Exponent®
Engineering & Scientific Consulting

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Professional Profile

Dr. Slone specializes in solving complex problems related to metallurgy, welding, corrosion, and material embrittlement and degradation. He applies his expertise to investigating and preventing failures in a wide range of components, products, and systems.

Overview

Dr. Slone's work focuses on the performance of materials across a wide range of industries. He applies the fundamental principles of metallurgy, materials science, and engineering mechanics to determine why failures occur, or to support clients' efforts preventing future failures. He has leveraged his expertise to help clients understand or solve problems related to material and manufacturing issues, time-dependent material damage or degradation (including fatigue, corrosion, environmentally assisted cracking, and hydrogen embrittlement), or component overload. A common theme throughout his work is elucidating the connections between engineering design, fabrication or manufacturing, metallurgical fundamentals, and component/system operating environments. He also frequently evaluates components or processes in the context of standards and codes from organizations such as ASME, ASTM, AWS, ISO, API, and SAE. Dr. Slone is a registered Professional Engineer and a Certified Welding Inspector. Selected examples of industry experience and additional projects are provided below.

Petrochemical Piping and Equipment

Dr. Slone has investigated failures or supported integrity management efforts in a wide variety of petrochemical systems, including natural gas transmission and distribution piping, process piping, and refinery equipment. He has analyzed failure mechanisms such as stress-corrosion cracking, hydrogen embrittlement, fatigue, corrosion, and selective seam weld corrosion, among others. He has experience interpreting industry codes and standards such as API 1104, ASME B31.1 and B31.3, ASME BPVC Sections VIII and IX, and API 579. He has also provided metallurgical support for fire investigations involving ruptured piping and pressure vessels.

Energy, Infrastructure, and Machinery

Dr. Slone has investigated failures or supported integrity management efforts in applications such as electric power transmission and distribution, industrial machinery, and large structures. He has evaluated metallurgical aspects of rotating machinery and components such as gas turbines, wind turbine generators, and evaporator fans. Dr. Slone has also supported corrosion assessments or material selection efforts for various components and structures exposed to outdoor environments.

Vehicles

Dr. Slone has investigated component failures in automotive, utility, and micromobility vehicles. He has analyzed failure mechanisms such as wear, fatigue, and overload fracture, often in cast or welded components. He has also provided metallurgical expertise in vehicle battery fire investigations. Dr. Slone has expertise applying various SAE and international materials standards. He often collaborates with experts in accident reconstruction, human factors, and vehicle engineering to evaluate complex accidents or failures.

Consumer Products and Recalls

Dr. Slone has investigated failures and evaluated material properties in consumer products, including various household items, appliances, and recreational / sporting goods. His work often involves supporting technical aspects of product recall investigations.

Professional Background

Dr. Slone is an active contributor to the scientific research community and has a significant peer-reviewed publication record spanning a wide range of materials, engineered systems, and industries. Prior to joining Exponent, Dr. Slone was a National Science Foundation Graduate Research Fellow at The Ohio State University. His doctoral thesis focused on how composition and processing affect the mechanical properties of high entropy alloys. He also studied strain localization in welded nickel-base alloys during high-temperature loading. Dr. Slone has expertise and hands-on experience with many materials characterization and imaging techniques, including SEM, EDS, EBSD, ECCI, XRF, XRD, X-ray CT, and others. He has performed mechanical testing across a wide range of temperatures and loading modalities. Additional examples of project experience are listed below.

Academic Credentials & Professional Honors

Ph.D., Materials Science and Engineering, The Ohio State University, 2019

B.S., Materials Science and Engineering, The Ohio State University, 2014

Best Paper of 2024 in Journal of Failure Analysis and Prevention

National Science Foundation Graduate Research Fellowship, 2015

Licenses and Certifications

American Welding Society Certified Welding Inspector (CWI)

Professional Affiliations

ASM International (member)

American Association for the Advancement of Science (member)

American Welding Society (member)

The Minerals, Metals & Materials Society (TMS) (member)

Publications

Slone CE, Kaplowitz DA, Bowers ML, Roepke C, Mazánová V, James BA, Aguiar DJ. Effects of heat treatment on vintage pipeline electric resistance welds. Metall Mater Trans A 2025; 56:3670–3680.

Slone CE, Mazanova V, Kumar P, Cook DH, Heczko M, Yu Q, Crossman B, George EP, Mills MJ, Ritchie RO. Partially recrystallized microstructures expand the strength-toughness envelope of CrCoNi medium-entropy alloy. Communication Materials 2024; 5(263).

Stewart JR, Ganot GS, Slone CE, James BA, Roepke CT. Fractography of weldments. In: Schroeder CJ, Parrington RJ, Maciejewski JO, Lane JF, editors. Fractography. ASM metals handbook, Volume 12; ASM International 2024; 441–449.

