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# DALE E. ALEXANDER, Ph.D., P.E.
# PRINCIPAL
# DIRECTOR OF MATERIALS

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Experienced materials consultant with demonstrated proficiency in selecting and testing materials, investigating and reconstructing material failures, and developing scientifically supportable recommendations and conclusions. Dr. Alexander's materials expertise is applicable to all categories of industrial, military, commercial, and consumer products. He also provides opinion testimony as a materials expert in litigated matters in state and federal courts and international venues.

Drawing on a career of specializing in materials research, engineering, and failure analysis, Dr. Alexander coordinates and delivers ESi's multidisciplinary expertise to solve technically complex materials problems using innovative thinking, reliable methods, and proven techniques.

Dr. Alexander's experience spans a variety of such industry segments as aviation, transportation, power generation, heavy equipment and machinery, medical devices, and household products. He leverages his knowledge of fracture mechanisms, corrosion, wear and degradation, microstructure, physical properties, and material joining to understand and solve problems with both non-metallic materials (polymers, elastomers, GFRP), and metallic alloys, including ferrous alloys (steel, stainless steel, iron-based super alloys), and non-ferrous alloys (aluminum, copper, brass, nickel-based super alloys).

Before joining ESi in 2001, Dr. Alexander worked for ten years as a materials scientist at Argonne National Laboratory's Materials Science Division. During his tenure there, his research resulted in dozens of publications in peer reviewed journals and invitations to present at international organizations and conferences.

In addition to his consulting work, Dr. Alexander is the Director of the Materials practice within ESi, managing materials and analysis personnel, projects, and laboratory facilities across multiple offices nationwide.

## Areas of Specialization

Materials characterization, selection, engineering, and testing
Fracture mechanisms and fractographic analysis
Failure analysis
Materials joining: welding, brazing, and mechanical fastening
Corrosion
Tribology
Laboratory tools and investigative techniques

## Licensed Professional Engineer (P.E.)

State of Illinois ..... License No. 062-056175

*February 2019*

## Professional Affiliations/Honors

### ASM International

Editorial Board Member, Journal of Failure Analysis and Prevention, 2007-2016
Member and Past Chairman, Failure Analysis Committee 2005
ASM MVP Recognition, 2005
Co-Chair, Aerospace Session in the Failure Analysis Symposium at MS&T 2015
Co-Chair, Tools and Techniques Session in the Failure Analysis Symposium at MS&T 2014
Co-Chair, Nuclear Session in the Failure Analysis Symposium at MS&T 2009
Co-Chair, Charles R. Morin Memorial Session in the Failure Analysis Symposium at MS&T 2009
Co-Chair, Aircraft Engine Component Degradation/Failure Phenomena Session in the Failure Analysis Symposium at MS&T 2006
Co-Chair, Failure Analysis Symposium at MS&T 2005
Co-Chair, Litigation Session in the Failure Analysis Symposium at 2004 ASM Materials Week

### Failure Analysis Society, an affiliate society of ASM International

Founding Member, 2016
Member, International Relations Committee, 2016-present
Co-Chair, Non-metallics Session in the Failure Analysis Symposium at MS&T 2016

### Mensa

Member since 2003

### American Nuclear Society

Member
Graduate Student of the Year, 1986, Materials Science and Technology Division

### The Minerals, Metals, and Materials Society

Member

## Positions Held

### Engineering Systems Inc., Aurora, Illinois

Principal, 2010 – Present
Director, Materials Practice, 2016 – Present
Director, Materials and Mechanics Practice, 2009 – 2015
Director, Materials and Applied Sciences, 2007 – 2009
Manager, Materials Engineering, 2004 – 2007
Senior Consultant, 2001 – 2009

### Argonne National Laboratory, Materials Science Division, Argonne, Illinois

Materials Scientist, 1995 – 2001
Assistant Materials Scientist, 1991 – 1995
Post-Doctoral Researcher, 1990 – 1991

## Education

Ph.D., Nuclear Engineering, University of Michigan, 1990
M.S., Nuclear Engineering, University of Michigan, 1986
B.S., Nuclear Engineering (Magna Cum Laude), University of Michigan, 1984

## Additional Training

Nitinol for Medical Devices
ASM International, 2018

Intensive Course on Electrical Contacts and Connector Design for Electronics and Microelectronics Applications
Timron Scientific Consulting, Inc., 2016

