Gopal B Viswanathan (Babu)

Professor Research
Department of Materials Science and Engineering
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Professional Preparation

University of Cincinnati, Cincinnati, USA	Materials Science and Engineering	Ph.D.	1998
Indian Institute of Technology Kanpur, India	Metallurgical Engineering	M.S.	1985

Appointments:

2018-present	Research Full Professor, Dept. of Materials Science and Engineering, The Ohio State University
2013-2017	Senior Research Scientist, Dept. of Materials Science and Engineering, The Ohio State University
2009-2012	Senior Scientist, UES Inc., AFRL Wright-Patterson AFB OH-45433
2001-2009	Research Scientist, Dept. of Materials Science and Engineering, The Ohio State University
1999-2000	Post Doc. Dept. of Materials Science and Engineering, The Ohio State University

Summary of work experience

I have considerable research experience, both experimental and theoretical in the area of structure/property relationship in structural and energy materials. Specifically, I have initiated and conducted research, both independent and collaborative, in the advancement of Titanium, Nickel, Iron based and High Entropy alloys. My experience also includes the use of additive manufacturing methods for the development of Ti, Ni and compositionally complex alloy (CCA) systems. Currently, I have also been active with independently funded research programs through several JIP (Joint Industry Project) projects sponsored by the oil and gas industries to address the material selection for sub-sea equipment design for high temperature and high pressure (HPHT) applications. Separately, I also have funded programs to assess the damage evolution in above-the-ground transport pipelines subjects to sour environments. My experience also includes design and development of Ti, Ni and HEA alloys particularly suitable AM manufacturing.

All the above-mentioned research programs have one common thread which is the requirement for in-depth characterization of microstructure from macro to the atomic level. I have decades of experience in analytical electron microscopy techniques (SEM, TEM) in the areas of imaging, diffraction and spectroscopy. I have extensively used experimental techniques such as Hi-Resolution microscopy, HAADF-STEM microscopy and EDS/EELS spectroscopy and image simulation methods for my research. This vast experience has been the principal reason I have been able to initiate independent and collaborative research at multiple levels (see below).

Funded Research

- Research contract (PI) with Pratt & Whitney, Hartford, Connecticut.
  Topic: Investigation of Dwell Fatigue Mechanism in Ti-6246 Alloy ($300,000)
- Research contract (PI) with Rolls-Royce North American Technologies, Indianapolis.
  Topic: Microstructure investigation of environmentally accelerated crack growth ($500,000) with Rolls-Royce North American Technologies, Indianapolis.
- Research contract (PI) with Rolls-Royce North American Technologies, Indianapolis.
  Topic: A focused study on the effect of microstructure on the fracture behavior to identify the root cause of failures in dwell-fatigue tested alloy ME3, a Ni-base Superalloy ($65,000)
- Research contract (PI) with DNV GL Columbus Ohio.
  Topic: Development of guidelines for the use of high strength alloys for subsea fasteners ($155,000)
  Research Contract with Trelleborg INC
- DOE-NETL research (Co-PI) ($600,000)

Topic: ICME for Advanced Manufacturing of Ni Superalloy Heat Exchangers with High Temperature Creep and Oxidation Resistance for Supercritical CO_2

- Research contract (Co-PI) with Exxon Mobile ($600,000)
  Topic: Transition of Micro fissures to Cracking of High Strength Low Alloy Steels in Sour Environments.
- Research contract (PI) with Pratt & Whitney, Connecticut ($40,000)
  Topic: Evaluation of ME16 γ' Microstructure.
- Upcoming research contract (PI) with Pratt & Whitney, Connecticut ($60,000) potential to grow into multiple years
  Topic: Dwell Fatigue microstructure/property correlative investigation in titanium alloys.
- Leading Researcher in a program funded by Air Force Research Laboratory (AFRL).
  Topic: Precision Measurement Tools for Advanced Characterization.
- Leading Researcher and a Co-PI in a program funded by Trelleborg ($200,000)
  Topic: Material characterization of Mo-Si-B alloys
- Sufficient experience in proposal writing to government (NSF, AFOSR, ONL) and industrial (GE, TIMET, Rolls-Royce, Special Metals) funding agencies.

Professional Experience

Senior Scientist (UES Inc.) Air Force Research Laboratory, Wright Patterson AFB, OH-45433.

