

Dr. Saravanan R Arunachalam

719-216-2325. sa@saf-engineering.com

Summary of Qualification

- Project Development and Management
- Technical advisor
- Customer support specialist
- Training and mentoring
- TIG, MIG Welding Process
- Surface modification using TIG torch
- Material processing – conventional, coatings, advanced technology
- Failure analysis
- Material testing and characterization
- Analytical techniques – Optical, Stereo and scanning electron microscopies, FIB-nano machining, EDX, EBSD, X-Ray, X-ray – CT, OES, Micro and Nano hardness
- Aluminum alloys, steels, Titanium alloys, magnesium alloys, Composites and Ceramic MEMS
- Wear - Tribology

Professional Experience:

Principal Scientist – Senior Metallurgical Engineer

(July. 2004 – Present)

United States Air Force Academy – Center for Aircraft Structural Life Extension (CASTLE)

- Technical and project lead for Aircraft Structural Teardown on C5, C130, KC-135, T37
- Manage projects and people for materials and metallurgical activities
- Standardize testing and reporting procedures and documentations specific to individual programs across the organization
- Lead engineer in mechanical testing (fatigue and fracture) of aircraft aluminum alloys, titanium alloys, steels
- Developed protocols for failure analysis
- Lead effect of different welding parameters on the heat affected zone using TIG, plasma and conventional welding
- Lead for spectrum validation for full scale fatigue testing for B-1B for Boeing
- Lead for fatigue crack growth testing for Lufthansa structural modification
- Lead for metallurgical evaluation of forging components for L3 communications
- Primary responsible for equipment maintenance and training junior engineers
- Reviewed and approved more than 1400 failure analysis reports and presented in the technical committee
- Responsible for overseeing and guiding engineers in testing in compliance with ASTM standards as well as custom non-standard testing after getting approval from customers
- Prioritize tasks based on individual project schedule and cost effectiveness
- Play an active role in project planning, budget, reviews, hazard and waste management, upgrading facility, preventive maintenance and hiring junior engineers
- Supervisor for stress corrosion testing for aluminum skin panel from legacy aircraft structures

Senior Research Associate

Department of Mechanical Engineering, University of Colorado, Boulder

(June 2001 - June 2004)

- Lead research engineer for the development and characterization ultra-high temperature ceramic MEMS
- Developed batch process through photo-polymerizable polymer precursors for ceramic MEMS applications
- MEMS lab proctor maintaining good lab practices, inventory, clean room maintenance, chemical hazardous waste management, laboratory equipment maintenance and safety control
- Collaborated with Aeronautical Engineering Department, Electrical Engineering Department and Physics Department on projects related to Fluidic MEMS, RF MEMS and MEMS circuit and MEMS mirrors for Bose Einstein condensate studies
- Collaborated with inter-disciplinary program between multiple departments writing technical proposals including all aspects of technical, schedule and budgeting

Post-Doctoral Researcher
Department of Applied Physics, University of Alicante, Spain

(Aug 1999 – May 2001)

- Performed processing and characterization of high volume fraction Aluminum-ceramic composites using pressure infiltration technique
- Performed fundamental studies on wetting characterization of aluminum at high temperatures under different atmospheric conditions
- Installed and commissioned to work a 3 ton capacity special furnace to produce A356 Aluminum and metal-ceramic composites through melt stir technique

(Work sponsored by "Spanish – Ministerio de Educacion y Cultura")

Post-Doctoral Researcher
School of Applied Science – Singapore

(Sept. 1998 – July 1999)

- Surface modification and characterization of titanium and its alloys by surface melting using TIG torch
- Development of aluminum A356 - matrix composites by melt stir technique

Research Associate
Korea Institute of Machinery and Materials (KIMM), South Korea

(Jan. 1998 – Aug. 1998)

- Fundamental tribological Studies on A356 aluminum matrix composites under pure inert (Argon) and oxidizing (Oxygen) environment
- Development of A356-aluminum matrix composites (Conversion of existing aluminum casting unit to process aluminum composites)