Helicopter Accident Investigation
USC Viterbi School of Engineering, 2015

Fundamentals of Glass Science and Technology
American Ceramic Society, 2013

Rolls Royce M250 Series IV Aircraft Turbine Engine Maintenance Training, 2013

Lubrication Fundamentals, 2013
Decatur Professional Development, LLC

Lycoming Aircraft Piston Engine Service School, 2009

Automotive Accident Investigation I & II
Northwestern University, Center for Public Safety, 2001

Principles of Failure Analysis
ASM Materials Engineering Institute, 2001

## Selected Project Experience

***Power Generation*** **- Electric Utility Generator Failure**

A power utility's large electric generator suffered an explosive stator failure. A materials failure analysis of Copper electrical windings determined they fractured due to high-cycle fatigue. This work involved microscopic examinations of the fractures as well as metallographic studies of the Copper microstructure and chemistry. The potential effects of metallic brazing on the condition of Copper windings was also addressed.

***Medical Device*** **- Orthotic Leg Brace Failure**

A personal injury was sustained when a leg orthopedic brace supporting Aluminum alloy bar upright fractured. Optical and scanning electron microscope examinations of the fractured metal revealed cracking initiated from the legs side of the bar initially as a result of stress-corrosion cracking (SCC) that transitioned to fatigue cracking and eventually to overload failure. Chemical (elemental) analysis of residue in the crack initiation area showed composition typical of human perspiration that served as a corrosive element to the metal bar. Metallographic examination of the bar in the area of failure revealed secondary surface cracking typical of SCC. Mechanical property testing of the failed bar confirmed that it had the proper specified metal strength.

***Aviation*** **- Brazilian Helicopter Accident**

The tailboom from a helicopter separated in-flight resulting in hard ground impact. A materials failure analysis of the aircraft's separated tailboom connection was performed. Optical and scanning electron microscope examinations revealed that one of four forged Aluminum tailboom attach fittings experienced a fatigue crack that lead to complete fitting fracture. Chemical (elemental) analysis revealed the presence of Aluminum Oxide where the crack intersected the fracture surface. Review of design load analysis and a fracture mechanics study indicated that prior inspections, if appropriately performed, would have identified the fatigue cracking prior to complete failure.

***Aviation*** **- General Aviation Plane Crash**

A small general aviation plane experienced an in-flight engine failure and flew into the ocean. After the aircraft was salvaged, the engine's magneto was found to have its impulse coupling steel coil spring fractured. A materials failure analysis was performed on the failed spring with optical and scanning electron microscopic inspections of the spring showing intergranular fracture features consistent with a brittle failure. Analysis of the corrosive environment presented by the magneto's Magnesium alloy cast housing and the steel spring determined that the spring experienced cracking due to hydrogen embrittlement during corrosive exposure in the ocean water electrolyte.

***Aviation*** **- General Aviation Plane Fuel Servo Bellows Failure**

After a post-crash fire, a small plane engine's fuel servo was heat damaged and an internal metal bellows component was discovered fractured. It was alleged that the small electroless Nickel-Phosphorous bellows experienced fatigue failure in-service, allowing an overly rich engine fuel condition to occur. Optical and microscopic examination for the bellow's fracture revealed brittle fracture. In collaboration with a mechanical engineer, vibration testing was performed on exemplar bellows until they experienced fatigue failure. The resulting exemplar fractures revealed fatigue beach marks and features distinct from the subject bellows. The brittle fractures in the subject bellows were a consequence of elevated temperature exposure embrittling the Nickel-Phosphorous metallic alloy and not due to fatigue failure in-flight.

***Aviation*** **- Italian Air Force Plane Engine In-Flight Shutdown**

An air force training plane experienced an engine shutdown in-flight when its crankshaft gear separated. The investigation involved travel to Rome, Italy and working with the court-appointed expert magistrate to perform a failure analysis of the gear connection. Optical and scanning electron microscope examination of a steel locating pin on the gear revealed it experienced fatigue cracking. Fretting wear was observed on the mating surfaces of the gear and crankshaft end; observations consistent with joint looseness. As part of the investigation, the engine factory was visited to observe proper gear installation procedures. Review of records for the subject aircraft indicated that the required entry for gear assembly installation torque was missing, implicating improper maintenance practice.

***Aviation*** **- Aircraft Engine Turbine Blade Failures**

Various projects examining Nickel-based superalloy turbine blade failures for both fixed-wing and rotary aircraft. Fracture mechanisms studied have included fatigue, creep-stress rupture, sufidation/hot corrosion failures and overload fractures due to shroud contact.

