DONALD S. SHIH
Distinguished Professor
Magnesium Research Center
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Education

Georgia Institute of Technology	Metallurgy	Ph.D. (1983)

Appointments

Kumamoto University, Magnesium Research Center	Mar 2017 - Present
Distinguished Professor	
Boeing (and McDonnell Douglas Research Lab)	Mar 1992 – Mar 2017
Boeing Technical Fellow	2008 – Mar 2017
Adjunct Professor, Southern Illinois University – Edwardsville	2000 – 2003
GE Aircraft Engines	1986 – 1991
Postdoctoral Fellow, University of Illinois – Urbana, Champaign	1983 – 1986

Noteworthy Honors and Awards

- NSF Award: Microstructure-Sensitive Design of Multiphase Structural Alloys. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1333083 August 2013 – July 2017.
- Invited Distinguished Keynote Speaker at the "Aerospace Industry and New Materials in Next Generation" Symposium in Kumamoto, Japan, April 2013.
- Invited Keynote Speaker at the TMS Annual Meeting, Orlando, FL, February 2012.
- Invited Keynote Speaker at the TMS Annual Meeting, San Diego, CA, March 2011.
- More than US$14M of contracts/ grants captured for the past 20 years from DARPA, AFRL, and ONR.
- Inducted and honored as Boeing Technical Fellow, 2008
- Boeing Pride Award, 2007 - outstanding performance in winning 2 external programs
- Two Boeing Pride Achievement Awards, 2006 – for gaining a key technology transfer
- Boeing Pride Achievement Award, 2002 & 2004 – for leading proposal/ win to NASA
- Outstanding Scholar, Midwest Chinese American Science & Technology Association, 2001
- Boeing Leading Edge Award, 1998
- Materials Research Society Award, 1998
- Invited and participated as a top 40 gamma-TiAl technology scientist in a workshop in Germany, 1994 – GKSS Forschungszentrum Geesthacht, invited 40 top scientists in the world in titanium aluminides to an expense-paid workshop in Kloster Irsee.
- McDonnell Douglas Teammate of Distinction Award, 1993
- GE Superior Achievement Award, 1988.

Expertise and Research Interests

- Integrated Computational Materials Engineering (ICME) for Ti and Mg alloys for aerospace applications: multiscale modeling and simulation, physics-based microstructural modeling linked with crystal plasticity modeling for property prediction and component application. Statistics-based

data mining with digital databases integrated with computational and experimental tools. Have had case studies in both Ti and Mg alloys.

- Titanium and titanium aluminide alloys and structures: alloy design, development and application. Ultra-fine grained Ti, high-temperature Ti alloys, superplastic forming and diffusion bonding.
- Mg alloy design and process, and application development – Ultrahigh strength Mg alloys with 30% lower density than Al7xxx alloys, but with the strengths of Al7055 for aerospace, auto, and rail applications; nonflammable Mg alloys; die-casting for 3C and wrought processing for transportation applications; "green" applications; thermal management for computers.
- Metallic thermal protection systems – manufacturing, testing, modeling and analysis of titanium and superalloys honeycomb sandwich structures based for hypersonic and supersonic applications. Ultralight and robust sandwich structures are built with thin foils of Ti alloys and superalloys.
- Very high strength Al-Mg-X alloys
- Ultrahigh strength stainless steels; high specific strength stainless steels
- Data-mining methodology
- Structural porous materials, metallic foams, cellular materials and their sandwich structures for multifunctional applications [e.g. structural & thermal management, structural & sensing, crashworthy: Ti foams, Al foams, Ti *in situ* low-density core sandwich structures, Cu foams.
- Hydrogen in metals; Hydrogen embrittlement in Ti alloys, superalloys and steels: hydrogen – dislocation interaction, microsturcure-property relationship.
- Nacelle thermal insulation technology: thermal blanket, integrated design for thermal management

Most Selected Products Closely Related to My Research Interests

More than 50 papers published, one book edited, more than 20 government technical reports completed, over 100 oral presentations made, one U.S. patent granted (on gamma-TiAl Ti aluminides), and two U.S. and world patents applied [as of May 2017]. More than US$14M of contracts/ awards captured. The selected ones include:

1. Smith, B.D., **Shih, D.S.,** and McDowell, D.M., "Cyclic Plasticity Experiments and Polycrystal Plasticity Modeling of Three Distinct Ti Alloy Microstructures," Intl J Plasticity, Vol 101, 11-23, Feb 2018.
2. **Shih, D.S.,** Wilson, P.N., Kim, S-K., Kim, B-H. and Yoon, Y-O., US Patent Ser #15/488,454; 16-1923-US-NP, "Aluminum Alloy with Additions of Magnesium and At Least One of Chromium, Manganese and Zirconium, and Methods of Manufacturing the Same.", Oct 18, 2018.
3. **Shih, D.S.,** Wilson, P.N., Kim, S-K., Kim, B-H. and Yoon, Y-O., US Patent Ser #15/48,456; 16-2871-US-NP, "Aluminum Alloy with Additions of Magnesium, Calcium and At Least One of Chromium, Manganese and Zirconium, and Methods of Manufacturing the Same." Oct 18, 2018.
4. Pan, Z., Liang, S.Y., Garmestani, H., **Shih, D.S.**, and Hoar, E., "Residual stress prediction based on MTS model during machining of Ti-6Al-4V," Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, https://doi.org/10.1177/0954406218805122, Oct 2018.
5. Lee, S.W., Kim, K.M., Park, C.H., Hong, J.K., Yeom, J.K., and Shih, D.S., "Effect of the B2-Structured TiFe Intermetallic Compound on the Tensile Behavior of the Ti-4Al-4Fe-0.25Si Alloy," Metall Matls Trans A, Vol 48A, 561-567, Feb 2017.
6. Pan, Z., Tabei, A., Shih, D.S., Garmestani, H., and Liang, S.Y., "The effects of dynamic evolution of microstructure on machining forces," http://journals.sagepub.com/doi/abs/10.1177/0954405417703430, J Eng Manuf, April 2017.

7. Pan, Z., Shih, D.S., Tabei, A., Garmestani, H., and Liang, S.Y., "Modeling of Ti-6Al-4V machining force considering materials microstructure evolution," Intl J Adv Manuf Technol, 1-8, Jan 2017.
8. Pan, Z., Shih, D.S., Garmestani, H., and Liang, S.Y., "Machining Induced Residual Stresses of Ti-6Al-4V: Experimental and Finite Element Modeling," Submitted J of Eng Manufacture, 2016. (Accepted).
9. Pan, Z., Shih, D.S., Garmestani, H., and Liang, S.Y., "Microstructure Sensitive Flow Stress Modeling of Ti-6Al-4V in the Machining Process," Submitted to J of Machining Science & Technology, 2016. (Accepted).
10. Smith, B.D., Shih, D.S., and McDowell, "Fatigue Hot Spot Simulation for Two Widmanstätten Ti Alloy Microstructures," Intl Journal Fatigue, 92, 116-129, 2016.
11. Pan, Z., Liang, S.Y., Garmestani, H., and Shih, D.S., "Prediction of Machining-Induced Phase Transformation and Grain Growth of Ti-6Al-4V Alloy," Intl J Adv Manufacturing Tech, (in press; published online March 1, 2016).
12. Tabei, A., Shih, D.S., Garmestani, H., and Liang, S.Y., "Dynamic Recrystallization of Al Alloy 7075 in Turning," J Manufacturing Science Eng, 138 (7), 2016.
13. Tsuchiya, K., Emura, S., and Shih, D.S., "Effect of Caliber Rolling on Microstructure and Mechanical Properties of Ti-6Al-4V," Proc of the 13th World Conference on Titanium (eds V Venkatesh et al), John Wiley & Sons, Inc., USA, May 2016.
14. Emura, S., Jiang, B., Tsuchiya, K., and Shih, D.S., "Influence of Cold Caliber Rolling on Alpha Phase Formation in Metastable Beta Ti Alloys," Proc of the 13th World Conference on Titanium (eds V Venkatesh et al), John Wiley & Sons, Inc., USA, May 2016.
15. Tabei, A., Shih, D.S., Garmestani, H., and Liang, S.Y., "Micro-Textural Evolution in Aggressive Machining of Al Alloy 7075," Matls & Manufacturing Proc, vol 31, Issue 13, 2016.
16. Tabei, A., Shih, D.S., Garmestani, H., and Liang, S.Y., "Derivation of Process Path Functions in Machining of Al Alloy 7075," J Matls Eng & Performance, 24 (11), 4503-4509, 2015.
17. Lee, T., Shih, D.S., and Lee, C.S., "Manufacturing Ultrafine-Grained Ti-6Al-4V Bulk Rod Using Multi-Pass Caliber-Rolling," Metals, 5 (2), 777-789, 2015.
18. Singh, A., Osawa, Y., Somekawa, H., Mukai, T., Parrish, C.J., and Shih, D.S., "Effect of Alloy Composition on Microstructure and Strength of Fine Grained Extruded Mg-Zn-Y Alloys Containing Quasicrystal Phase," Magnesium Technology, The Materials Society, 215-220, 2015.
19. Heo, T.W., Shih, D.S., and Chen, L-Q., "Kinetic Pathways of Phase Transformation in Two-Phase Ti Alloys," Metall Matls Trans, 45A (8), 3232-3240, 2014.
20. Singh, A., Osawa, Y., Somekawa, H., Mukai, T., Parrish, C.J., and Shih, D.S., "Development of Very High Strength and Ductile Dilute Magnesium Alloys by Dispersion of Quasicrystal Phase," Metall Matls Trans, 45A (8), 3438-3445, 2014.
21. Shih, D.S., "Alloy by Design – R&D Effort on Ti and Mg Alloys at Boeing Research & Technology," Distinguished Keynote Address in *Aerospace Industry and New Materials in Next Generation*, Kumamoto, Japan, Apr 2013.
22. Shih, D.S., "Development and Application of Mg Alloys for Aerospace Applications," 2012 TMS Keynote Address, Orlando, FL, Mar 2012.
23. Liu, M., Shih, D.S., Parrish, C., and Atrens, A., "The Ignition Temperature of Mg Alloys WE-43, AZ31 and AZ91," Corrosion Science, Vol. 54, 2012, pp. 139-142.
24. Shih, D.S., Britt, S.E., and McDowell, D.L., "Modeling the Deformation Response of Fully Lamellar α+β Titanium Alloys," Ti-2011, The 12th World Conference on Titanium, Beijing, China, June 2011.

