Publications

1. A Mass Spectrometrical Surface Chemistry Study of Aluminum Nitride ALD from Tris-Dimethylamido Aluminum and Ammonia. **Materials Advances**. Mpofu, P., Hafdi, H., Lauridsen, J., Alm, O., Larsson, T., & Pedersen, H. (2024).
2. Surface chemistry in atomic layer deposition of AlN thin films from Al(CH3)3 and NH3 studied by mass spectrometry. **Journal of Materials Chemistry C**. Mpofu, P., Hafdi, H., Niiranen, P., Lauridsen, J., Alm, O., Larsson, T., & Pedersen, H. (2024).
3. Physicochemical and statistical modeling of Reactive Yellow 145 enhanced adsorption onto Pyrrhotite Ash-Based novel (Catechin-PG-Fe)-Complex. **Materials Science for Energy Technology**. (6) 2023, pp 65-76.B.Hatimi A. Loudiki, J.Mouldar, H.Hafdi, M.Joudi, M.Bensemlali, A.Aarfane, ,H.Nasrellah, M.A.El Mhammedi, El M.Bakasse. (2023).
4. One-step synthesis and characterisation of crystalline nano-calcite from phosphogysum by precipitation method. **The European Physical Journal Applied Physics**. M.Bensemlali, M. Joudi, H. Nasrellah, I. Yassine, A. Aarfane, B. Hatimi, H. Hafdi, J. Mouldar and M. Bakasse. The European Physical Journal Applied physics. 97, 50 (2022).
5. Adsorption of Chromuim VI onto Hydroxyapatite –Chitosan- Montmorillonite ThinFilm. **Materials Proceedings Today**. In press. Joudi, M., Nasserlah, H., Hafdi, H.,Mouldar, J., Hatimi, B., El Mhammedi, M. A., Bakasse, M (2022).
6. Novel synthesis and characterization of crystalline fluorapatite from Moroccan phosphogypsum waste. **Matériaux & Techniques**, 110(1), 102. Nasrellah, H., Joudi, M., Bensemlali, M., Yassine, I., Hatimi, B., Hafdi, H., Bakasse, M. (2022).
7. Synthesis of brushite from phophogypsum industrial waste. **Biointerface Research in Applied Chemistry**. Yassine, I., Joudi, M., Hafdi, H., Hatimi, B., Mouldar, J., Bensemlali, M. Bakasse, M. (2022)., 12(5), 6580-658815.
8. Nickel sulfide impregnated on natural phosphate: characterization and applications in photocatalytic degradation of indigo carmine dye**. Journal of Optical and Quantum Electronics. Springer Nature**. Hafdi, H., Joudi, M., Mouldar, J., Hatimi, B., Nasrellah, H., El Mhammedi, M. A., & Bakasse. April (2021).
9. Synthesis of an efficient hydroxyapatite–chitosan–montmorillonite thin film for theadsorption of anionic and cationic dyes: adsorption isotherm, kinetic and thermodynamic study. **Springer Nature**. Joudi, M., Nasserlah, H., Hafdi, H., Mouldar,J., Hatimi, B., El Mhammedi, M. A., & Bakasse, M. June (2020).
10. Pyrrhotite Ash Waste for Capacitive Adsorption and Fixed-Bed Column Studies:Application for Reactive Red 141 Dye. **Water Air and Soil Pollution** 231 (5) Mouldar,J., Hatimi, B. H., Hafdi, Joudi, M.,El Alaoui Belghiti, M., Nasserlah, H., ElMhammedi, M. A., El Gaini, L., Bakasse, M. May (2020).
11. Design of a new low cost natural phosphate doped by nickel oxide nanoparticles for capacitive adsorption of reactive red 141 azo dye. **Environmental Research**, 109322. Hafdi, H., Joudi, M., Mouldar, J., Hatimi, B., Nasrellah, H., El Mhammedi, M. A., & Bakasse. February (2020).

12. Low cost pyrrhotite ash/clay-based inorganic membrane for industrial wastewaters treatment. **Journal of Environmental Chemical Engineering**, 8(1), 103646. B.Hatimi, J.Mouldar, A.Loudiki, H.Hafdi, M.Joudi, E.M.Daoudi, H.Nasrellah, M.A.El Mhammedi, M.Bakasse. December (2019).

