

Henry J. Rack

Professor
Materials Science & Engineering

Phone: (864) 656-5636
Office: 213 Olin Hall
E-mail: rackh@clemson.edu



EDUCATION

Dr. Rack received his B.S., M.S. and Sc.D degrees in Metallurgy from Massachusetts Institute of Technology.

2001-present, Professor, School of Materials Science and Engineering, Clemson University

2003, 2006. Visiting Professor, Technical University of Clausthal, Clausthal-Zellerfeld, Germany

2000, Humboldt Foundation Senior Research Fellow Brandenburgische Technische Universität, Cottbus, Germany

1999-2001, Chair and Professor, Department of Ceramic and Materials Engineering, Clemson University

1997-1998, Humboldt Foundation Senior Research Fellow, Technical Universität of Munich, Munich, Germany

1995-1998, Professor, Materials Science and Engineering, Department of Materials Science and Engineering, Clemson University

1993, Visiting Professor, Hiroshima University, Hiroshima, Japan.

1985-1995, Professor of Mechanical Engineering and Metallurgy, Clemson University

1984, Manager, High Performance Alloys and Composites Department, ARCO Metals Technical Center, Arlington Heights, IL

1981-1984, Manager, Metallurgy Department, ARCO Metals SILAG Operation, Greer, SC

1975-1981, New Mexico Institute of Mining and Technology, Socorro, NM, Adjunct Professor,

1972-1981, Sandia Laboratories, Albuquerque, NM, Member of Technical Staff,

1968-1972, Lockheed-Georgia Company, Marietta, GA, Scientist.

RESEARCH

Planar Flow Casting of Amorphous Metals

This examination focuses on the achievement of amorphous and nanocrystalline Cu, Ni, Al and Fe alloys utilizing planar flow casting. The detailed consideration of the amorphous to crystalline transformation and its effect on the physical/mechanical properties of these materials is also under investigation. Future studies will incorporate reactive amorphous metal alloys, e.g., Mg, Ti and Zr base systems.

Severe-Plastic Deformation of Advanced Metallics and Composites

This examination considers the influence of severe plastic deformation in single and two phase systems. Particular focus on achieving an understanding of grain boundary structure in bulk nano/ultra-fine grained titanium alloys and composites and the influence of this structure on surface reactivity, high cycle fatigue and wear performance.

Adaptive Manufacturing of Smart Materials

This examination combines the attributes of amorphous/nanograined metallic materials, ceramics and polymer composites to form bulk components utilizing ultrasonic consolidation. Includes definition of the effect of ultrasonic energy on localized deformation and phase stability in metallic, ceramic/metallic and ceramic/polymeric composites.

Synthesis of Low Modulus, Wear Resistant Biocompatible Orthopedic Alloys

This examination focuses on first principal synthesis of low modulus, wear resistant titanium alloys for orthopedic application. It is being conducted in cooperation with a multi-disciplinary group examining the influence of alloy chemistry, processing and surface treatment on control and optimization of this new class of alloys.

Phase Transformations in Titanium Alloys

This examination considers martensitic and diffusional transformations in titanium alloys. It includes consideration of composition, microstructure particularly at the nano-scale and crystallography (texture) on aging response of metastable beta titanium alloys, transition temperatures in titanium shape memory alloys and the effect of cooling/heating rate on martensitic/diffusion controlled transformations in titanium alloys.

MEMBERSHIPS

National Materials Advisory Board (NMAB)
ASM International
The Materials Society (TMS)

PROFESSIONAL SERVICE

Chairman, Albuquerque Chapter (1975-76), American Society for Materials.