- Led advanced characterization initiatives aimed at fundamental understanding and derivation of structure-property relationships across various material systems through multiple techniques, including X-Ray and Neutron diffraction, Analytical and High-Resolution Scanning Transmission Electron Microscopy (HRSTEM), Electron energy-loss spectroscopy (EELS) in an aberration-corrected microscope.
- Led research efforts in the development of nano-scale γ/γ' microstructure in various Ni base superalloys. The efforts were focused on understanding the kinetics in morphological, structural and chemical changes in γ' precipitates during nucleation, growth and coarsening stages. The work was conducted in partnership with The Ohio State University and University of North Texas.
- Led research efforts in understanding the fundamental mechanisms for failures in advanced hybrid-disk Ni-based superalloys in dwell fatigue conditions at high temperatures. Extensively used synchrotron X-Ray beam line at Argon National Laboratory to study the compositionally complex strengthening precipitates.
- Led research efforts in understanding the effects of microstructure on the mechanical properties in α/β Ti alloys. The efforts were focused on the effect of size and scale of constituent phases, grains and their morphological and crystalline relationships on the tensile and fracture properties.

Visiting Scholar, Institut für Werkstoffe Werkstoffwissenschaft, Ruhr-Universität, Bochum, Germany

- Conducted research to study the microstructure effects on the creep behavior in a fine-grained TiAl based intermetallic alloy. Issues such as recrytallization, texture and operating micro-mechanisms were addressed to explain the creep behavior in this alloy.
- Devised and implemented testing techniques to identify grain boundary sliding behavior exhibited in this alloy during creep at high temperature.
- A focus study on grain boundary segregation effects in Cu-Bi alloy.

Research Scientist, Dept. of Materials Science & Engineering, The Ohio State University

- Fundamental understanding on the effect of micro-texture obtained through extensive use of orientation imaging microscopy (OIM) and Neutron-diffraction on phase transformation in forged and heat-treated Ti-6246 and Ti-64 alloys (Ladish, CAMM).
- Nano-scale probing to investigate the strength of *individual* phases in α/β Titanium alloys by a combination of techniques including Nano-indentation, Focused Ion Beam, Orientation imaging and TEM. (NSF)
- Advanced characterization initiatives aimed at fundamental understanding of structure-property relationships across various material systems through multiple techniques such as OIM, EFTEM, including aberration-corrected High-Resolution Scanning Transmission Electron Microscopy (HRSTEM)
- Microstructure based neural network modeling of tensile and fracture toughness in α/β Ti alloys. (AFOSR)
- Morphological investigation of intertwined alpha laths in an α/β Ti alloy using three-dimensional 3D-stereology.

(ONR)

Post-Doctoral Researcher, Dept. of Materials Science & Engineering, The Ohio State University

- Conducted research in understanding the fundamental issues during creep in a selected Ni-base superalloy containing varying γ and γ' scales of microstructure at temperatures where this alloy is most effectively used in service. Various operating mechanisms at the nano scale some of them previously unknown were mapped out depending on the microstructure, operating temperatures and stress levels. (AFOSR, DARPA)
- Extensive research done towards the understanding of the kinetics of slip transmission between α and β phases in oriented crystals of Ti-5Al-2Sn alloys (AFOSR).
- Studied the effect of interstitial elements on the creep behavior in Ti-6242 and γ TiAl alloys.
- Through the development of new microstructural characterization techniques, led team efforts to establish and standardize the characterization and quantification methodology for nano-scale precipitates in Ni-base superalloys.
- Microstructure effects and analytical modeling of creep behavior in TiAl based intermetallic alloys (AFOSR)
- Microstructural studies in friction stir welding of Ti alloys (NSF)

Graduate Research Associate, Dept. of Materials Science & Engineering, University of Cincinnati

- Ph.D. work involved the determination of the microstructural dependence of the tensile and creep properties and deformation mechanisms in γ-TiAl based alloys. Novel processing and heat treatment procedures were established to obtain various microstructures and samples tested for Tensile and Creep properties. Studies were coupled with detailed TEM characterization of the matrix and interface deformation structures to develop an understanding of the deformation mechanisms. Based on the experimental observations and theoretical understanding, mechanisms associated with tensile and creep deformation in these materials and their relationship with microstructure were proposed.
- Conducted Acoustic Emission probe experiments to monitor deformation process at RT.
- Co-developed a Temperature and Electrical Resistivity Measurements Setup (TERMS), an excellent instrument to study determine phase transitions in bulk materials.