13. Conversion of the Nitro Group to the Nitroso in Aromatic Compounds: Case ofp-Nitrophenol Using the Catalytic Effect of Palladium. Lahrich, S., Hrioua, A.,Laghrib, F., Hafdi, H., Bouzidi, A., Bakasse, M., & Abderrahim El Mhammedi,M.. **ChemistrySelect**, 4(42), 12320-12327.November (2019).

14. Removal of azodyes using natural phosphate doped by titanium dioxide (NP-TiO2) nanoparticles. Joudi, M., Hafdi, H., Mouldar, J., Nasrellah, H., Hatimi, B., El Mhammedi, M. A., & Bakasse, M. **Desalination and Water Treatment**, 168, 298-307. January (2019).

15. Kinetic, equilibrium and thermodynamic modeling of disperse dye adsorption onto fly ash. **International Journal of Advanced Research**. 816-824 H. Hafdi, J. Mouldar, M. Joudi, H. Nasrellah, M. A. El Mhammedi, M. Bakasse. February 2018.

16. Equilibrium and Kinetic Modeling Of Adsorption Of Disperse Blue 79 Onto Different Adsorbents. **Global Journal of Engineering Science and Research Management.** Joudi, M., Hafdi, H., Mouldar, J., Nasrellah, H., El Mhammedi, M. A., & Bakasse, M. June 2017.

17. Isotherm, Kinetic And Thermodynamic Studies On The Adsorption Behavior Of Disperse Blue 165 Dye Onto Chitosan And Phosphogypsum. J. Mouldar, M. Joudi1, H.Hafdi, H. Nasrellah, L. El Gaini, M. Bakasse. **Global Journal of Engineering Science and Research Management**. December 2017.

List of Publications

Dissertation Topic: Void Strengthening and Growth in Structural Metals: A Mesoscale Perspective

Roach, A. M.
University of California, Santa Barbara
Materials Department

Under embargo- will be available for online access through ProQuest after 10/27/2025.

1. **Void growth in the lithium anode of a solid state battery**

Roach, A. M.[1,2], Zhu, W.[1,2], Vema, S.[3], McMeeking, R.M.[4], Grey, C.P.[2,3], Deshpande[1,2], V.S., Fleck[1,2], N.A., *In Review*

Personal Contributions: Investigation, Methodology, Formal Analysis, Visualization, Writing- Original Draft

Affiliations:
[1] Department of Engineering, University of Cambridge, Trumpington St., Cambridge CB2 1PZ, UK
[2] The Faraday Institution, Quad One, Harwell Campus, Didcot OX11 0RA, UK
[3] Yusuf Hamied Department of Chemistry, University of Cambridge, Lensfield Rd., Cambridge CB2 1EW, UK
[4] Department of Mechanical Engineering and Materials Department, University of California Santa Barbara, Santa Barbara, CA, 93106, USA

2. **Interaction of extended dislocations with nanovoid clusters**

Roach, A. M.[1], Xu, S.[2], Luscher, D. J.[3], Gianola, D. S.[1], Beyerlein, I. J. [1][4]
International Journal of Plasticity (2023), 103684

Citations: 12

Personal Contributions: Visualization, Formal Analysis, Investigation, Writing- original draft

Abstract: Voids of nanoscale dimensions in irradiated metals can act as obstacles to dislocation motion and cause strengthening. In this work, nanovoid strengthening and the influences of void size, void spacing and material properties, such as stacking fault

energies, on dislocation bypass mechanisms are investigated using Phase Field Dislocation Dynamics, a three-dimensional mesoscale model that predicts the minimum energy pathway taken by discrete dislocations. A broad range of face centered cubic metals (copper, nickel, silver, rhodium, and platinum) and nanovoid sizes and spacings are treated, altogether spanning void size–to–dislocation stacking fault width ratios from less than unity to ten. Material -surfaces, calculated from ab initio methods, are input directly into the formulation. The analysis reveals that the critical bypass stress scales linearly with the linear void fraction, effective isotropic shear modulus, and ratio of the intrinsic to unstable stacking fault energies. With only a few exceptions, the critical stress is controlled by the stress required for the leading partial to impinge the voids (to move within range of the attractive image stress field of the void). When the void diameter is nearly an order of magnitude greater than the stacking fault width, the mechanism determining critical strength shifts to the stress for the dislocation to breakaway after partially cutting the void. This situation corresponds to that treated by line tension models and is realized here for Pt, with a sub-nanometer stacking fault width.