Chairman, Titanium Committee (1980-82)

Chairman, Joint TMS/ASM Composites Committee (1993-1995)

Chairman, Sub-Group/Materials-Nuclear Spent Fuel and High-Level

Waste Transport Packagings Committee (1980-81)

ASME Member, Advisory Technical Awareness Council, ASM

Secretary, Mechanical Behavior Activities, Mechanical Testing and

Quality Control Division, ASM

HONORS

National Materials Advisory Board, 1999-2005

Senior Humboldt Fellow, 1997

American Men and Women of Science

Who's Who in America

Who's Who in Engineering

Who's Who in Technology Today

Fellow, ASM International, 1989

VASCO Fellow (MIT), 1965-68

AIME Annual Paper Award, 1965

Dow Chemical Award (MIT), 1964

Recent Publications

Invited Reviews

H. J. Rack and I. Gheorghe, P/M METAL MATRIX COMPOSITES, Encyclopedia of Composites, Vol. 2, Elsevier Press, London, 2000, p. 679.

Archival Journals

M. Long and H. J. Rack, TITANIUM ALLOYS IN TOTAL JOINT REPLACEMENT - A REVIEW, Biomaterials, Vol. 19,1621(1998).

V. Venkatesh and H. J. Rack, ELEVATED TEMPERATURE STRAIN HARDENING OF INCONEL 690, Mech. of Mat'ls, Vol. 30, 69(1998).

I. Philippart and H. J. Rack, HIGH TEMPERATURE HIGH STRAIN DEFORMATION OF Ti-6.8Mo-4.5Fe-1.5Al, Mat'l Sci. Eng., Vol. A254, 253(1998).

S. Azimzadeh and H. J. Rack, PHASE TRANSFORMATIONS IN Ti-6.8Mo-4.5Fe-1.5Al, Met. Trans., Vol. 29A, 2455(1998).

V. Venkatesh and H. J. Rack, INFLUENCE OF MICROSTRUCTURAL INSTABILITIES ON ELEVATED CREEP DEFORMATION OF INCONEL 690, Mat'ls Sci. & Tech., Vol.15, 408(1999).

M. Long, R. Crooks and H. J. Rack, HIGH-CYCLE FATIGUE BEHAVIOR OF SOLUTION TREATED METASTABLE β TITANIUM ALLOYS, Acta Met., Vol.47, 661(1999).

V. Venkatesh and H. J. Rack, A NEURAL NETWORK APPROACH TO ELEVATED TEMPERATURE CREEP-FATIGUE LIFE PREDICTION, Int. Jn Fatigue, Vol 21, 225(1999).

A. C. Geiculescu, H. G. Spencer, H. J. Rack and B. Sullivan, AQUEOUS SOL-GEL MODIFICATION OF THE FIBER-MATRIX INTERFACE IN GRAPHITE FIBER ALUMINUM MATRIX COMPOSITES, Adv. Mat'ls & Man., Vol 14, 489(1999).

X. Tang, T. Ahmed and H. J. Rack, MARTENSITIC PHASE TRANSFORMATION IN Ti-Nb-Ta and Ti-Nb-Ta-Zr ALLOYS, Jn. Mat'ls Sci., Vol 35, 1805(2000).

A. C. Geiculescu and H. J. Rack, ATOMIC-SCALE STRUCTURE OF WATER-BASED XEROGELS BY X-RAY DIFFRACTION, Jn. Sol-Gel Sci. & Tech., Vol. 30, 13(2001).

S. Menon and H. J. Rack, FLOW STABILITY IN BINARY Al-Li ALLOYS, *Mat'l Sci. Eng.*, Vol. 297, 244(2001).

K. Kharia and H. J. Rack, PHASE TRANSFORMATIONS IN IMI 550, *Met. Trans.*, Vol. 32A, 671(2001).

P. D. Rack, A. C. Geiculescu and H. J. Rack, GROWTH OF REACTIVE SPUTTER DEPOSITED TUNGSTEN-CARBON THIN FILMS, *Jn. Vac. Sci. Tech.*, Vol. 19, 62(2001).

M. Long and H. J. Rack, FRICTION AND SURFACE BEHAVIOR OF SELECTED TITANIUM ALLOYS DURING RECIPROCATING-SLIDING MOTION, *Wear*, Vol.249, 158(2001).