Education and Industrial Training

Ph.D. in Mechanical and Metallurgical Engineering
M. Tech in Process Metallurgy

August 1991 - July 1996

August 1989 – May 1991

Bhilai Steel Plant

3 months in-plant training at
 Blast furnace 7 (Aug-Oct 1990)

Gupta Steel Industries
B.E. in Metallurgical Engineering

July 1988 – May 1989

July 1984 – May 1998

Publications in International Journals:

1. Flip-chip assembled air-suspended inductors: with P. Bell, N. Hoivik, N. Ehsan, V. Bright, Z. Popovic, IEEE Trans. On Advanced Packaging, Vol. 30, No. 1, Feb. 2007.
2. Atom chip Bose Einstein Condensation in a portable Vacuum cell, with S. Du, M. B. Squires, Y. Imai, L. Czaia, V. Bright, J. Reichel, T.W. Hansch and D.Z. Anderson:, Phy. Rev A, 70, 053606/1-4 (2004)
3. Atom Michelson Interferometer on a Chip using a Bose-Einstein Condensate, with Y.J. Wang, D.Z. Anderson, V.M. Bright, E.A. Cornell, Q. Diot, T. Kishimoto, M. Prentiss, S.H. Sigel and S. Du: Phy. Rev. Let, 94 (9): Art. No. 090405 MAR 11 2005
4. Surface Modification of 2014 Al Alloy/Al₂O₃ particle composite by Ni electrochemical deposition, with J. M. Molina, J. Narciso and E. Louis:, Material Science and Engineering A, 383, 2004, pp. 299-306.
5. A Methodology for analyzing the variability in the performance of MEMS actuator made from a novel Ceramic, with J.S. Kong, D.M. Frangopal, M. Raulli, K. Maute, L-A. Liew and R. Raj: Sensors and Actuators A, 116, 2004, pp. 336-344.
6. Thermal expansion coefficient and wear performance of aluminum/SiC composites with bimodal particle distributions, with J. M. Molina, R Arpon, Garcia-Cordovilla c, E. Louis and J. Narciso: Mater. Sci. Tech, Lon, Vol. 19 (14), 2003, pp. 491-496.
7. Thermal expansion Coefficient and thermal hysteresis of Al/SiC composites with bimodal distributions, with R. Arpón, J.M. Molina, C. García-Cordovilla, E. Louis and J. Narciso: THERMEC'2003, PTS 1-5, Materials Science forum, 426-4: 2003, pp 2187-2192.
8. Al/SiC composites with bimodal particle distributions: Particle surface area, threshold pressure for infiltration and thermal hysteresis, with R. Arpón, J.M. Molina, C. García-Cordovilla, E. Louis and J. Narciso: Scripta Materialia, Volume 51, Issue 6, September 2004, pp 623-627.
9. A real time human-machine interface for an ultrahigh temperature MEMS sensor-igniter, with J.S. Kong, K. Maute, D. M. Frangopol, L.A. Liew, and R. Raj:, Sensors and Actuators A 105, 2003, pp. 23-30.
10. Integration of ceramics research with the development of a Microsystems, with L.A. Liew, V.M. Bright and Rishi Raj: J. American Ceramics Society, 86 (7), 2003. pp. 1217-1219.
11. Processing and characterization of silicon carbon-nitride ceramics: Application of electrical properties towards MEMS thermal actuators, with Li-Anne Liew, Victor M. Bright, Martin L. Dunn, John W. Daily, Rishi Raj: Sensors and Actuators A 103, 2003, pp. 171-181.
12. Thermal expansion behaviour of Aluminium/SiC composites with bimodal particle distributions, with R. Arpón, J.M. Molina, C. García-Cordovilla, E. Louis and J. Narciso: Acta Materialia, Vol. 51 (11), 2003, pp. 3145-3156.
13. Surface tension of pure aluminum in argon/hydrogen and nitrogen/hydrogen atmospheres at high temperatures, with J.M. Molina, J. Narciso, C. Garcia-Cordovilla and E. Louis: J. Mater. Sci. Letts. Vol. 21(4) 2002, pp. 309-311.
14. Pressure infiltration of packed ceramic particulates with bimodal distribution, with J. M. Molina, A. Roberto, C. Garcia-Cordovilla, E. Louis and J. Narciso: Acta Materialia, Vol. 50(2), 2002, pp. 247-257.
15. Effects of surface tension of aluminum at high temperatures, with R.A. Saravanan, J.M. Molina, J. Narciso, C. Garcia-Cordvillia and E. Louis: Scripta Materilia, Vol. 44(6), 2001, pp. 265-970.
16. Effects of atmospheric condition on mechanical mixed layer formation and wear behavior in A356-15 vol. % SiCp composites, with S.B. Kang and J.M. Lee: Mater. Sci. Technol., Vol. 17,

