The National Academies of SCIENCES ENGINEERING MEDICINE

NATIONAL MATERIALS AND MANUFACTURING BOARD
BOARD ON PHYSICS AND ASTRONOMY
Division on Engineering and Physical Sciences

Frontier of Materials Research: A Decadal Survey
Meeting #2

Thursday, July 27, 2017
Berthoud Hall, Colorado School of Mines, Colorado

Open SESSION

8:00 a.m. – 8:30 a.m.	**Working Breakfast (in the meeting room)**
8:30 a.m. – 8:45 a.m.	**Welcome** Study Co-chairs and the Colorado School of Mines (CSM)
8:45 a.m. – 10:15 a.m.	**Panel 1: Materials in Global Grand Challenges** **Tzahi Cath,** Director, Advanced Water Technology Center, CSM **Rod Eggert,** Director, Critical Materials Institute, CSM **Mike Gazarik,** VP Engineering, Ball Aerospace **Nancy Haegel,** Director, Materials Science Center, NREL **John Poate,** VP Research emeritus, CSM **Stein Sture,** Vice Chancellor Res. emeritus, CU-Boulder
10:15 a.m. – 10:30 a.m.	Break
10:30 a.m. – 10:50 p.m.	**Perspective on deliberate design and discovery of functional materials with target properties** **Alex Zunger,** Physics, CU-Boulder
10:50 a.m. – 11:10 a.m.	**Steel: a lot left to learn** **John Speer,** Director, Adv. Steel Proc. and Prod. Res. Center, CSM
11:10 a.m. – 11:30 a.m.	**Ceramics: not just pottery and bricks** **Ivar Reimanis,** Director, CO Center for Advanced Ceramics, CSM
11:30 a.m. – 11:50 a.m.	**Soft Matter: beyond polyethylene and polystyrene** **Noel Clark,** Director, Soft Materials Research Center, CU-Boulder
12:00 p.m. – 1:00 p.m.	Lunch
1:00 p.m. – 2:30 p.m.	**Panel 2: New Frontiers for Traditional Materials Classes** **Frank Anderson,** VP R&D, CoorsTek Advanced Ceramics **David Marshall,** Mech. & Aerospace Eng., CU-Boulder **Margaret Murnane**, Physics & Elec./Comp. Eng., CU-Boulder **Amy Clarke**, Director of CANFSA, CSM **Melissa Krebs**, Chemical and Bio. Eng., CSM

CLOSED SESSION

2:30 p.m. – 4:00 p.m.	**Committee Closed session issues.** All Members (only)

Open SESSION

4:30 p.m.	**CoorsTek visit**/happy hour (ALL ATTENDEES, Bring Photo ID)
7:00 p.m.	**Dinner** (TBD), Committee and planning team only **Angel Abbud-Madrid**, Director, Center for Space Resources, CSM

Friday, July 28, 2017
Berthoud Hall, Colorado School of Mines, Colorado

Open SESSION

8:00 a.m. – 8:30 a.m.	**Working Breakfast (in the meeting room)**
8:30 a.m. – 8:50 a.m.	**Risk and Materials in Harsh Operating Conditions** **Sylvia Johnson,** emeritus Chief Mat. Technologist, NASA
8:50 a.m. – 10:20 a.m.	**Panel 3: Reducing Deployment Risk for New Materials/Structures** **Jim Fekete**, Material Measurement Laboratory, NIST **Seth Miller,** President, Heron Scientific **Corinne Packard**, Met. & Materials Eng., CSM and NREL **Nicole Smith**, CSM **Reginald Stilwell,** Head of Innov. & Development, Allosource
10:20 a.m. – 10:35 a.m.	Break
10:35 a.m. – 10:55 a.m.	**Rethinking Materials Processing** **Geoff Brennecka**, Met. & Materials Engineering, CSM
11:00 a.m. – 12:30 p.m.	**Panel 4: Advanced Materials Fabrication/Integration** **Craig Brice,** Research Scientist, Lockheed Martin **Arrelaine Dameron,** Director of R&D, ForgeNano **Jerry Martin,** CEO, Synthio Chemicals, LLC **Karin Payne,** Director, Regen. Orthopedics Lab, CU-Denver **Andriy Zakutayev,** Staff Scientist, NREL
12:30 p.m. – 1:30 p.m.	Lunch
1:30 p.m. – 2:00 p.m.	**Thank you and wrap up** Study Co-chairs and the Colorado School of Mines