S. Menon and H. J. Rack, HIGH TEMPERATURE, HIGH STRAIN FORGING BEHAVIOR OF BINARY Al-2Li, *Mat'l Sci. & Tech.*, Vol. 17, 836(2001).

A. C. Geiculescu and H. J. Rack, ATOMIC SCALE STRUCTURE OF ALCOHOL-BASED ZIRCONIA XEROGELS BY X-RAY DIFFRACTION, *Jn. Non-Crystalline Solids*, Vol. 289 53(2001).

I.Gheorghe and H. J. Rack, INFLUENCE OF TiO₂ TO Al RATIO ON THE REACTION IN TiO₂ /Al COMPOSITES, *Mat'ls Sci and Tech.*, Vol. 18, 1079(2002).

A. C. Geiculescu and H. J. Rack, X-RAY SCATTERING OF POLYMERIC ZIRCONIUM SPECIES IN AQUEOUS XEROGELS, *Jn. Non-Crystalline Solids*, Vol. 306, 30(2002).

I.Gheorghe and H. J. Rack, REACTIVE INFILTRATION OF 25 V/O TiO₂/Al COMPOSITES, *Met. Trans.*, Vol. 33A, 2155(2002).

G.G. Yapici, I. Karaman, Z. P. Luo and H. Rack, MICROSTRUCTURE AND MECHANICAL PROPERTIES OF SEVERELY DEFORMED POWDER PROCESSED Ti-6Al-4V USING EQUAL CHANNEL ANGULAR EXTRUSION, *Scripta Materialia*, Vol. 49,1021(2003).

J. I. Qazi, B. Marquardt and H. J. Rack, HIGH STRENGTH METASTABLE BETA TITANIUM ALLOYS FOR BIOMEDICAL APPLICATIONS, *JOM*, Vol. 56, No. 11, 49(2004).

M. Long and H. J. Rack, SUBSURFACE DEFORMATION AND MICROCRACK FORMATION IN Ti-35Nb-7Zr-5Ta-O(x) DURING RECIPROCAL SLIDING WEAR, *Mat'ls Sci. & Eng.*, Vol. C25 382(2005)

J. I. Qazi, B. Marquardt, L. Allard and H. J. Rack, PHASE TRANSFORMATIONS IN Ti-35Nb-7Zr-5Ta(0.06-0.7)O ALLOYS, *Mat'ls Sci. &*

Eng., Vol. C25 389(2005).

M. Kocan, H. J. Rack and L. Wagner, FATIGUE PERFORMANCE OF METASTABLE BETA TITANIUM ALLOYS: EFFECTS OF MICROSTRUCTURE AND SURFACE FINISH, Jn. Mat'ls Eng. & Perf., Vol. 14, 765(2005).

B. Yazgan-Kokuoz, Y. Kosaka and H. J. Rack, HIGH CYCLE FATIGUE CRACK INITIATION AND GROWTH IN TIMET LCB, Jn. Mat'ls Eng. & Perf., Vol. 14, 773(2005).

J. Qazi and H. J. Rack, METASTABLE BETA TITANIUM ALLOYS FOR BIOMEDICAL APPLICATIONS, Advanced Eng. Mat'ls, Vol. 7, 11(2005).

V. Jablokov, N. Murray, H. J. Rack, R. H. Trust and H. Freese, INFLUENCE OF OXYGEN CONTENT ON THE MECHANICAL PROPERTIES OF TITANIUM-35NIOBIUM-7ZIRCONIUM-5TANTALUM BETA TITANIUM ALLOYS, Jn ASTM(JAI), Vol. 2, #8, 12(2005).

J. I. Qazi, V. Tsakris, B. Marquardt and H. J. Rack, EFFECT OF AGING TREATMENTS ON THE TENSILE PROPERTIES OF Ti-35Nb-7Zr-5Ta(0.06-0.7)O ALLOYS, Jn ASTM(JAI), Vol. 2, #8, 19(2005).