2001, pp. 933-937.

17. Fabrication and characterization of pure magnesium – 30 vol. % SiCp particle composites, with M. K. Surappa: Mater. Sci. and Engg. A, A276, 2000, pp. 108-116.
18. Dry sliding wear behavior of A356-15% SiCp composites under controlled atmospheric conditions, with Jung-Moo Lee and Suk Bong Kang: Metall. Trans. A, Vol. 30 A, 1999, pp. 2523-2537.
19. Fabrication and characterization of SiC/MoSi₂ composites, with J. Pan, M.K. Surappa, B.W. Lin and D.M. Yang: Mater. Sci. and Engg. A, A244, 1998, pp. 191-98.
20. Microstructural characterization of the plastic zone formed during erosion of A356 Al alloy and its composites, with I. Samajdar and M. K. Surappa: Wear, Vol. 215, 1998, pp. 223-231.
21. Erosion of A356-Al-SiCp composites due to multiple particle impact, with M. K. Surappa and B.N. Pramila Bai: Wear, Vol. 202, 1997, pp. 154-164.

Publications and presentation at International conferences

1. Saravanan R Arunachalam, Case Studies: Mixed mode failures and cold work evaluation from aircraft teardown subjects, Fifth International conference on engineering failure analysis, The HAGUE, Netherlands, 1- 4 July 2012
2. Saravanan R Arunachalam, Metallurgical Failure analysis of Aircraft Structures: Interesting case studies from teardown, MST 2011, Columbus, Ohio, Oct 16-20, 2011.
3. Saravanan R Arunachalam, Sandeep R Shah, Scott A Fawaz and Gregory A Shoales: C/KC 135 teardown analysis program: Protocol 8 - Failure analysis, development and execution, 2010 Aircraft Airworthiness and Sustainment Conference (AA&S), Austin, Texas, May 10-14 2010.
4. Sarah E. Galyon, Saravanan R. Arunachalam, James Greer, Matthew Hammond and Scott A. Fawaz: Three dimensional crack growth predictions, 25th International committee on Aeronautical Fatigue (ICAF) Symposium, Rotterdam, Netherlands, 27-29 May 2009
5. R. A. Saravanan, Brian McCarthy, Matthew B. Squires, Dana Z. Anderson, Victor M. Bright: Electroplated Atom Chips for Ultracold Atom optics, Transducers 2005.
6. J. Kong, K. Maute, D. Frangopol, L. A. Liew, R. A. Saravanan, V. M. Bright and R. Raj: Developing an Ab-Initio Human-Machine Interface for an Ultrahigh Temperature MEMS Sensor made from a Novel Polymer Derived Ceramic, presented and published for the AIAA meeting in Atlanta, GA, Sept. 4-6, 2002.
7. Hee Yeon Ryu, R. A. Saravanan, and Rishi Raj: TiN coating – A solution for high temperature interconnects, IMAPS – 2002, Denver, Colorado, and USA.
8. R. A. Saravanan, Li-Anne Liew, Victor M. Bright and Rishi Raj: Silicon carbon-nitride ceramics – a high temperature semiconductor material for MEMS applications, IMAPS – 2002, Denver, Colorado, USA. (Best paper of the Session).
9. J. M. Molina, R. Arpón, R. A. Saravanan, C. García-Cordovilla, E. Louis and J. Narciso, SiC-Aluminium Composite with Bimodal Distribution of Particles, Euromat 2001, Remini, Italy.
10. R. A. Saravanan, J. M. Molina, J. Narciso, and E. Louis: Surface modification of Al/Al₂O₃ composite by Ni electrochemical deposition, Euromat 2001, Remini, Italy.
11. J. M. Molina, A. Roberto, R. A. Saravanan, J. Narciso, C. García-Cordovilla and E. Louis: Pressure infiltration of packed ceramic particles with bimodal distribution by liquid aluminium, HTC – 2000,