CLOSED SESSION

2:00 p.m. – 2:15 p.m.	Break
2:15 p.m. – 5:00 p.m.	**Committee Closed session issues.** All Members (only)
5:00 p.m.	Adjourn

BIOS

Tzahi Cath (Director of Advanced Water Technology Center, Ben L. Fryrear Professor, Colorado School of Mines)
Tel: (303)-273-3402 Email: tcath@mines.edu

Dr. Cath's and his students conduct research in the area of water and wastewater treatment, and specifically we focus on the use of commercial and novel membrane processes. In the area of wastewater treatment and reuse we investigate the performance and enhancement of on-site wastewater treatment using novel hybrid membrane bioreactors and sequencing batch reactors. In this study we focus on the simultaneous optimization of energy consumption, chemical use, and nutrient and organic removal. We also explore the use of byproducts such as biosolids for bio-energy production. We also investigate novel membrane processes such as osmotically driven membrane processes (forward osmosis and pressure-retarded osmosis) for multi-barrier treatment of domestic and industrial wastewater for ultimate direct potable reuse. Specifically, our research focuses on investigation of solute and solvent mass transport in forward osmosis and the effects of these phenomena on future industrial implementation of the technology.

Roderick Eggert, (Professor, Deputy Director of the Critical Materials Institute, Viola Vestal Coulter Foundation Chair in Mineral Economics, and Interim Division Director, Colorado School of Mines)
Tel: (303) 273-3981 Email: reggert@mines.edu

CMI researcher Rod Eggert is a geochemist turned economist. More formally, he is professor and former director of the Division of Economics and Business at the Colorado School of Mines, where he has taught since 1986. As deputy director of the Critical Materials Institute, he works with the director and the rest of the leadership team to guide and manage CMI, oversee the supply-chain and economic analysis that provides the context for CMI's technical research, and chair the data management committee. Before joining Colorado School of Mines, Rod taught at Penn State University and held research appointments at Resources for the Future (Washington, D.C.) and the International Institute for Applied Systems Analysis (Austria). Between 1989 and 2006, he was Editor of Resources Policy, an international journal of mineral economics and policy. He has lectured around the world on the economics of mineral resources, including rare earths and other critical elements. Rod received the 2010 Mineral Economics Award of the American Institute of Mining, Metallurgical and Petroleum Engineers. He chaired the U.S. National Research Council committee that prepared the 2008 study Minerals, Critical Minerals, and the US Economy (National Academies Press). He has a B.A. in earth sciences from Dartmouth College, a M.S. in geochemistry and mineralogy from Penn State University, and a Ph.D. in mineral economics also from Penn State.

Mike Gazarik (VP Engineering. ball-aerospace)
Email: gazarik@ball.com

Dr. Gazarik is responsible for engineering, manufacturing and test operations, supply chain management, technology development and resource planning. Mike is focused on developing and maintaining the company's core technologies and capabilities and on developing technical personnel. Mike joined Ball in March, 2015 from NASA where he was the Associate Administrator for the Space Technology Mission Directorate at NASA headquarters. Since then, he has worked to align Ball's technology development with business development and growth strategies. As the Vice President for Engineering, he will provide overall strategic and operational leadership of the organization, which includes all disciplines of engineering as well as manufacturing, testing, supply chain management, facilities, IRAD and intellectual property. He earned a bachelor's degree in Electrical Engineering from the University of Pittsburgh and a Master's and Ph.D. from the Georgia Institute of Technology, also in Electrical Engineering.