***Consumer Product*** **- Miter Saw Blade Guard Failure**

A worker sustained a hand injury while using an electric miter saw. A failure analysis of the blade guarding system included fractographic examinations of the polycarbonate (plastic) blade shield and an Aluminum rivet. Examination of witness marks on other metallic shield guard components was performed including a retention bolt. The directionality of the observed rivet shear supported a reconstruction of saw use in which the retention bolt was removed to defeat the blade guard operation, permitting a thicker cut.

***Consumer Product*** **- Recreation Rock Climbing Wall Equipment Failure**

A recreational rock climbing wall, operated at a children's day camp, sustained a pneumatic actuator failure resulting in a personal injury from a fall. The design of the wall used pneumatic actuators, re-purposed for use with hydraulic fluid, to retract climbing rope and also serve as mechanical cushions to sudden drops. A materials failure analysis was performed on an Aluminum alloy, die-cast cylinder retention end-cap that fractured. With input from ESi mechanical engineers, I also studied the design of the unit to understand the failure. The fractured casting contained an internal void alleged to have rendered the end cap defective. Fracture mechanics and finite element stress analyses were performed that showed, given the location of the void, there was minimal effect on the cap's load bearing capacity. Instead, it was determined that the climbing wall was inadequately designed allowing forces on the cylinders that were too excessive.

***Transportation*** **- Rail Tank Car Derailment**

A train derailment occurred in a tunnel underground in the downtown area of Baltimore, MD. A 30,000 gallon tank car separated from one its wheeled trucks, was punctured and released the hazardous chemical it was carrying. A materials failure analysis and reconstruction were performed and determined the steel tank was punctured by a brake linkage in the derailment process. After the incident, the detached truck was found missing its tank's centering pin. My inspection found physical evidence of contact damage on the truck's Manganese steel bolster bowl from a centering pin. A mechanical loading analysis was performed that showed the plain carbon steel center pin was readily fractured in shear during separation of the tank from the truck in the derailment.

## Publications/Presentations

"Divining the Origin of Metallurgical Witness Marks Using Reverse Engineering Techniques," **D.E. Alexander**, R. Franzese, M. Kenner, A. Maratea, G. Novak, M. Stevenson, J. Wagner, presented at the ASM International Indianapolis Chapter Spring Conference, Columbus, IN, February 12, 2019

"Investigative Use of Reverse Engineering Techniques: Application to Metallurgical Laboratory Analysis of an Aircraft Accident," **D.E. Alexander**, R. Franzese, M. Kenner, A. Maratea, G. Novak, M. Stevenson, J. Wagner, presented at the Materials Science & Technology Conference, Columbus, OH, October 15, 2018

"Investigation of a Compressor Turbine Blade Failure Involving the Fir Tree Attachment Condition," E. Wright, G. Novak, R. Baron, D. Ahearn, **D.E. Alexander**, presented at the Materials Science & Technology Conference, Columbus, OH, October 15, 2018

"New Techniques in Aircraft Accident Investigation", **D.E. Alexander**, presented at the General Aviation Air Safety Investigators 2014 Advanced Technical Workshop, Wichita, KS, September 17, 2014 (**Invited**)

"Failure Investigation of an Aircraft Crankshaft Gear Connection", M.E. Stevenson, D.G. Klepacki, J.L. McDougall and **D.E. Alexander**, Journal of Failure Analysis and Prevention, 12(6), pp.617-623 (2012)

"Radiography in Failure Analysis: X-ray vs. Neutron" D. M. Norfleet, **D.E. Alexander**, C. Cherry and J. Gauthier, presented at the Failure Analysis Symposium, Materials Science and Technology 2008, Pittsburgh, PA, October 8, 2008

"Laser Based Dimensional Characterization in an Automotive Component Failure Analysis Investigation," **D.E. Alexander**, C. R. Morin, J.T. Eaganhouse, J. Mass, T. Hays, presented at the Failure Analysis Symposium, Materials Science and Technology 2007, Detroit, MI, September 17, 2007

"A Fiberglass Reinforced Plastic Case Study – A Focus on the Importance of Joint Testing Protocols in Current Forensic Practice," C. R. Morin, **D.E. Alexander**, M. P. Van Bree, presented at the Failure Analysis Symposium, 2004 Materials Solutions Conference, ASM International, Columbus, OH, October 19, 2004

"Silicone Replication as a Non-Destructive Failure Analysis Tool," **D.E. Alexander**, E.V. Dargelis, and C.R. Morin, presented at the 2003 ASM International Materials Solutions Conference, Pittsburgh, PA, October 13, 2003.