- Japan, published in Trans. of JWRI, Vol.30 special issue-2001.
12. R. A. Saravanan, J. M. Molina, A. Roberto, J. Narciso, C. García-Cordovilla and E.Louis: Effect of nitrogen on surface tension of pure aluminium at high temperatures, HTC – 2000, Japan, published in Trans. of JWRI, Vol.30 special issue-2001.
 13. Suk Bong Kang, R.A. Saravanan and Jung Moo Lee: Effects of atmospheric condition on mechanical mixed layer formation and wear behavior in A356-15 vol.% SiCp composites, presented 6th International Conference on Composites Engineering, ICCE – 6, 1999, USA.
 14. R. A. Saravanan and S. Mridha: Titanium aluminide by surface melting: SMT/PFAM – 1999 International Conference, Singapore.
 15. Chua May Lee Pauline, P. N. Bindumadhavan, R. A. Saravanan, Heng Keng Wah and O. Prabhakar: "Studies on interface bonding in aluminium - SiCp metal matrix composites", SMT/PFAM – 1999 International Conference, Singapore.
 16. R. A. Saravanan, and M. K. Surappa: Sliding wear behaviour of AMCs during cyclic loading, 5th Japan international SAMPE symposium and exhibition, JISSE- 5, Oct. 28-31, 1997, Tokyo, Japan, p. 445- 450.
 17. R. A. Saravanan, S. Seshan and M. K. Surappa: Processing and characterisation of pure magnesium matrix composites, 5th Japan International SAMPE Symposium and exhibition, JISSE- 5, Oct. 28-31, 1997, Tokyo, Japan, p. 1661- 1666.
 18. R. A. Saravanan and M. K. Surappa: Lubricated sliding wear of A356 and A356-30 vol.% SiCp composites, Proceedings of ASM International conference on "Wear of materials", Indianapolis, USA, 18 Sept. 1997.
 19. R. A. Saravanan, S. Seshan and M. K. Surappa: Dry sliding wear of A356-10 vol.% SiCp composites during cyclic loading, Proceedings of Golden Jubilee International conference on "Recent advances in Metallurgical Processes", ed.: D. H. Sastry, 6-19 July, 1997, Bangalore-India, p. 585.
 20. B. Dutta, R. A. Saravanan and M.K. Surappa: Synthesis of discontinuously reinforced metal matrix composites (DRMMCs) and their mechanical properties, Joint Indo-Japanese seminar on Manufacturing Science of Advanced composites, Univ. of Tokyo, Tokyo, Japan, 1997, p. 13.
 21. N.R.M.R. Bhargava, I. Samajdar, S. Nagarajan, R. A. Saravanan, B.N. Pramila Bai and M. K. Surappa: Microscopic investigation on the strain localization in Al alloys and AMCs, Microscopy of Composite Materials III, held at St John's College, Oxford, 1-3 April 1996.
 22. B.N. Pramila Bai, R. A. Saravanan, and M.K. Surappa: Tribological studies on Aluminium Matrix Composites, "Discussion Meeting on Inorganic Matrix Composites" held on 7-10th March, 1995 in Bangalore, INDIA, 1995, p. 171.