Nancy Haegel (Director, Materials Science Center, NREL)
Tel: 303-384-6548 Email: nancy.haegel@nrel.gov

Dr. Nancy Haegel is Center Director of the Materials Science Center in the Materials and Chemical Science and Technology Directorate. Prior to joining NREL in 2014, Haegel was Distinguished Professor of Physics at the Naval Postgraduate School. Previously, she held faculty positions at Fairfield University and UCLA. Her research interests are in electronic materials and materials physics, imaging of electronic and energy transport using integrated e-beam and near-field optical techniques, high resistivity semiconductors, characterization of solar cells, nuclear radiation detectors and infrared imaging and spectroscopy. She contributed to the development of transient models for the infrared detectors on the Spitzer Space Telescope and prototyped remotely triggered Identification Friend or Foe devices for individual and vehicle protection. Her research has been supported by the National Science Foundation, the David and Lucile Packard Foundation, Research Corporation, NASA, the Office of Naval Research, and the Domestic Nuclear Detection Office of the Department of Homeland Security.

John Poate (emeritus VP-Research at CSM; retired Bell labs)
Tel: (303)384-2375 Email: jpoate@mines.edu

Dr. Poate is Emeritus Senior Vice-President of Research at the Colorado School of Mines and Editor-in-Chief of Applied Physics Reviews. He previously served as a Harwell Fellow of the United Kingdom Atomic Energy Authority, Head of the Silicon Processing and Interface Physics Research Departments at Bell Laboratories, Dean of the New Jersey Institute of Technology and Chief Technology Officer of Axcelis Technologies. Poate is a Fellow of the American Physical Society (APS) and the Materials Research Society (MRS). He served as President of the MRS and Chair of the APS Division of Materials Physics. He has served on advisory panels of councils from NATO, US and overseas universities, the National Science Foundation, National Research Council and Department of Energy (DOE) and the Board of the DOE National Renewable Energy Laboratory (NREL). He currently serves as Chair of the Director's Review Committee for Physical and Life Sciences at Lawrence Livermore National Laboratory, the Board of the Energy Change Institute of the Australian National University, the South Dakota School of Mines Advisory Board, The CSU Energy Institute External Advisory Board and the Purdue University Strategic Research Advisory Council. His awards include the John Bardeen Award of The Metallurgical Society (TMS) and an Honorary Doctorate of Engineering from the Colorado School of Mines. He has over 300 publications in archival journals and 12 patents. Dr. Poate obtained his BSc and MSc in Physics from Melbourne University and his PhD in Nuclear Physics from The Australian National University in 1967.

Stein Sture (Emeritus Vice Chancellor for Research, and Huber and Helen Croft Professor Emeritus, CU-Boulder)
Tel: 303-735-6971 Email: stein.sture@colorado.edu

Stein Sture retired in June 2015 after 35 years of service to the campus, including his role as vice chancellor for research during the past nine years. During Sture's tenure as vice chancellor for research, CU-Boulder's sponsored research awards to the university rose from $257 million to $412 million. He has overseen a number of successful initiatives and collaborations in a wide variety of research ranging from planetary sciences and environmental engineering to climate change and biomedical exploration. In recent years Sture has served as both interim provost and executive vice chancellor for academic affairs. He also served as dean of the Graduate School from 2005 to 2009. Sture was pivotal in the establishment of the BioFrontiers Institute, a revolutionary $160 million research and teaching facility that opened its doors on CU-Boulder's East Campus in 2012. Under the leadership of Nobel laureate and Distinguished Professor Tom Cech and Professor Leslie Leinwand, the 336,800-square-foot institute facilitates work on a wide swath of pressing societal challenges ranging from cancer and heart disease to tissue engineering research and studies of how the human microbiome influences health and disease.