Scientist, Metallurgical Research Laboratory, Hyderabad, India

- Conducted research in the area of laser material processing of engineering materials
- Rapid solidification processing of Al alloys.

Research Areas and Interests

Physical metallurgy, phase transformations, mechanical behavior, structure-property relations in high temperature alloys, intermetallics, processing, testing and characterization, analytical and high-resolution transmission electron microscopy of advanced structural and energy materials and nano-structures,

Teaching and Advising

- Mechanical Behavior of Materials, Physical Metallurgy and Phase Transformation, Analytical Electron Microscopy.
- Instructed and helped supervise over 35 graduate students (B.S., M.S. and Ph.D.)

Synergistic Activities:

Member of Titanium Alloys Committee TMS
Member of Phase Transformation Committee TMS
Member of the ASM International 1991-Present
Member of the TMS International 2000-Present
Organizer: "International symposium on Light Metals for Defense and Transportation: Trends, Paradigms and Strategy", Goa, India 2017
Organizer: "Symposium on Emerging Materials", OSU Materials Week 2018

Other Academic Activities & Honors:

- *Peer Review*: Serves as a reviewer for academic journals
- *Scholar, Institut für Werkstoffe-Werkstoffwissenschaft, Ruhr-Universität Bochum, Germany 2007.*
- *Scholar at SriRanmachnadra Medical College and Research Center, Chennai, India 2005-Present*
- *Research Consultant SriRamachandra Innovis, Chennai, India, 2011-Present*
- *Finalist for best poster award. MRS, 1997*
- *Best poster award, Gordon Conference on Physical Metallurgy, 2004, Plymouth, USA*
- *Recipient of Arthur Focke Outstanding Graduate Student Award, University of Cincinnati (1992). Institute Graduate Fellowship, Indian Institute of Technology, Kanpur, India (1983-85)*
- *100% Government of India National Merit Scholarship for five full year undergraduate Education.*

Partial List of Present and Past Collaborators:
Hamish Fraser (OSU), Michael Mills (OSU.), David Mills (Rolls-Roce), Gerald Frankal (OSU) Marc De Graef (Carnegie Mellon U.) Maryam Gazisaeidi (OSU), Boian Alexandrov (OSU), Glenn Daehn (OSU), William Clark (OSU), Rajarshi Banerjee (University of North Texas), Dan Evans (AFRL), Vijay Vasudevan (U. of Cincinnati), Dennis Dimiduk (Air Force Research Lab), Gunther Eggeler (Ruhr-Universität Bochum), Catherin Rae (Cambridge University), William Nix (Stanford University), Easo George (University of Tennessee), Michael Loretto (University of Birmingham), Pat Martin (Air Force Research Lab), Dallas Martin (Air Force Research Lab), William Nix (Stanford U), Dennis Maher (North Carolina State U.), Gregory Olson (Northwestern U.), Nick Birbilis (Monash University), Jay Tiley (Air Force Research Lab), Yunzhi Wang (The Ohio State U.), Chris Woodward (Air Force Research Lab), Tom Broderik (GE Aviation), Srikumar Banerjee (Chairman, Atomic Energy Commission, India), Dipankar Banerjee (IISc Bangalore, India), Neeraj Thirumali (Exxon Mobil). Yoji Kosaka (TIMET), Steve Fox (TIMET), Ramgopal Thodla (DNV GL). Michael Sangid (Purdue University)

Selected List of Publications:

1. M. Nartu , B Welk , S. Mantri , N. Taylor , G.B. Viswanathan , N. Dahotre , R. Banerjee, 'Underlying factors determining grain morphologies in high-strength titanium alloys processed by additive manufacturing', *Nature communications, Accepted (2023)*
2. **S**. Mukherjee, S. Kar, S. Tarafder , G.B. Viswanathan [c], H.L. Fraser , "Creep-Fatigue Response, failure mode and deformation mechanism of HAYNES 282 Ni based superalloy: Effect of dwell position and time", International Journal of Fatigue, V. 159, , 106820, 2022.
3. A.M. Panindre, H.O. Colijn, G.B. Viswanathan, X. Guo, C.D. Taylor, G.S. Frankel,"Corrosion of a non-equimolar multi-principal element alloy containing 13 at% Ru after aging", Corrosion Science 198 (2022) 110105
4. Z. Kloenne, Jean-Philippe Couzinié, Milan Heczko, Roman Gröger , Gopal B. Viswanathan [a], William A.T. Clark, Hamish L. Fraser, "On the *bcc/*B2 interface structure in a refractory high entropy alloy", Scripta Materialia, 223, 117071 (2022).
5. Z. Kloenne, K. Kadirvel, B. Welk, J. Couzinie, G.B. Viswanathan and H.L. Fraser, "High Temperature Phase Stability of the Compositionally Complex Alloy $AlMo_{0.5}NbTa_{0.5}TiZr$", *Applied Physics Letters, (2021)*
6. G.B. Viswanathan, B. Welk, Z. Kloenne, J. Couzinie, and H.L. Fraser, "Deformation Mechanism of a BCC-B2 Refractory High Entropy Alloy" in preparation, Acta materialia (2023).
7. M. Kattoura, G.B. Viswanathan, S.R. Mannava, D. Qian and V. K. Vasudevan, "Tensile Properties and Fracture Behavior of ATI 718Plus Alloy at Room and Elevated Temperatures", *Metall Mater Trans A*(2021). https://doi.org/10.1007/s11661-021-06329-y
8. X. Guo, S. Gin, P. Lei, T. Yao, H Liu, D. Schreiber, D Ngo, GB. Viswanathan T. Li, H. Kim, J. Vienna, J. Ryan, J. Du, J. Lian, G. Frankel, Self-accelerated corrosion of nuclear waste forms at material interfaces, *Nature Materials* 19 (3), 310-316 (2020).
9. Z Kloenne, G Viswanathan, S Fox, M Loretto, H Fraser, 'Interface and colony boundary sliding as a deformation mechanism in a novel titanium alloy', Scripta Mater, 178, 15 (2020).
10. A. J. Egan, Y. Rao, G. B. Viswanathan, T. M. Smith, M. Ghazisaeidi, S. Tin, and M. J. Mills, "Effect of Nb Alloying Addition on Local Phase Transformation at Microtwin Boundaries in Nickel-Based Superalloys", S. Tin et al. (eds.), Superalloys 2020, pp 640-650, The Minerals, Metals & Materials Series.
11. Li, Xiaoji; Viswanathan, Gopal Babu; Thodla, Ramgopal, "Hydrogen Embrittlement Study of Two Heats of UNS N07725 in Sea Water Under Cathodic Polarization Conditions", NACE International Corrosion Conference Proceedings; Houston, (Summer 2020)