"Hardening and Precipitate Character in Proton Irradiated Model Pressure Vessel Steel Alloys," Q. Yu, G.S. Was, **D.E. Alexander**, and R. Odette, in the proceedings of the 10th International Conference on Environmental Degradation of Materials in Nuclear Power Systems – Water Reactors, (NACE, Houston, TX, 2002).

"Hardening and Microstructure of Model Reactor Pressure Vessel Steel Alloys Using Proton Irradiation," Q. Yu, G.S. Was, L.M. Wang, R. Odette, and **D.E. Alexander**, in the proceedings of the symposium Microstructural Processes in Irradiated Materials, edited by G. E. Lucas, L. L. Snead, M. A. Kirk, and R. G. Elliman, (Materials Research Society, Warrendale, PA, 2001).

"Correlating Radiation Exposure with Embrittlement: Comparative Studies of Electron and Neutron Irradiated Pressure Vessel Alloys," **D.E. Alexander**, B.J. Kestel, L.E. Rehn, G.R. Odette, G.E. Lucas, D. Lingensmith, D. Gragg, S. Seifert and P.R. Jemian, Reactor Dosimetry, ASTM STP 1398, edited by John G. Williams, David W. Vehar, Frank H. Ruddy and David M. Gilliam (American Society for Testing and Materials, West Conshohocken, PA, 2000), pp. in press.

"Understanding the Role of Defect Production in Radiation Embrittlement of Reactor Pressure Vessels," **D.E. Alexander**, L.E. Rehn, G.R. Odette, G.E. Lucas, D. Klingensmith and D. Gragg, Ninth International Symposium on Environmental Degradation of Materials in Nuclear Power Systems-Water Reactors, edited by S. Bruemmer, P. Ford and G. Was (The Minerals, Metals & Materials Society, Warrendale, PA, 1999), pp. 827-833.

"Modeling the Post-Yield Flow Behavior After Neutron and Electron Irradiation of Steels and Iron-Base Alloys," R.J. DiMelfi, **D.E. Alexander** and L.E. Rehn, Microstructural Processes in Irradiated Materials, Vol. 540, edited by S.J. Zinkle, G.E. Lucas, R.C. Ewing and J.S. Williams (Materials Research Society, Warrendale, PA, 1999), pp. 463-469.

"Exploring the Use of Pulsed Irradiations for Studying the Transient Sink Formed by Cascade Producing Radiation," **D.E. Alexander**, Microstructural Processes in Irradiated Materials, Vol. 540, edited by S.J. Zinkle, G.E. Lucas, R.C. Ewing and J.S. Williams (Materials Research Society, Warrendale, PA, 1999), pp. 673-678.

"Anomalous Small-Angle X-Ray Scattering Characterization of Model Pressure Vessel Alloy Microstructures," **D.E. Alexander**, B.J. Kestel, P.R. Jemian, G.R. Odette, D. Klingensmith and D. Gragg, Microstructural Processes in Irradiated Materials, Vol. 540, edited by S.J. Zinkle, G.E. Lucas, R.C. Ewing and J.S. Williams (Materials Research Society, Warrendale, PA, 1999), pp. 415-463.

"Deformation Behavior in Reactor Pressure Vessel Steels as a Clue to Understanding Irradiation Hardening," DiMelfi, R. J., **D.E. Alexander** and L.E. Rehn, Proceedings of the 6th International Conference on Nuclear Engineering, (published jointly by ASME, JSME, SFEN, 1998), paper number 6079.

"The Role of Gamma Rays and Freely-Migrating Defects in Reactor Pressure Vessel Embrittlement," **D.E. Alexander** and L.E. Rehn, Proceedings of the 9th International Symposium on Reactor Dosimetry, edited by H.A. Abderrahim, P. D'Hondt and B. Osmera (World Scientific Publishing, Singapore, 1998), pp. 508-515.

"Post-Yield Strain Hardening Behavior as a Clue to Understanding Irradiation Hardening," R.J. DiMelfi, and **D.E. Alexander**, Journal of Nuclear Materials **252**, 171-177 (1998).