M. Kocan, B. Yazgan-Kokioz, H. J. Rack and L. Wagner, High CYCLE FATIGUE PERFORMANCE OF LIGHTWEIGHT TITANIUM AUTOMOTIVE SUSPENSIONS, JOM, vol. 57, #11, 66 (2005).

H. J. Rack, BETA TITANIUM ALLOYS FOR ORTHOPEDIC APPLICATIONS, JOM, vol. 57, #11, 61(2005).

C. Yao, E. B. Slamovich, J. Qazi, H.J.Rack, and T. J. Webster, IMPROVED BONE CELL ADHESION ON ULTRAFINE GRAINED TITANIUM AND Ti-6Al-4V, Ceramic Trans., Vol. 159, 239(2005).

H. J. Rack and J. Qazi, TITANIUM ALLOYS FOR BIOMEDICAL APPLICATIONS, Mat'ls Sci. & Eng. C, Vol. 26, 1269(2006).

T. Ludian, M. Kocan, H. J. Rack and L. Wagner, RESIDUAL STRESS-INDUCED SUBSURFACE FATIGUE CRACK NUCLEATION IN TITANIUM ALLOYS, Zeitschrift fur Metallkunde, Vol. 97, 2006, 1425-1431.

H. J. Rack, RECENT ADVANCES IN TITANIUM ALLOYS FOR BIOMEDICAL DEVICE APPLICATIONS, Bone Zone, Vol. 7, #1, 62(2008).

R. Z. Valiev, L. Dluhos, D. Hrusak, V.V. Latysh, T.C. Lowe, H.J.Rack, J. Petruzelka, J. Scohova, and I.P. Semenova, NANOSTRUCTURED TITANIUM FOR BIOMEDICAL APPLICATIONS, Advanced Engineering Materials, in press.

Y. Orlov, K. Maekawa, N. Tsuji and H. J. Rack, Ti-ZrO₂ Interactions during Manufacturing of High Porosity Ti/Ti-based MMC with Regulated Structures, Materials Science Forum, in press.

L. Dluhos, D. Hrusak, V.V. Latysh, T.C. Lowe, H.J.Rack, J. Petruzelka, J. Scohova, I.P. Semenova, R.Z. Valiev, NANOSTRUCTURED SPD PROCESSED TITANIUM FOR DENTAL APPLICATIONS, Mat'ls Science Forum, in press.

H. J. Rack, L. Allard, J. Qazi and R.Z. Valiev, THERMAL STABILITY OF NANOSTRUCTURED TI-6AL-4V, Mat'ls Sci. Forum, in press.

N. Kukalov and H. J. Rack, CONTROL OF 3003-H18 ALUMINUM ULTRASONIC CONSOLIDATION, SME Journal, submitted.

N. Kukalov and H. J. Rack, SURFACE DAMAGE DURING ULTRASONIC CONSOLIDATION OF 3003-H18, Rapid Prototyping, submitted.

J. Qazi, L. Allard and H. J. Rack, PHASE TRANSFORMATIONS DURING COOLING OF Ti-6Al-4V FROM ALPHA-BETA SOLUTION TREATMENT, Mat'ls Sci. & Eng. A, submitted.

J. Qazi, L. Allard and H. J. Rack, PHASE TRANSFORMATIONS DURING COOLING OF IMI 550, Mat'ls Sci. & Eng. A, submitted.

J. Qazi, L. Allard and H. J. Rack, PHASE TRANSFORMATIONS DURING COOLING OF Ti-6Al-22-22 FOLLOWING SOLUTION TREATMENT, Mat'ls Sci. & Eng. A, submitted.

Conference Proceedings

A.Roussel, I. Duta and H. J. Rack, GRAIN GROWTH PHENOMENA IN Ti-15V-3Al-3Cr-3Sn, Microstructural Modeling and Prediction during Thermomechanical Processing, R. Srinivasan and S. L. Semiatin, eds., TMS, Warrendale, PA, 2001, pp. 157-165.