Affiliations:
[1] Materials Department, University of California, Santa Barbara, CA 93106-5050, USA
[2] School of Aerospace and Mechanical Engineering, University of Oklahoma, Norman, OK 73019-1052, USA
[3] Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA
[4] Department of Mechanical Engineering, University of California, Santa Barbara, CA 93106-5070, USA

3. **Size dependent stochastic tensile properties in additively manufactured 316L stainless steel**

Roach, A. M. [1], White, B. C. [1], Garland, A. [1], Jared, B. H. [1], Carroll, J. D. [1], & Boyce, B. L. [1]
Additive Manufacturing (2020), 32, 101090

Citations: 141

Personal Contributions: Investigation, Writing – original draft

Abstract: Recent work in metal additive manufacturing (AM) suggests that mechanical properties may vary with feature size; however, these studies do not provide a statistically robust description of this phenomenon, nor do they provide a clear causal mechanism. Because of the huge design freedom afforded by 3D printing, AM parts typically contain a range of feature sizes, with particular interest in smaller features, so the size effect must be

well understood in order to make informed design decisions. This work investigates the effect of feature size on the stochastic mechanical performance of laser powder bed fusion tensile specimens. A high-throughput tensile testing method was used to characterize the effect of specimen size on strength, elastic modulus and elongation in a statistically meaningful way. The effective yield strength, ultimate tensile strength and modulus decreased strongly with decreasing specimen size: all three properties were reduced by nearly a factor of two as feature dimensions were scaled down from 6.25 mm to 0.4 mm. Hardness and microstructural observations indicate that this size dependence was not due to an intrinsic change in material properties, but instead the effects of surface roughness on the geometry of the specimens. Finite element analysis using explicit representations of surface topography shows the critical role surface features play in creating stress concentrations that trigger deformation and subsequent fracture. The experimental and finite element results provide the tools needed to make corrections in the design process to more accurately predict the performance of AM components.

Affiliations:
[1] Materials, Physical, and Chemical Sciences Center, Sandia National Laboratories, Albuquerque, NM 87185-0889, United States

4. **Automated high-throughput tensile testing reveals stochastic process parameter sensitivity.**

Heckman, N. M. [1],, Ivanoff, T. A. [1],, Roach, A. M. [1],, Jared, B. H. [1],, Tung, D. J. [1],, Brown-Shaklee, H. J. [1], ... & Boyce, B.L. [1],
Materials Science and Engineering: A (2020), 772, 138632

Citations: 53

Personal Contributions: Investigation

Abstract: The mechanical properties of additively manufactured metals tend to show high variability, due largely to the stochastic nature of defect formation during the printing process. This study seeks to understand how automated high throughput testing can be utilized to understand the variable nature of additively manufactured metals at different print conditions, and to allow for statistically meaningful analysis. This is demonstrated by analyzing how different processing parameters, including laser power, scan velocity, and scan pattern, influence the tensile behavior of additively manufactured stainless steel 316L utilizing a newly developed automated test methodology. Microstructural characterization through computed tomography and electron backscatter diffraction is used to understand some of the observed trends in mechanical behavior. Specifically, grain size and morphology are shown to depend on processing parameters and influence the observed mechanical behavior. In the current study, laser-powder bed fusion, also known

as selective laser melting or direct metal laser sintering, is shown to produce 316L over a wide processing range without substantial detrimental effect on the tensile properties. Ultimate tensile strengths above 600 MPa, which are greater than that for typical wrought annealed 316L with similar grain sizes, and elongations to failure greater than 40% were observed. It is demonstrated that this process has little sensitivity to minor intentional or unintentional variations in laser velocity and power.