Technical reports

More than 40 technical failure analysis reports were submitted to customers like SKT technologies and AFRL in C5 teardown down program, apart from 3 reports to Navy Research laboratory (NRL) on C130 failure analysis. Listed below are few reports that were included in USAFA technical documentation.

1. Sarah E. Galyon Dorman, James Greer, Saravanan R Arunachalam, Matthew J Hammond and Scott A Fawaz: Three Dimensional Crack Growth – AA 2024-T351, USAFA-TR-2009-08
2. Gregory A. Shoales, John C. Brausch, Sandeep R. Shah, Saravanan R. Arunachalam, and Scott A.

Fawaz: Procedure for aircraft structural teardown analysis, USAFA TR 2008-02

3. Saravanan R Arunachalam: Microstructural evaluation of fuel exposed materials (Additive P39, Additive P47, High Acid number, 100 LT), 2007
4. Saravanan R Arunachalam, Shoales, Shah, Rausch, Walters, Hammond: C-130 Center Wing Box Structural Teardown Analysis Final Report, 2006, USAFA TR 2006-11
5. Saravanan R Arunachalam: Microstructural evaluation of fuel exposed materials (JP8, FT, P-47), 2006
6. Saravanan R Arunachalam and Gregory Shoales: CASTLE Metallurgical Evaluation Request Report Summary: C-5A Structural Risk and Model Revalidation Program, 2006, USAFA TR 2006-07
7. Molly Walters, Scott Fawaz and Saravanan R Arunachalam: Fatigue Crack Growth Rate Effects on Single and Multi-Layered Cold Expanded Aircraft Aluminum, 2006, USAFA-TR-2006-02
8. R.A. Saravanan: Failure Analysis of C-130E Rainbow Fitting Skin Panels for SN 63-7860 Right Wing at Nodes 13 & 14 and SN 63-7830 Left Wing at Node 14, 2006
9. R.A. Saravanan: Failure Analysis of C-130E SN 62-1789 Corner Fitting, SN 63-7890 Right Wing Spar Cap and SN 72-1295 Right Wing Spar Cap, 2005
10. R.A. Saravanan: Metallurgical Investigation and Failure Analysis of C-5 Aft Upper Crown Fuselage Skin Cracks, 2005.
11. R.A. Saravanan: Metallurgical Failure Analysis of T34 Lower Rear Spar at Wing Station 66, 2005
12. R.A. Saravanan: Metallurgical Failure Analysis of C-130 Part Number 372903-1R T9936A, 2004

Undergraduate Project Supervised:

1. Russell Morales: Fundamental materials research: Ti-Titanium, Titanium gum metal characterization, Fall 2006
2. Catsulis, Davis, Fuchs, Woodason: Determination of plastic zone size surrounding a fatigue crack using electron backscatter diffraction, Fall 2007
3. John Harvey, Matt Davis, Eric Gall, Matt Sparta: To measure crack trajectory of an ARCAN specimen subjected to mixed mode loading, Fall 2008
4. Andrew J. Roberts: Characterization of titanium gum metal oxidation, 2008
5. Corey Curtis, Alex Frank, Eric May, Steven Meyer: Lap-joint residual fatigue life analysis, Fall 2009
6. Debonis, Daniels, Littlefield: Corrosion characterization using micro-machining technology, Fall 2011
7. R. Noble, O'Donnell, Williams: Fabricate and characterize a micro-temperature sensor using FEI-dual beam microscope, Fall 2011
8. Street and Stuard: Determine thickness and residual stress in platinum and tungsten thin films deposited using an ion-beam deposition, Fall 2011

Patents

A novel process for the fabrication of Mg-305 SiC particle reinforced composites by casting route, with M.K. Surappa, patent No. 932/MAS/1999.

Microsystems Fabricated from Polymer-Derived, Multifunctional Si-C-N Ceramics, with L.A. Liew, R. Raj, A. Saha and V.M. Bright, Invention Disclosure submitted to the C.U. Office of Technology Transfer and Industry Outreach, February 27, 2002, C.U. Ref No. 2002.078B.