H. J. Rack, I. Gheorghe, K. Kharia and A.C. Geiculescu, IN-SITU FABRICATION OF FIBER REINFORCED METAL MATRIX COMPOSITES, Affordable Metal Matrix Composites for High Performance Applications, A. Pendey, K. Kendig and T. Watson, eds., TMS, Warrendale, PA, 2001, pp. 211-221.

J. Fitzgerald, P. D. Rack, A. C. Geiculescu and H. J. Rack, DEPOSITION OF

CERAMIC MATERIALS USING POWDER AND PRECURSOR VEHICLES VIA DIRECT WRITE PROCESSING, Materials Development for Direct Write Technologies, MRS Proc. Vol. 624, 2000, pp. 29-34.

A. Roussel, L. Reister and H. J. Rack, HIGH CYCLE FATIGUE RESPONSE OF SOLUTION TREATED AND AGED Ti-15V-3Al-3Cr-3Sn SHEET, FATIGUE 2002, Proc. 8th Int. Fatigue Congress, Stockholm, Sweden, June 2002, A. F. Blom, ed., Heath, West Midlands, UK : Engineering Materials Advisory Services, Vol. 3, pp. 1823-1832.

A. Roussel, I. Duta and H. J. Rack, GRAIN GROWTH PHENOMENA IN Ti-15V-3Al-3Cr-3Sn, Microstructural Modeling and Prediction during Thermomechanical Processing, R. Srinivasan and S. L. Semiatin, eds., TMS, Warrendale, PA, 2001, pp. 157-165.

H. J. Rack, I. Gheorghe, K. Kharia and A.C. Geiculescu, IN-SITU FABRICATION OF FIBER REINFORCED METAL MATRIX COMPOSITES, Affordable Metal Matrix Composites for High Performance Applications, A. Pendey, K. Kendig and T. Watson, eds., TMS, Warrendale, PA, 2001, pp. 211-221.

J. Fitzgerald, P. D. Rack, A. C. Geiculescu and H. J. Rack, DEPOSITION OF CERAMIC MATERIALS USING POWDER AND PRECURSOR VEHICLES VIA DIRECT WRITE PROCESSING, Materials Development for Direct Write Technologies, MRS Proc. Vol. 624, 2000, pp. 29-34.

M. Gheorghe, J.I. Qazi and H. J. Rack, ANISOTHERMAL ALPHA PHASE FORMATION IN Ti-6.8Mo-4.5Fe-1.5Al, Ti-2003: Science and Technology, G. Luertjering and J. Albrecht, eds., Wiley-VCH Verlag GmbH, Weinheim, Germany, Vol. II, pp. 1155-1162.

M. Long, J.I. Qazi and H.J. Rack, RECIPROCATING SLIDING WEAR RESISTANCE OF b21SRx TITANIUM, Ti-2003: Science and Technology, G. Luertjering and J. Albrecht, eds., Wiley-VCH Verlag GmbH, Weinheim, Germany, Vol. II, pp. 1691-1698.

J.I. Qazi, V. Tsakiris, B. Marquardt and H. J. Rack, THE EFFECT OF DUPLEX AGING ON THE TENSILE BEHAVIOR OF Ti-35Nb-7Zr-5Ta-(0.06-0.7)O ALLOYS, Ti-2003: Science and Technology, G. Luertjering and J. Albrecht, eds., Wiley-VCH Verlag GmbH, Weinheim, Germany, pp.1651-1658.

J. I. Qazi and H. J. Rack, EFFECTS OF THERMAL TREATMENT ON THE MECHANICAL PROPERTIES OF BIOMEDICAL TITANIUM ALLOYS, Mat'ls and Processes for Medical Devices I, ASM Int., Materials Park, OH, 2004, pp. 349-356.