Affiliations:
[1] Sandia National Laboratories, Albuquerque, NM, 87185, USA

Ph. D /she/her

Postdoctoral Researcher

| Linköping University. Sweden

EDUCATIONAL BACKGROUND

Postdoc | Materials chemistry

Linköping University. Sweden

2023 – Present

Ph.D. | Physical chemistry

Chouaib Doukkali University Morocco

2015 – 2021

Double Msc | Analytical chemistry, instrumentation and environment

Mohammed 5 Agdal University, Morocco | 2011-2013

Paul Sabatier University of Toulouse, France | 2011-2013

Bsc| Mining Engineering

Hassan Premier University, Morocco

2009 – 2011

SKILLS

Chemical vapor deposition

Atomic vapor deposition

Sustainability Assessment

Life Cycle Assessment

Nanomaterial Synthesis

Heterogeneous Catalysis

Quality assessment

Research and process technology

Academic Writing

Adsorption/Desorption

Entrepreneurial Skills

Project/team Management

LANGUAGE

Arabic (native)

French (bilingual proficiency)

English (professional proficiency)

Spanish (Intermediate)

Turkish (basic)

PERSONAL STATEMENT

I am a Postdoctoral researcher in Henrik Pedersen Research group, I conduct research on the environmental impact of the CVD/ALD process using the Life Cycle Assessment methodology. I also work on investigating the surface chemistry of the deposition of semiconductors using the ALD process.

PROFESSIONAL EXPERIENCE AND AREAS OF EXPERTISE

Postdoctoral Researcher / Key achievements | 2023-Present

Operated the ALD reactor for the deposition of ALN and GaN thin films.

Investigated the surface chemistry of the ALD of AlN, AlTiN and GaN thin films deposition.

Operated the SimaPro software for the life cycle assessment of the ALD Process.

Investigated the sustainability of the ALD process

Characterized semiconductors using SEM, XPS, APXPS, XRD, OES.

Doctoral Researcher / Key achievements | 2015-2021

Developed multimetal-doped materials (thin films, powders, membranes) for industrial wastewater treatment via adsorption/desorption and heterogeneous catalysis.

Research assistant for many multidisciplinary industrial projects, working with professionals to develop eco-friendly solutions.

Supervisor / Instructor to undergraduate and postgraduate students for their final graduation projects.

Professional/ Work experience

Freelancer | 2021 – Present

I provide online proofreading and editing services of scientific research papers.

Certified Active Reviewer in ELSEVIER platform.

Chemistry instructor/ Wastewater treatment | 2017-Present

Work safety and health instructor | 2021

Taught the fundamentals of safety and health at a workplace to postgraduate students of the Cadi Ayyad University of Marrakech, Morocco.

Quality manager intern at laboratory of research LPEE, Casablanca Morocco | 2013

Assessment of production quality of cement/ Monitoring and managing laboratory activities for similar projects. Foreign visitors guide of the facility.

Chemical process Intern at OCP group in Khouribga Morocco | 2009-2010-2011

Process and quality manager at the municipal waste water plant and phosphate exploitation plants/ developed concepts for effective production results.

Part-time English language teacher | 2016 – 2019

Volunteer Leadership skills tutor | 2021-2022

HONORS AND AWARDS

The Excellence Research Scholarship Award | CNRST, Morocco | 2015-2017

First place winner at the "My Thesis in 180s" public speaking competition |2016

First place winner at the public speaking competition held by UCD-UM6P-ACT4 |2020: Post-COVID

Life (Community values, Education, Employment, Environment).

First place winner of best junior Start up in Morocco |2016

International prize for innovative product of the year of in Bahrain | 2016

An active participator in /international symposiums through poster and oral communications |

MAIN INTERESTS

Research
Teaching
Traveling
Reading Books

LEADERSHIP/ VOLUNTEERING EXPERIENCE

Volunteer instructor of Sustainable Development Goals | 2019

AIESEC program Myself My World, Turkey

Volunteer Tutor of entrepreneurial skills | 2017 – present

Mentored and taught communication and entrepreneurial skills to young high school and university students to create innovative products and compete for best Start Up as part of INJAZ Al MAGHRIB competition.

Adaptable and inquisitive scientist with extensive expertise in mechanical testing and characterization, analytical and computational research into fundamental deformation mechanisms for structural metals, and structural mechanics theory. Primary strengths include experimental design, large scale and sub-scale mechanical testing, electron microscopy, meso-scale energy-based modeling using Phase-Field Dislocation Dynamics (PFDD). Current research efforts focus on characterization of failure mechanisms in battery systems including electrochemical testing and materials design and engineering.