12. G.B. Viswanathan, D.E. Mills, M.J. Mills, "Oxidation-Related Microstructural Changes at a Crack Tip in Waspaloy After Elevated-Temperature Dwell-Fatigue Testing, Metallurgical and Materials Transactions A 50 (12), 5574-5580 (2019).
13. X. Wang, F. Yang, G. Viswanathan, Shan-Shan Wang and G.S. Frankel, "Characterization and electrochemical assessment of Al-Zn-In alloy with trivalent chromium process coating", Corrosion Science, (176), 108933 (2020).
14. R Buntain, B Alexandrov and G. B. Viswanathan, "Characterization of the interpass microstructure in low alloy steel/Alloy 625 HW-GTAW narrow groove welds", Materials Characterization, (170), 110638 (2020)
15. Michael S. Titus, Robert K. Rhein, Philip C. Dodge, Gopal Babu Viswanathan, Michael J. Mills, Anton Van der Ven and Tresa M. Pollock. ***Science,*** Vol. 2, No. 12, Dec 2016.
16. Y. Zheng, R. William, G.B. Viswanathan, W. Clark, H.L. Fraser, "Determination of the Structure of α-β Interfaces in Metastable β-Ti Alloys", Revised and resubmitted to Acta materialia (2018).
17. S.A. Mantri, D. Choudhuri, T. Alam, G.B. Viswanathan, J.M. Sosa, H.L. Fraser and R. Banerjee, "Tuning the scale of α precipitates in β-titanium alloys for achieving high strength", *Scripta Materialia*, 154 (2018) 139-144.
18. Y. Zheng, R. William, G.B. Viswanathan, W. Clark, H.L. Fraser, "Determination of the Structure of α-β Interfaces in Metastable β-Ti Alloys", Acta *Materialia*., 150 (2018) p. 25-39.
19. T. M. Smith, B. D. Esser, B. Good, M. S. Hooshmand, G. B. Viswanathan, C. M. F. Rae, M. Ghazisaeidi, D. W. McComb, D. W. McComb, M. J. Mills, "Segregation and Phase Transformations Along Superlattice Intrinsic Stacking Faults in Ni-Based Superalloys", *Metallurgical and Material Transactions A* 9, (2018) p. 4186-4198.
20. V. Soni, B. Gwalani, O. Senkov, G.B Viswanathan, D. Miracle and R. Banerjee, "Phase stability as a function of temperature in a refractory high-entropy alloy", *Journal of Materials Research*, v.33, pp. 3235–3246 (2018)
21. A. Venkataraman, Paul A. Shade, R. Adebisi, S. Sathish, A.L. Pilchak, G.B. Viswanathan, M.C. Brandes, M.J. Mills and M.D. Sangid, "Study of Structure and Deformation Pathways in Ti-7Al Using Atomistic Simulations, Experiments and Characterization", Met. Trans. A, 48, 5, (2017) p. 2222-2236.
22. H. Wang, A. Vivek, Y Wang, G Viswanathan and . Daehn, "High strain rate embossing with copper plate", *International Journal of Material Forming,* 10, 5 (2017) p. 697-705
23. Michael S. Titus, Robert K. Rhein, Philip C. Dodge, Gopal Babu Viswanathan, Michael J. Mills, Anton Van der Ven and Tresa M. Pollock. *Science Advances, (*2016) Vol. 2, No. 12.
24. S. Mehr, G. B. Viswanathan, S. Nag, H.L. Fraser and R. Banerjee, "Determination of the γ/γ interface width in a Co-Al-W alloy via coupled aberration-corrected scanning transmission electron microscopy and atom probe tomography", *Scripta Materialia* 121, (2016) p. 23-27.
25. J. Jensen, B. Welk, R. Williams, J. Sosa, D. Huber, O. Senkov, G.B. Viswanathan and H.L. Fraser, "Characterization of the microstructure of compositionally complex alloy Al1Mo0.5Nb1Ta0.5Ti1Zr1", *Scripta Materialia* 121, (2016) p. 1-4.
26. R. Shi, V. Dixit, G.B. Viswanathan, H.L. Fraser, Y. Wang, "Experimental assessment of variant selection rules for grain boundary ***α*** in titanium alloys" Acta Materialia, 102, 1 (2016) p. 197-211.
27. T.M. Smith, B.D. Esser, N. Antolin, G.B. Viswanathan, T. Hanlon, A. Wessman, D. Mourer, W. Windl, D.W. McComb, M.J. Mills, "Segregation and <ε> Phase Formation Along Stacking Faults During Creep at Intermediate Temperatures in a Ni-Based Superalloy" Acta Mater., 100 (2015) p. 19-21.
28. Three-dimensional characterization of the microstructure of a high entropy alloy using STEM/HAADF tomography, "J.M. Sosa, J.K. Jensen, D.E. Huber, G.B. Viswanathan, M.A. Gibson and H.L. Fraser, *Materials Science and Technology*, 31, 10 (2015) p. 1250-1258.
29. G.B. Viswanathan, R. Shi, A. Genc, V.A. Vorontsov, L. Kovarik, C.M.F. Rae and M. J. Mills, "Segregation at Stacking Faults within the γ' Phase of Two Ni-Base Superalloys Following Intermediate Temperature Creep", 1, Scripta *Materialia*., 94, (2015) p. 5–8.
30. Brian A. Welk, Robert E.A. Williams, Gopal B. Viswanathan, Mark A. Gibson, Peter K. Liaw, Hamish L. Fraser "Nature of the interfaces between the constituent phases in the high entropy alloy CoCrCuFeNiAl", Ultramicroscopy, 134,11 (2013) p. 193-199.
31. G.B. Viswanathan, K. Bain, D. Huber, S. Jha, S. Kuhr, J. Tiley, C. Woodward and H.L. Fraser, "Analysis of deformation substructures in a notched LCF sample under dwell condition in a Ni-based superalloy", Sueralloys 2012 (2012) p. 403-410.
32. G. B. Viswanathan, R. Banerjee, A. Singh, S. Nag, J. Tiley, H.L. Fraser, "Precipitation of ordered phases in metallic solid solutions: A synergistic clustering and ordering process", Scripta *Materialia*, 65,6 (2011) 485-488.
33. S. Nag, R. Srinivasan, R.A. Williams, N. Gupta, G. B. Viswanathan, S. Banerjee, G. Srinivasan, H. L. Banerjee and R. Banerjee, "Noval mixed-mode phase transitions involving a composition dependent displacive component", Phys. Rev. Lett., (2011) 106, 24, p. 245701-04.