R. Z. Valiev, V. V. Stolyarov, H. J. Rack and T. C. Lowe, SPD-PROCESSED

ULTRA-FINE GRAINED TI MATERIALS FOR MEDICAL APPLICATIONS, Mat'ls and Processes for Medical Devices I, S. Shrivastava, ed., ASM Int., Materials Park, OH, 2004, pp. 362-367.

M. Kocan, T. Ludian, M. Ishii, H. J. Rack and L. Wagner, OPTIMIZATION OF MICROSTRUCTURE OF TIMETAL LCB FOR APPLICATION AS SUSPENSION SPRINGS, Light Materials for Transportation Systems(LIMAT), W. E. Frazier, Y.D. Han, N. J. Kim and E. W. Lee, eds., CAAM, 2004,pp. 417-425.

E. K. Y. Fu, H. C. Bellum, J. I. Qazi, H. J. Rack and V. Stolyarov, RECIPROCATING-SLIDING WEAR OF ULTRA-FINE GRAINED Ti-6Al-4V, Ultrafine Grained Materials III, Y. T. Zhu, T. G. Langford, R. Z. Valiev, S. L. Semiatin, D. H. Shin and T. C. Lowe, ed., TMS, Warrendale, PA, 2004 pp. 547-552.

M. Kocan, H. J. Rack and L. Wagner, EFFECTS OF AGING TREATMENT AND SHOT PEENING VARIABLES ON HCF PERFORMANCE OF TIMETAL LCB, Shot Peening and Other Mechanical Surface Treatments, V. Schulze and A. Niku-Lari, eds.,IITT, Noisy-le-Grand, France, 2005,pp. 320-325.

I.Trausch, N. Istephanous and H. J. Rack, EFFECT OF GRAIN SIZE ON THE ELECTROCHEMICAL PROPERTIES OF OXIDE FILMS ON TITANIUM AND ITS ALLOYS FOR ORTHOPEDIC AND SPINAL APPLICATIONS, Mat'ls and Processes for Medical Devices II, ASM Int., Materials Park, OH, 2005,pp. 380-385.

M. Kocan,H. Rack and L. Wagner, RESIDUAL STRESS-INDUCED SUBSURFACE FATIGUE CRACK NUCLEATION IN TITANIUM ALLOYS, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 367-370.

B. Yazgan-Kokouz, J. Hudson and H. J. Rack, ANISOTHERMAL ALPHA PHASE TRANSFORMATION IN TI-3Al-8V-6Cr-4Zr-4Mo, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 969-972.

Senthilkumar Chandrasekaran, B. Yazgan-Kokouz, J. Hudson and H. J. Rack, THE POTENTIAL FOR ACHIEVING ENHANCED MECHANICAL PERFORMANCE IN TIC PARTICULATE REINFORCED TI-6Al-6V-2Sn POWDER METALLURGY COMPOSITES, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 599-602.

B. Yazgan-Kokouz, J. Brasell,P. Martin, J. Hudson and H. J. Rack, STABILITY OF TI-5Al-5Mo-2Cr-1Ni (CORONA-X), Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan

Institute of Metals, 2007, pp. 965-968.

M. Kocan, H. J. Rack and L. Wagner, CONSIDERING ENVIRONMENTAL AND MEAN STRESS EFFECTS IN UNDERSTANDING THE FATIGUE PERFORMANCE OF SHOT PEENED TITANIUM ALLOYS, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 1241-1244.

J. Mueller, T. Ludian, H. J. Rack and L. Wagner, MICROSTRUCTURAL AND MEAN STRESS EFFECTS IN FATIGUE PERFORMANCE OF SHOT PEENED TI-6AL-4V, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 375-378.

J. Mueller, H. J. Rack and L. Wagner, EFFECTS OF SUPRA- AND SUBTRANSUS HEAT TREATMENT ON THE FATIGUE PERFORMANCE OF Ti-6Al-4V, Ti-2007 Science and Technology, ed., M. Ninomi, S. Akiyama, M. Ibeda, M. Hagiwara and K. Maruyama, The Japan Institute of Metals, 2007, pp. 383-386.