EDUCATION

PhD in Materials Science August 2023

University of California Santa Barbara, Santa Barbara, CA

Dissertation: "Void Strengthening and Growth in Structural Metals: A Mesoscale Perspective"

- Structural Materials Specialization
- Gianola Group, Beyerlein Group

B.S. in Mechanical Engineering May 2017

University of New Mexico, Albuquerque, NM

- Minor in Mathematics and Minor in Physics
- Graduated Summa Cum Laude

EXPERIENCE

Research Associate for **University of Cambridge Department of Engineering**, Cambridge, UK

Sep 2023- Present

Principal Investigator Norman Fleck, collaborating with Vikram Deshpande and Clare Grey

Faraday Institution Lithium Metal Solid State Battery Degradation Study

Project 1: Interfacial Voids

Motivation: Lithium-ion all solid state batteries (SSBs) have the potential to provide increased energy densities and safer operation than conventional Li-ion technologies. Unfortunately these benefits have not been fully realized because these batteries fail prematurely in application, with one failure mechanism being runaway voltage rise during battery discharge. Conventional thinking attributes the runaway voltage to loss of contact between the electrode and the electrolyte, which has been conceptualized as interfacial void growth in the literature. However Li metal experiences two driving forces for void closure, not growth, during battery operation: 1) creep strain due to the compressive pressure applied during operation, and 2) the bulk migration of the Li metal electrode towards the Li/ceramic interface due to Li-ion flux during stripping. The confluence of these two factors should make loss of contact due to voiding an inaccessible failure pathway, but no experimental evidence for this argument exists in literature to date.

Project Contributions:

- Designed a model battery cell to directly track void evolution at the Li electrode/ceramic electrolyte interface in-situ during operation. This enabled direct in-situ tracking of voids during battery operation, which has not been previously achieved in literature with Li SSBs.
- Developed a material model combining creep and stripping effects on void closure for use when designing future batteries, which identifies a window of electrode geometries, stripping currents, and applied pressures that will give optimized properties for void closure.

- Performed creep experiments on the highly constrained Li metal electrodes to characterize creep mechanisms and determine the creep exponent following friction hill theory.
- Performed battery discharge tests both with and without applied pressure to track void evolution.
- Presented every quarter for Faraday Institution collaborators

Main Results: Interfacial voids at the Li/ceramic interface have been shown experimentally to close under conditions representative of battery operation. Further, the void collapse behavior can be fully characterized, at least to first order, by the linear combination of creep and electrode drift during discharge. This is the first experimental evidence of its kind, and can be used to better inform the understanding of voiding in Li SSBs. By extension, these findings can lead to better-informed treatments for voltage rise during discharge than what is currently state-of-the art in literature.

Project 2: Failure During Discharge

Motivation: Experimental investigations have confirmed that void growth at the Li/ceramic electrolyte interface is not favored when considering conventional creep theory and Butler-Volmer kinetics. However it remains true that Li SSBs fail by a rapid and catastrophic increase in interface resistance during discharge. Further, post-mortem focused ion beam (FIB) cross-sectioning show voids at the interface, and in-situ computed tomography (CT) studies of analogous Na solid state batteries have shown void evolution during stripping. The question then remains: what is reason for this failure pathway, and what driving force is large enough to grow voids against both creep and stripping forces for closure?

Project Contributions:

- Designed a parameter space for systematic investigation of fabrication techniques, applied pressures during discharge, and discharge currents and their influence on cell performance for cells with Lithium-Lanthanum-Zirconium-Oxide (LLZO) as the ceramic electrolyte.
- Performed battery testing within this parameter space.
- Analyzed both battery performance and Li/ceramic interface structures using SEM and EDX.

Main Results: While this is an ongoing study, evidence has emerged for an oxygen-rich structure developing at the Li/LLZO interface. Conventional understanding in the literature is that LLZO is non-reactive with Li, calling into question where this structure is originating from, how sensitive it is to contamination, if any gaseous reaction products occur during formation, and if any volume changes are attributed to formation.