"In-Situ Irradiation Studies on the Effects of Helium on the Microstructural Evolution of V-3.8 Cr-3.9 Ti," Doraiswamy, N., B. Kestel and **D.E. Alexander**, Microstructure Evolution During Irradiation, Vol. 439, edited by I.M. Robertson, G.S. Was, L.W. Hobbs and T.D. de la Rubia (Materials Research Society, Pittsburgh, PA, 1997), pp. 337-341.

"Defect Production Considerations for Gamma Ray Irradiation of Reactor Pressure Vessel Steels," **D.E. Alexander**, Journal of Nuclear Materials **240**, 196-204 (1997).

"Electron Irradiation-Induced Mechanical Property Changes in Reactor Pressure Vessel Alloys," **D.E. Alexander**, L.E. Rehn, G.R. Odette and G.E. Lucas, Thermodynamics and Kinetics of Phase Transformations, Vol. 398, edited by J.S. Im, B. Park, A.L. Greer and G.B. Stephenson (Materials Research Society, Pittsburgh, PA, 1996), pp. 177-182.

"Gamma-Ray (Electron) Irradiation Effects on Tensile Properties of Ferritic Alloys," **D.E. Alexander**, K. Farrell and R.E. Stoller, Journal of Nuclear Materials **228**, 68-76 (1996).

"TEM Studies for DIGM in Kr Ion Irradiated AU-CU Bilayers" G. Yuzun, **D.E. Alexander**, and L.E. Rehn, Trans. Nonferrous Met. Society China, (General Research Institute for Nonferrous Metals, Beijing 100088), Vol. 6, No. 3, 1996

"Analysis of Gamma Ray Displacement Damage in Light Water Reactor Pressure Vessels," **D.E. Alexander**, and L.E. Rehn, Seventh International Symposium on Environmental Degradation of Materials in Nuclear Power Systems Water Reactors, edited by G. Airey, et al. (NACE International, Houston, TX, 1995), pp. 783-794.

"Gamma Ray-Induced Embrittlement of Pressure Vessel Alloys," **D.E. Alexander**, K. Farrell, R.E. Stoller and L.E. Rehn, Microstructure of Irradiated Materials, Vol. 373, edited by I.M. Robertson, L.E. Rehn, S.J. Zinkle and W.J. Phythian (Materials Research Society, Pittsburgh, PA, 1995), pp. 155-163.

"Gamma-Ray Displacement Damage in the Pressure Vessel of the Advanced Boiling Water Reactor," **D.E. Alexander**, and L.E. Rehn, Journal of Nuclear Materials **217**, 213-216 (1994).

"The Contribution of High Energy Gamma Rays to Displacement Damage in LWR Pressure Vessels," **D.E. Alexander**, and L.E. Rehn, Journal of Nuclear Materials **209**, 212-214 (1994).

"Neutron-Induced Collision Cascade Mixing in Nb/V Superlattices," **D.E. Alexander**, E.E. Fullerton, P.M. Baldo, C.H. Sowers and L.E. Rehn, Nuclear Instruments and Methods in Physics Research **B 90**, 344-348 (1994).

"Temperature-Dependent Ion Mixing," Rehn, L.E. and **D.E. Alexander**, Laser and Ion Beam Modification of Materials, Vol. 17, edited by I. Yamada, et al. (Elsevier Science B.V., Amsterdam, Holland, 1994), pp. 571-577.

"Modulation Wavelength Dependence of Ion Mixing in Metallic Superlattices," **D.E. Alexander**, E.E. Fullerton, P.M. Baldo, C.H. Sowers and L.E. Rehn, Materials Synthesis and Processing Using Ion Beams, Vol. 316, edited by R.J. Cullbertson, O.W. Holland, K.S. Jones and K. Maex (Materials Research Society, Pittsburgh, PA, 1994), pp. 271-276.

"Diffusion-Induced Grain Boundary Migration During Ion Beam Mixing of Au/Cu Bilayers," **D.E. Alexander**, P.M. Baldo and L.E. Rehn, Nuclear Instruments and Methods in Physics Research B80/81, 412-416 (1993).

"The Effect of DIGM and Irradiation-Induced Grain Growth on Interdiffusion in Bilayer Ion-Beam Mixing Experiments," **D.E. Alexander**, L.E. Rehn, P.M. Baldo and Y. Gao, Beam-Solid Interactions: Fundamentals and Applications, Vol. 279, edited by M. Nastasi, L.R. Harriott, N. Herbots and R.S. Averback (Materials Research Society, Pittsburgh, PA, 1993), pp. 497-502.