34. A.R.P. Singh, S. Nag, J.Y. Huang, G.B. Viswanathan, J. Tiley, R. Srinivasan, H.L. Fraser and R. Banerjee, "Influence of cooling rate on the development of multiple generations of γ' precipitates in a commercial Ni base superalloy", Material Characterization, 62, (2011) p. 878-886.
35. G.B. Viswanathan, R. Banerjee, A. Singh, S. Nag, J. Tiley, H.L. Fraser, "Precipitation of ordered phases in metallic solid solutions: A synergistic clustering and ordering process", Scrip. *Materialia*., 65, 6(2011) p. 485-488.
36. H. Bei, Y. Yang, G.B. Viswanathan, C. J. Rawn, E.P. George, J. Tiley and Y. A. Chang, "Formation, stability and crystal structure of the σ phase in Mo-Re-Si alloys" Acta Materialia (2010). 58, 18, p. 6027-34.
37. J. Tiley, G. B. Viswanathan, A. Shiveley, M. Tschopp, R. Banerjee, H.L. Fraser, "Measurement of precipitates in a Nickel based superalloy using energy-filtered TEM coupled with automated segmenting" *Micron* (2010) *41, p. 641-47*.
38. J. Tiley, G. B. Viswanathan, J. Y. Wang, A. Shiveley and R. Banerjee, "Evaluation of γ' volume fractions and lattice misfits in a Ni-base superalloy using external standard X-ray diffraction method", M*aterials Science and Engineering A528* (2010).
39. D. Peter, G.B Viswanathan, A. Dlouhy and Gunther Eggeler, "Analysis of local microstructure after shear creep deformation of a fine-grained duplex γ TiAl alloy", Acta Materialia 59 (2010) p. 6431-43.
40. J. Tiley, G.B. Viswanathan, R. Srinivasan, R. Banerjee, and H.L. Fraser, "Coarsening kinetics of γ' precipitates in commercial Nickel base superalloy Rene 88 DT. *Acta materialia* (2009) 57, p. 2538-49.
41. R. Srinivasan, G.B.Viswanathan, V.I. Levit and H.L. Fraser, "Orientation Effect on Recovery and Recrystallization of Cold-Rolled Niobium Single Crystals", M*aterials Science and Engineering* A1-2 (2009), p. 179-189.
42. R. Srinivasan, R. Banerjee, G.B. Viswanathan, J. Tiley, D.M. Dimiduk, H.L. Fraser, "Atomic scale structure and chemical composition across order-disorder interfaces" *Phys. Rev. Lett*. (2009) 102, p. 086101.
43. J. Tiley, R. Srinivasan, R. Banerjee, G.B. Viswanathan, B. Toby and H.L. Fraser, "Application of X-ray and neutron diffraction to determine lattice parameters and precipitate volume fractions in low misfit nickel base superalloys", *Mater. Sci. Tech*. 25, (2009) p. 1369-1376.
44. R. Srinivasan, G.B. Viswanathan, A. Genc, R. Banerjee, J.Y. Hwang, H.L. Fraser "Coupling LEAP and HRSTEM to study the nanoscale structure and chemistry of interfaces", *Microsc. Microanal*. (2008) 14 (S2), p. 376.
45. J.Y. Hwang, R. Banerjee, J. Tiley, R. Srinivasan, G.B. Viswanathan, and H.L. Fraser, "Nanoscale Characterization of elemental partitioning between γ and γ' phases in Rene 88 DT Nickel base superalloy." *Metallurgical and Material Transactions A* (2009) 40, p. 24-35.
46. J. Y. Hwang, S. Nag, R. Srinivasan, J. Tiley, G. B. Viswanathan, H. L. Fraser, and, R. Banerjee**, "**Compositional variations between different generations of γ' precipitates forming during continuous cooling of a commercial nickel base superalloy**",** *Metallurgical and Material Transactions A*, 40 (2009) p. 3059-67.
47. Mark Yavorsky, Vladimir Segal, Phil Young, G. B. Viswanahan, Vladimir Levit and Hamish Fraser, "Microstructure and properties of AA 5083 after warm ECAE and rolling: the flat billet version", *Materials Science and Engineering A*, (2007).
48. D. Bhattacharyya, G. B. Viswanathan, Hamish L. Fraser, "Crystallographic and Morphological Relationships between b phase and the Widmanstätten and Allotriomorphic α phase at Special β Grain Boundaries in an a α/β Titanium Alloy, *Acta materialia*, (2003), 51, 16, 4679-91.
49. G. B. Viswanathan, S. Karthikeyan, P. M. Sarosi, R. R. Unocic and M. J. Mills, "Microtwinning During Intermediate Temperature Creep of Polycrystalline Ni Base Superalloys: Mechanism and Modeling, *Philosophical Magazine A*, 86 (29-31) (2006) p. 823-4840.
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51. D. Bhattacharyya, G.B. Viswanathan, S.C. Vogel, D.J. Williams, V. Venkatesh and H.L. Fraser, "A neutron-diffraction Study of phase transformations by tracking texture evolution with temperature in Ti-6Al-4V", *Scripta Msterialia* (2006), 54(2), 231-236.
52. S. Kar, T. Searles, E. Lee, G.B. Viswanathan, J. Tiley, R. Banerjee, and H. L. Fraser, "Modeling the tensile properties in β processed α/β Ti Alloys", *Metallurgical and Material Transactions A* (2006), 37A, 559-566.
53. G.B Viswanathan, Eunha Lee, Dennis M. Maher, S. Banerjee and Hamish L. Fraser, "Direct observations and analyses of dislocation substructures in the α phase of an α/β ti-alloy formed by nanoindentation", *Acta Materialia* (2005), 53(10), p. 5101-3057
54. G. B. Viswanathan, P. M. Sarosi, M. F. Henry, D. D. Whitis, W.W. Milligan and M. J. Mills, "Investigation of creep deformation mechanisms at intermediate temperatures in Rene 88 DT", *Acta Materialia* (2005), 53(10), p. 3041-3057.