Publications

- Roach, A.M., Grey, C.P., Deshpande, V.S., Fleck, N.A. (2024). Driving Force for Void Closure at Lithium Metal-Garnet Interface of Solid State Electrolytes. *In Review*

Experimental Proficiencies

- Lithium metal processing and handling in Argon glove box
- Solid state battery assembly and testing using Biologic battery cyclers
- Hot press fabrication and tube furnace annealing of LLZO garnet
- Python and Matlab image processing of void evolution and bulk strains
- SEM and EDX characterization of failure interfaces
- Electrochemical impedance signal analysis of batteries before, during, and after cycling

Graduate Student Researcher for **UCSB Structural Materials Department**, Santa Barbara, CA

Sep 2017- Aug 2023

Co-advised by Dr. Daniel S. Gianola and Dr. Irene J. Beyerlein
Externally advised by D.J. Luscher at Los Alamos National Lab (LANL), Theoretical Division

Office of Naval Research (ONR) Ductility Screen for Refractory Alloy Design Study

Motivation: Refractory Multi-Principle Element Alloys (RMPEAs) are a promising set of materials for their high operating temperatures and limited reactivities to many extreme environments, but their compositional space has not been extensively explored due to the high melting temperatures for most of the component elements. For the compositions that have been explored, many are found to be brittle and functionally unusable for structural applications. To rapidly explore the ductility of a larger compositional space, a thin film co-deformation test was devised to enable room temperature sputter deposition of a wide compositional range and rapid pass/fail ductility tests by measuring the co-deformation behavior of each compositional patch during tensile testing.

Project Contributions:

- Designed and fabricated room temperature tensile ductility screening coupon for co-deformed thin film RMPEA. This was done by magnetron sputtering a continuous compositional range of two ternary alloys MoNbTi, which is known to be brittle at room temperature, and TaNbTi, which is known to have some finite ductility at room temperature.
- Performed tensile tests on a Ta dogbone substrate and measured dynamic crack spacings of co-deformed ternary films with strain using a high speed camera.
- Validated this experimental approach with preliminary tests on the ductile TaNbTi and the brittle MoNbTi films co-deformed on a single substrate, while also identifying equipment limitations for resolution of crack spacing across multiple films simultaneously.

Main Results: By dynamically measuring the crack spacing of the co-deformed RMPEA film and identifying the strain at which these crack spacings saturate, a quick pass/fail metric of film ductility in relation to substrate ductility can be used to rapidly identify compositions that have the promise of some non-negligible room temperature ductility at a fraction of the time and cost that conventional alloy characterization takes with RMPEAs.

DOE NNSA Laboratory Residency Graduate Fellowship (LRGF) Nanovoid Strengthening in FCC

Motivation: The impact of irradiation damage on the mechanical properties of structural, such as austenitic stainless steels, are of concern for nuclear power plants. A large contributor to irradiation hardening, a common consequence of irradiation damage, in structural metals is nanovoid strengthening, where nanovoids (<10-20nm diameter) will act as obstacles to dislocation motion during plastic deformation. However, conventionally held understandings of this mechanism are limited to dislocation models that can't fully capture the effects of dislocation dissociation, which is expected to be the form dislocations take in face centered cubic (FCC) metals such as the austenitic stainless steels which are used prolifically in nuclear power plants.

Project Contributions:

- Outlined the relevant parameter space of the problem and simulated nano-scale void strengthening using Phase Field Dislocation Dynamics (PFDD) to understand influence of void geometries and material properties.
- Revisited conventionally-held understandings of dislocation bypass mechanisms by developing a simple empirical model for dissociated dislocations.
- Presented poster at LRGF Annual Review June 2022
- Presented at TMS Spring Conference 2023
- Presented at LRGF Annual Review June 2023

Main Results: Using the meso-scale PFDD model, it was found that not only does dissociation change the overall strengthening trends for nanovoids, but a new empirical strengthening model was devised to predict the combined influence of stacking fault energy and elastic modulus. This model was developed to be a simple and universally applicable as possible, and was found to capture the trends of previously published atomistic data for dissociated dislocations as well, suggesting the theory is robust and widely relevant.