"Cross-Sectional TEM Studies of DIGM in Irradiated Au-Cu Bilayers," Y. Gao, **D.E. Alexander** and L.E. Rehn, Beam-Solid Interactions: Fundamentals and Applications, Vol. 279, edited by M. Nastasi, L.R. Harriott, N. Herbots and R.S. Averback (Materials Research Society, Pittsburgh, PA, 1993), pp. 369-374.

"Enhancement of Diffusion-induced Grain Boundary Migration by Ion Irradiation," **D.E. Alexander**, L.E. Rehn, P.M. Baldo and Y. Gao, Gold Bulletin **26**, 67 (1993).

"Enhancement of Diffusion-Induced Grain Boundary Migration by Ion Irradiation," **D.E. Alexander**, L.E. Rehn, P.M. Baldo and Y. Gao, Applied Physics Letters **62**, 1597-1599 (1993).

"Thermal-Spike Treatment of Ion-Induced Grain Growth: Theory and Experimental Comparison," **D.E. Alexander**, and G.S. Was, Physical Review B **47**, 2983-2994 (1993).

"The Effect of Ion Irradiation on Inert Gas Bubble Mobility," **D.E. Alexander**, and R.C. Birtcher, Journal of Nuclear Materials 191-194, 1289-1294 (1992).

"Application of a Thermal Spike Model to Experimental Ion-Induced Grain Growth Data," **D.E. Alexander** and G.S. Was, Surface and Coatings Technology **51**, 333-337 (1992).

"Interdiffusion and Grain Boundary Migration in Au/Cu Bilayers During Ion-Irradiation," **D.E. Alexander**, in Phase Formation and Modification by Beam-Solid Interactions, Vol. 235, edited by G.S. Was, L.E. Rehn and D.M. Follstaedt (Materials Research Society, Pittsburgh, PA, 1992), pp. 559-564

"The Effect of Ion Irradiation on Inert Gas Bubble Mobility," **D.E. Alexander**, and R.C. Birtcher, Phase Formation and Modification by Beam-Solid Interactions, Vol. 235, edited by G.S. Was, L.E. Rehn and D.M. Follstaedt (Materials Research Society, Pittsburgh, PA, 1992), pp. 545-550.

"Thermal Spike Model of Ion-Induced Grain Growth," **D.E. Alexander**, and G.S. Was, Evolution of Thin Film and Surface Microstructure, Vol. 202, edited by C.V. Thompson, J. Y. Tsao and D. J. Sorolovitz (Materials Research Society, Pittsburgh, PA, 1991), pp. 205.

"Ion-Induced Grain Growth in Multilayer and Coevaporated Metal Alloy Thin Films," **D.E Alexander**, G.S. Was and L.E. Rehn, Nuclear Instruments and Methods in Physics Research **B59/60**, 462466 (1991).

"The Heat-of-Mixing Effect on Ion-Induced Grain Growth," **D.E. Alexander**, G.S. Was and L.E. Rehn, Journal of Applied Physics **70**, 1252-1260 (1991).

"Phase Formation in Ion-Irradiated and Annealed Ni-Rich Ni-Al Thin Films," **D.E. Alexander**, G.S. Was and L.E. Rehn, Journal of Applied Physics **69**, 2021-2027 (1991).

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“Grain Growth and Phase Formation in Ion Irradiated/Annealed Thin Ni-Al Alloy Films”, **D.E Alexander**, G.S. Was and L.E. Rehn, Beam-Solid Interactions: Physical Phenomena, Vol. 157, edited by J.A. Knapp, P. Borgesen and R.A. Zuhr (Materials Research Society, Pittsburgh, PA, 1990), pp. 155-160.

"The Effect of Ion Beam Surface Modifications on Fatigue Crack Initiation in Polycrystalline Nickel,” Morrison, D. J., J.W. Jones, **D.E. Alexander**, C. Kovach and G.S. Was, Materials Science and Engineering **A115**, 315-321 (1989).

"Grain Growth and Phase Morphology in Ion Beam Mixed Two Phase Ni-Al and Ni-Cr-Al Alloys,” **D.E. Alexander**, G. Was and J. Eridon, Nuclear Instruments and Methods in Physics Research **B39**, 130-135 (1989).

"Laser Driven Micro-explosive Bonding of Aluminum Films to Copper and Silicon,” **D.E. Alexander**, G.S Was and. F.J Mayer, Journal of Materials Science 23, 2181-2186 (1988).