Slone C, Mostaed E, Cline C, Kaplowitz D, Ganot G, James B, Aguiar D. Copper contamination cracking in a pipeline repair weld. Journal of Failure Analysis and Prevention 2024; 24:794–804.

- **Selected as Best Paper of 2024 in Journal of Failure Analysis and Prevention**

Rindler JJ, Slone CE, Herderick ED, Mills MJ, Ramirez AJ. Role of deformation twinning in fatigue of CrCoNi medium-entropy alloy at room temperature. Scripta Materialia 2021; 202:113985.

Slone CE, Barnett B, Georgin B, Vivek A, George EP, Daehn GS, Mills MJ. Ordering effects on deformation substructures and strain hardening behavior of a CrCoNi based medium entropy alloy. Acta Materialia 2021; 210:116829.

Slone CE, LaRosa CR, Zenk CH, George EP, Ghazisaeidi M, Mills MJ. Elevated temperature microstructure evolution of a medium entropy CrCoNi superalloy containing Al, Ti. Journal of Alloys and Compounds 2020; 817:152777.

Slone CE, Miao J, George EP, Mills MJ. Influence of deformation induced nanoscale twinning FCC–HCP transformation on hardening and texture development in medium entropy CrCoNi alloy. Acta Materialia 2018; 158:38–52.

Slone CE, Miao J, Mills MJ. The evolution of the deformation substructure in a Ni-Co-Cr equiatomic solid solution alloy. Acta Materialia 2017; 132:35–48.

Kramb RC, Buskohl PR, Slone CE, Smith ML, Vaia RA. Designed autonomic motion in heterogeneous Belousov–Zhabotinsky (BZ)–gelatin composites by synchronicity. Advanced Functional Materials 2013; 23(22):2835–2842.

Smith ML, Heitfeld K, Slone CE, Vaia RA. Autonomic hydrogels through postfunctionalization of gelatin. Chemistry of Materials 2012; 15:3074–3080.

Presentations

Slone CE, Miao J, George EP, Mills MJ. Ultra-high strength and anomalous hardening in FCC medium / high entropy alloys. TMS 2018, San Antonio, TX, March 2019.

Slone CE, Miao J, George EP, Mills MJ. Enhanced strength and ductility in Ni-Co-Cr alloys through cold work and annealing. 18th International Conference on the Strength of Materials, Columbus, OH, July 2018.

Slone CE, Chakraborty S, Niezgoda SR, Mills MJ. Experimental and computational analysis of deformation in solid solution and precipitation strengthened Ni-Cr-Co alloys. TMS 2018, Phoenix, AZ, March 2018.

Slone CE, Mills MJ. Elevated temperature tensile and creep behavior of equiatomic NiCrCo. TMS 2018, Phoenix, AZ, March 2018.

Slone CE, Mills MJ. Analysis of strain localization during creep of a polycrystalline superalloy using SEM DIC. TMS 2017, San Diego, CA, February 2017.

Slone CE, Bechetti DH, DuPont JN, Mills MJ. Localized deformation under severe microstructural gradients. National Science Foundation Center for Integrative Materials Joining Science for Energy Applications Meeting, Columbus, OH, January 2017.

Slone CE, Mills MJ. Measurement of strain localization during creep of a polycrystalline superalloy using SEM based digital image correlation. MS&T16, Salt Lake City, UT, October 2016.

Slone CE, Bechetti DH, DuPont JN, Mills MJ. Local measurement of creep deformation in polycrystalline superalloys. TMS 2016, Nashville, TN, February 2016.

Slone CE, Bechetti DH, DuPont JN, Mills MJ. Fundamental understanding of localized deformation under severe microstructural gradients. National Science Foundation Center for Integrative Materials Joining Science for Energy Applications Meeting, Golden, CO, July 2014.

Project Experience

Dr. Slone has applied his expertise to help clients understand and solve problems in many different industries. Selected examples are described below:

Energy and Utilities

- Electric power transmission conductor: failure analyses and proactive bend or shear testing of conductors, including composite core conductors.
- Electric power hardware: Analyses of hot- and cold-end transmission and distribution hardware. These projects have involved failure analyses as well as asset integrity management efforts to evaluate long-term fatigue, corrosion and wear performance of specific components.
- Telecommunications cables: evaluated effects of environmental exposure on metal-clad cables.
- Gasification technology: investigated several aspects of gasification facilities including chloride corrosion pitting in stainless steel process piping and stress corrosion cracking of dissimilar metal injection lance welds.
- Linear actuator springs: analyzed unexpected deformation and failures in nickel-base superalloy springs designed for high temperature applications.
- High-voltage fuses: performed a failure analysis on high-voltage fuses that were igniting under normal electrical loads.
- Solar power components: investigated aspects of components for solar power generation arrays, including cracking in steel torque tube couplers and galvanized coatings for steel components designed to endure 40 years of environmental exposure.