LANL Laboratory Directed Research and Development (LDRD) Void Growth Size Effects in FCC

Motivation: Void growth in structural metals, whether in classic ductile fracture theory or as spallation in high strain rate deformation, has been theorized to be size-dependent for voids that are under a micron in diameter, generally falling into the "smaller is stronger" and "smaller is slower"

categories. No direct experimental evidence for either the exact dislocation ensemble behavior driving void growth, or the size-dependent evolution of this plasticity, existed to date.

Project Contributions:

- Designed, fabricated, and tested lithographically-patterned small-scale mechanical testing film coupons (dogbone geometry, gauge section 5 by 10 microns, 100nm thick film) with intentional void defects for in-situ characterization of void growth in ductile FCC metals.
- Optimized magnetron sputtering and subsequent annealing approach to increase the grain size of very thin (100nm) sputtered Cu film.
- Performed in-chamber SEM uniaxial tensile tests coupled with transmission electron imaging through the use of a STEM detector.
- Tracked the void size in-situ using MATLAB image processing, and coupled the void evolution with transmission contrast evolution to correlate bulk stress strain results with void growth and discrete plastic events.
- Presented at TMS Spring Conference 2020

Main Results: An additional, and arguably equally or more relevant size effect, was identified in this study: the size of the void size in relation to the characteristic length scale of the microstructure. This had been quantified through CPFE simulations previously in literature, but direct experimental evidence did not yet exist. While it may be that the "smaller is stronger" and "smaller is slower" are size effects theorized in literature are valid, idealized model systems which predicted these relationships neglected to consider the complexity of real microstructures and the interplay between voids and other heterogeneities such as grain size.

Publications

- Roach, A. M., Xu, S., Luscher, D. J., Gianola, D. S., Beyerlein, I. J. (2023). Revisiting the force balance for nanovoid strengthening. *In Process*
- Roach, A. M., Xu, S., Luscher, D. J., Gianola, D. S., Beyerlein, I. J. (2023). Interaction of extended dislocations with nanovoid clusters. International Journal of Plasticity, 103684

Teaching Experience

- TA for MATRL 100B Winter 2018: Structures and Properties II, covering mechanical properties, bonding, elasticity, plasticity, and fracture, crystal structure defects, and strengthening and toughening.
- Instructor of Research Module for UCSB SIMS Program Summer 2020: Developed and taught a virtual lab on Digital Image Correlation (DIC) and MATLAB processing.

Experimental Proficiencies

UCSB Nanofab Cleanroom Facility

- cleanroom processes such as lithography, CVD and PVD, and selective etching

UCSB Materials Department Microscopy Facility

- SEM use for characterization
- Transmission-SEM (T-SEM) imaging
- Femtotools nanomechanical testing systems
- FIB use for creation and manipulation of samples

UCSB Materials Processing Laboratory

- Magnetron sputtering with combinatorial alloying capabilities
- Tube furnaces, hot-pressing furnaces, and vacuum annealing

UCSB High Performance Computing (HPC)

- PFDD modeling using UCSB-developed code, solved on GPU clusters

LANL HPC

- CPFE modeling using dynamic hydrocode FLAG developed at LANL

Data Processing

- Python

- MATLAB, use of open-source Digital Image Correlation (DIC) Toolbox

Student Intern for **Sandia National Laboratories, Materials Mechanics and Tribology**
Albuquerque, NM *Jun 2016- Jan 2018*

Statistically Relevant Data Sets for Additively Manufactured Metal Components

Motivation: At the time of this study, additive manufacturing was a promising, rapidly expanding field that promised unrivaled versatility in part geometry and speed of manufacturing. However the increased stochasticity of material properties for nominally identical sample populations posed a difficult problem for characterizing additively printed materials, and experiments in literature identified a troubling correlation between feature size and material properties. Increased variability necessitated robust statistics, motivating the development of a rapid tensile testing method to gather mechanical properties from statistically relevant populations. With this rapid approach, the apparent size effect observed in literature could be systematically characterized.

