WiMMN), 2013 - 2023
  - Helped graduate students create a support group for promoting the advancement of women in science, with participation from students from 3 graduate programs: Metallurgical and Materials Engineering Department, Materials Science Program, Nuclear Engineering Program.
  - Created club charter and formalization of club with school policies
  - Assisted with planning of meetings, new graduate student recruiting events, and professional development activities
  - Facilitated funding of group social and professional development activities
- Rocky Mountain Camp for Dyslexic Kids, 2015 - 2023
  - Co-Coordinator of Colorado School of Mines camp outreach efforts, 2019 - 2023

- Scheduled 2 weeks of daily science modules, train new participants for success in working with children with dyslexia
  - Continued involvement with the camp through Covid restrictions, with sanitation and masking
- Organizer, On-Campus Workshop for faculty training for Outreach to the Rocky Mountain Camp for Dyslexic Kids, 2019
  - Planned workshop, including a presentation by a K-12 teacher with specialization with Dyslexia
- Developer of module content for outreach, 2015 - 2023
  - Conceptualized, planned, documented, and delivered hour-long science modules of hands-on activities for children with dyslexia
  - Aligned modules with State of Colorado STEM learning objectives
  - 4 original modules developed: Polymorphism in Crystals (2022), Fracture of Materials (2022), Ceramics in Renewable Energy (2017), Sintering of Ceramics (2015, 2021). Modules are electronically archived for continued public use.
  - Outreach with the camp has been used as an example of NSF Broader Impacts in NSF presentations to members of Congress
- Graduate Teaching Fellows Program, 2014
  - Sponsored graduate student, Matthew Musselman, in the Graduate Teaching Fellows Program, where he spent 15-20 hrs. per week in an elementary school classroom as part of the outreach component of my NSF CAREER award
- Participant in REMRSEC K-8 Teacher Training Program, 2012, 2013