Oil and Gas

- Ongoing transmission integrity management: conducted over a dozen direct cause assessments associated with cutout-for-cause piping components for a large utility operator. Dr. Slone has investigated causes including stress corrosion cracking, selective seam weld corrosion, third party mechanical damage, welding deficiencies, and manufacturing issues, among others.
- In-service leaks and welding burn-throughs: conducted several failure analyses on leaking gas transmission pipelines and welding burn-throughs.
- Crude oil release litigation: supported litigation efforts related to an oil release from a leaking pipeline, which included analyzing in-line inspection (ILI) data.
- Petrochemical facility process piping: supported a multidisciplinary investigation of corrosion in piping at a petrochemical facility, including general corrosion in carbon steel pipes and pitting corrosion in stainless steel pipes. The corrosion was facilitated by delays in the pre-commissioning process for the pipe works, which left standing water in the pipes.
- Subsea pipeline arbitration: assessed documentation relating to a leaking subsea fuel oil pipeline in support of an international arbitration matter.
- Crude oil release: performed a failure analysis following crude oil release from a steel pipe. The direct cause of failure was determined to be internal corrosion.
- Gas pipeline explosion litigation: supported litigation efforts related to a gas pipeline explosion, which was caused by hydrogen embrittlement of hard spots that were produced during pipe manufacturing. Dr. Slone's support included analysis of in-line inspection (ILI) data per API 1163.
- Pressure vessel support weld cracking: investigated the cause of cracking that ran through a stiffener support and the adjacent weld to the body of a pressure vessel. Recommendations were made to the client about evidence preservation because the fractured components were extensively damaged during extraction, resulting in an inconclusive analysis.

Industrial Machinery, Equipment, and Facilities

- Gas turbine investigations: investigated multiple incidents involving fractured compressor blades in gas turbines. The analyses included assessments of non-destructive evaluation techniques and identification of cracking in additional blades. The failure and additional cracks were found to be caused by metal fatigue.
- Evaporator fan analysis: analyzed cracking in the duplex stainless steel impeller of a zero liquid discharge evaporator fan. Cracking was caused by high concentrations of chlorides that led to stress corrosion cracking.
- Mud drum and steam drum analyses: investigated leaks and cracking in boiler mud drum and steam drum walls caused by stress corrosion cracking.

Buildings and Structures

- Fractured girder investigation: supported failure analysis efforts related to fractures of steel girders. The cracks that led to the fractures were initiated by thermal cutting of the girders.
- Fractured steel bolts: performed a direct-cause failure analysis of bolts used to secure a structural steel moment-resisting frame system. A number of bolts were found to have fractured due to quench cracking and hydrogen-assisted cracking/hydrogen embrittlement.

Consumer Products and Sporting Goods

- Steam cleaners: evaluated the cause of ruptured cast aluminum steam cleaners, which involved a complex interaction between several mechanisms, including internal corrosion of the steam boiler.
- Fractured bicycle components: performed direct cause failure analyses on fractured bicycle spindles, spokes, and frames for multiple companies. Causes of failure have included hydrogen-assisted cracking/hydrogen embrittlement, sub-surface manufacturing flaws, and grain boundary embrittlement due to incipient melting of an aluminum frame.
- Wearable device warping: investigated austenitic stainless steel housings for wearable electronic devices that were warping during the manufacturing process.
- Frying pan rivet caps: analyzed frying pans on which rivet caps were being ejected at high speeds during use.

Vehicles and Personal Transportation

- Utility vehicles: failure analyses of various components in off-road utility vehicles. Examples of components include steering system universal joints and constant velocity joints.
- Motorcycles: failure analyses of various components on internal combustion and electric motorcycles. Examples of components include gasoline tanks and welds.
- Battery fires: engaged in two multi-disciplinary investigations into vehicle battery fires. Dr. Slone's role was assessing arcing damage and corrosion on metal components around the apparent fire initiation site.
- Drive clutch failures: investigated failures of cast aluminum drive clutches from a brand of off-road vehicles. The failures were related to porosity in the cast components.
- Scooter stem fractures: analyzed fatigue failures of handlebar stems on electric scooters.

Medical Devices

- Orthopedic implant: supported litigation efforts related to the fractured screws on a cervical spine fixation implant.
- Surgical devices: performed several failure analyses related to surgical grippers, clips, and other hardware. Dr. Slone has also engaged in proactive work that involved comparing components of the same design that were manufactured by different processes.