Project Contributions:

- Designed and created automated tensile testing apparatus to test and measure additively manufactured tensile samples at high rate — upwards of 500 tests a day.
- Designed artifact to test limits of powder-bed fusion metal printers and inspect structural and chemical properties of additively manufactured material.
- Developed in-house image processing MATLAB script to measure tensile specimen in rapid, automated non-contact method.
- Lead research project on size-dependent properties of additively manufactured (AM) metals and effects of HIP (Hot Isostatic Pressing) on structural properties and geometric tolerances of powder-bed fusion printed 316L stainless steel.
- Presented at TMS Spring Conference 2020

Main Results: The inherent surface roughness of as-printed specimen was identified as the primary reason for persistent size effects in samples that had nominally identical microstructures, confirmed by a collaboration with finite element modeling to simulate the exact surface roughness gathered from micro-CT scans of representative samples. While this seems a common-sense conclusion, it would have been quite difficult to definitely prove without the benefit of statistically-relevant sample sets. Ultimately this study speaks to the importance of either designing with as-printed surface roughness in mind, or planning for post-printing surface treatment that may ultimately somewhat detract from the benefits of additive manufacturing of speed and geometric versatility.

Publications

- Roach, A. M., White, B. C., Garland, A., Jared, B. H., Carroll, J. D., & Boyce, B. L. (2020). Size dependent stochastic tensile properties in additively manufactured 316L stainless steel. Additive Manufacturing, 32, 101090.
- Heckman, N. M., Ivanoff, T. A., Roach, A. M., Jared, B. H., Tung, D. J., Brown-Shaklee, H. J., ... & Madison, J. D. (2020). Automated high-throughput tensile testing reveals stochastic process parameter sensitivity. Materials Science and Engineering: A, 772, 138632.
- Boyce, B. L., Jared, B. H., Roach, A. M., Allison, J., Dressler, A. D., Seepersad, C. (2020). The stochastic behavior of additive lattices. No. SAND2020-9687C. Sandia National Lab.(SNL-NM)

Experimental Proficiencies

- MATLAB data processing and use of Image Recognition Toolboxes
- MTS procedure software
- GOM 3D scanner and software

Student Intern for **Sandia National Laboratories, Purchased Product Value Stream**,

Albuquerque, NM *Nov 2014- Jun 2016*

- Revised internal best-practice procedural guides
- Updated engineering drawings to improve manufacturability and ease of inspection

Research Assistant for **Dr. Douglas Fields of UNM Physics Department**, Albuquerque, NM
Jun 2014- Jan 2015

- Built components for new-age Gas Electron Multiplier (GEM) Detector

Math and Physics Tutor at **Engineering Student Services for UNM**, Albuquerque, NM
Sep 2013- Jan 2015

- Tutored engineering students in calculus and calculus-based physics

PUBLICATIONS

- Roach, A.M., Grey, C.P., Deshpande, V.S., Fleck, N.A. (2024). Driving Force for Void Closure at Lithium Metal-Garnet Interface of Solid State Electrolytes. *In Review*
- Roach, A. M., Xu, S., Luscher, D. J., Gianola, D. S., Beyerlein, I. J. (2023). Revisiting the force balance for nanovoid strengthening. *In Process*
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DIVERSITY EQUITY AND INCLUSION (DEI) INVOLVEMENT

- Founding member of UCSB Materials Student Association (MSA) in Fall 2020.
- Advised formation of UCSB Materials Department DEI faculty and staff committee in Fall 2020.
- Member of Outreach Committee for UCSB MSA Fall 2020 to Fall 2023. Planned and organized multiple events for undergraduates and younger graduate students.
    - Path to Graduate School Seminar for undergrads 2021
    - Graduate School Q+A Panel for undergrads 2021
    - How to be a Good Mentor Seminar for grads 2022
    - Journal Club for new grads 2022-2023
    - Connecting undergrad researchers with UCSB Materials labs

SOFTWARE

- Python
- MATLAB
- Solidworks
- LaTeX
- Slurm batch processing

- Panopto

ACADEMIC AWARDS AND HONORS

- DOE NNSA LRGF Fellow, 2020-2023
- UNM Presidential Scholarship Award, 2013-2017
- Undergraduate Speaker for UNM School of Engineering Convocation, Spring 2017
- Secretary of Pi Tau Sigma, The International Mechanical Engineering Honor Society, 2016-2017
- Student Member on Mechanical Engineering Student Advisory Board, 2016-2017
- General Samuel C. Phillips Endowed Scholarship, 2014-2015
- School of Engineering Outstanding Sophomore Award, 2013-2014