55. G.B Viswanathan, Eunha Lee, D. M. Maher, S. Banerjee and H. L. Fraser, "Direct observations of dislocation substructures formed by nano-indentation of the α-phase in an α/β titanium alloy", *Materials Science and Engineering A*400-401 (2005), p.463-466.
56. G. B. Viswanathan, P. M. Sarosi, M. F. Henry, D.D. Whitis and M.J. Mills, "Deformation mechanisms at intermediate creep temperatures in the Ni-base superalloy Rene88 DT", *Materials Science and Engineering A*400-401, (2005), p. 489-495.
57. P.M. Sarosi, G.B. Viswanathan, M.F. Henry, D.D. Whitis and M. J. Mills, "Imaging and characterization of fine γ' precipitates in a commercial nickel-base superalloy", *Ultramicroscopy* (2005), 103(1), p. 83-93.
58. Seung Min Han, R. Shah, R. Banerjee, G. B. Viswanathan, B. M. Clemens, W.D. Nix, "Combinatorial studies of mechanical properties of Ti-Al thin films using nanoindentation", *Acta Materialia* (2005), 53(7), p. 2059-2067.
59. S. Karthikeyan, G. B. Viswanathan and M. J. Mills, "Evaluation of the jogged-screw model of creep in equiaxed γ TiAl: identification of the key substructural parameters", *Acta Materialia* (2004), 52(9), p. 2577-2589.
60. R. Banerjee D. Bhattacharyya, P.C. Collins, G. B. Viswanathan, H. L. Fraser, "Precipitation of grain boundary α in a laser deposited compositionally graded Ti-8Al-xV alloy - an orientation microscopy study", *Acta Materialia* (2004), 52(2), p. 377-385.
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