25. Shih, D.S., "A Case for ICME - Ti Alloy Design Tool Development," 2011 TMS Invited Talk. San Diego, CA, March 2011.
26. Shih, D.S., Trimarchi, G., Shih, D., Wolverton, C., and Freeman, A.J., "Designing Lighter Ti Alloys using First-principles Computational Approach," MMM 5th International Conference on Multiscale Materials Modeling, Freiburg, Germany, Oct 2010.
27. Shih, D.S., Lawler, H., and Trinkle, D.R., "*Ab initio* Modeling to Improve Oxygen Tolerance of Ti Alloys," MMM 5th International Conference on Multiscale Materials Modeling, Freiburg, Germany, Oct 2010.
28. Shih, D.S. and Kim, Y.K., "Sheet Rolling and Performance Evaluation of Beta-Gamma (β–γ) Alloys, Proceedings of Ti-2007 Science and Technology, Kyoto, 1021, 2007.
29. Chan, K.S. and Shih, D.S., "Fundamental Aspects of Fatigue and Fracture in a TiAl Sheet Alloy," Metall Matls Trans A, 29A (1), 73-87, 1998.
30. Schwartz, D.S., Shih, D.S., Evans, A.G., Wadley, H.N.G., Editors, "Porous and Cellular Materials for Structural Applications," Matls Res Society, v.521, 1998.
31. Schwartz, D.S., Shih, D.S., Lederich, R.L., Martin, R.L., and Deuser, D.A., "Development and Scale-up of the Low Density Core Process of Ti-64", in *Porous and Cellular Materials for Structural Applications*, *Schwartz, D.S., Shih, D.S., Evans, A.G., Wadley, H.N.G., Editors,* Matls Res Society proceedings, v.521, 225-230, 1998.
32. Chan, K.S. and Shih, D.S., "Fatigue and Fracture of a Fine-Grained Lamellar TiAl Alloy," Metall Matls Trans A, 28A (1), 79-90, 1997.
33. Deve, H.E., Evans, A.G., and Shih, D.S., "A High-Toughness γ-Titanium Aluminide," Acta Metall Mater 40 (6), 1259-1265, 1992.
34. Huang, S.C. and Shih, D.S., "Microstructure and Ductility of TiAl Alloys Modified by Cr Addition," ISIJ international, 31 (10), 1100-1105, 1991.
35. Shih, D.S., Amato, R.A., "Interface Reaction between Gamma-TiAl Alloys and Reinforcements," Scripta Metall Mater, 24 (11), 2053-2058, 1990.
36. Shih, D.S. and Scarr, G.K., and Wasielewski, "On Hydrogen Behavior in Ti_3Al", Scripta Metall, 23 (6), 973-978, 1989.
37. Robertson, I.M., Bond, G.M., Lee, T.C., Shih, D.S., and Birnbaum, H.K., "Dynamic Studies of Deformation and Fracture at Grain Boundaries," Le Journal de Physique Colloques, 49 (C5), Oct 1988.
38. Shih, D.S. and Birnbaum, H.K., "Evidence of FCC Titanium Hydride Formation in β Titanium Alloy: an X-ray Diffraction Study," Scripta Metall, 20 (9), 1261-1264, 1986.
39. Shih, D.S., Robertson, I.M., and Birnbaum, H.K., "Hydrogen Embrittlement of α Titanium: *in situ* TEM Studies," Acta Metall, 36 (1), 111-124, 1988.

Synergistic Activities

Don Shih is a leading researcher in ICME and Materials Genome Initiative (MGI) related effort in the world, including digital databases and data mining, at Boeing Research & Technology (BR&T). He also serves on several committees (Ti, light metals, and EMPD) and the IMMI journal at TMS. He is a key technical fellow focal point for BR&T's global metal technology strategy and oversight. In August 2013, he, as the industry principle investigator, with Prof Dave McDowell and Prof Surya Kalidindi of Georgia Tech won a US NSF (National Science Foundation) award, http://www.nsf.gov/awardsearch/showAward?AWD_ID=1333083 ($720,000 for 3 years) on modeling and prediction of fatigue life in metallics with microstructural sensitivity using crystal plasticity theory and 2-point correlation methodology.