Alex Zunger (Professor, CU-Boulder)
Tel: 303-492-7084 Email: alex.zunger@colorado.edu

Prof. Alex Zunger of the University of Colorado, Boulder research field is Condensed Matter Theory of Real Materials, involving foundational work on Density Functional Theory, Pseudopotential theory, Quantum Nanostructures, Photovoltaic materials and Materials by Design. He is the recipient of the year 2013 Hume-Rothery Award on Theory of alloys, the 2011 (inaugural) "Materials Theory Award" of the Materials Research Society on Inverse Design, the 2010 "Tomassoni Prize" (Italy) and "2010 Medal of the Schola Physica Romana" celebrating the tradition of E. Fermi, the 2001 John Bardeen award of The Material Society on "Spontaneous Ordering in semiconductor alloys", the 2001 Rahman Award of the American Physical Society on 'foundational development of First Principles methods', and the 2009 Gutenberg Award (Germany) on correlated electron systems. He is a Fellow of the American Physical Society; Fellow of the Materials Research Society, Sakler Fellow of the Institute of advanced studies of Tel Aviv University. He received his Ph.D. from Tel-Aviv University, Tel Aviv Israel where he worked with Prof. Joshua Jortner and Binyamin Englman on quantum theory of molecular solids. He did his postdoctoral research at the Physics Dept. of Northwestern University (with Art Freeman). He then received the IBM Fellowship, which he spent at the Physics Dept. of U.C. Berkeley (with Marvin Cohen). Dr. Zunger established the Solid State Theory group at the National Renewable Energy Laboratory (NREL) Golden, Colorado, a position he held 1978-2010 where he has been an "Institute Research Fellow". He has been the founding Director of the $20 million 'Center for Inverse Design' (a DOE Energy Frontier Research Center). The impact of Dr. Zunger's work is partially reflected by the very high number of citations his papers have received (over 68,000, according to Google Scholar) and by his "h-number" of 119. He is the author of the fifth-most-cited paper in the 110-year history of Physical Review. In the course of his research; he has authored more than 600 articles in refereed journals, which includes over 150 articles in Physical Review Letters and Rapid Communications and three citation classics. He has also trained more than 75 post-doctoral fellows. Declared by the Institute of Scientific Information (ISI) as the 39th most-cited physicist out of more than 500,000 physicists examined, based on publications in 1981–1997 in all branches of physics.

John Speer (John Henry Moore Distinguished Professor of Metallurgical and Materials Engineering and Director of ASPPRC, Colorado School of Mines)
Tel: (303) 273-3897 Email: jspeer@mines.edu

Dr. Speer joined the CSM faculty after 14 years of research and research management in the steel industry. He is teaching alloying and phase stability at the undergraduate level, and ferrous physical metallurgy at the graduate level. My background is in physical metallurgy and solid-state phase transformations, and product development including alloy design/processing response/application and performance. My research interests involve ferrous physical metallurgy and steel processing / products in general, and my desire to link the fundamentals of physical metallurgy with industrial applications. I will be extensively involved with the Advanced Steel Processing and Products Research Center and hope to help maintain the strong relationships which have developed between CSM faculty/students and the steel producing/consuming community. The Center conducts leading programs in sheet, plate, bar, and stainless steels to develop a better understanding of alloying, microstructure, processing, and performance of steels for a variety of industrial applications.

Ivar Reimanis (Herman F. Coors Distinguished Professor of Ceramic Engineering and Director of CCAC at Colorado School of Mines)
Tel: (303) 273-3549 Email: ireimani@mines.edu

Dr. Reimanis is Professor of Ceramic Engineering and serves as Director of the Colorado Center for Advanced Ceramics. Ivar earned a BS in Materials Science and Engineering at Cornell University in 1984, a MS in Materials Science and Mineral Engineering at University of California, Berkeley, and a PhD in Materials at the University of California, Santa Barbara in 1990. He spent a year under a Max Planck Institute postdoctoral fellowship in Stuttgart, Germany. Ivar worked as a postdoc at Los Alamos National Laboratory after which he served as a technical staff member until 1994 when he joined the Colorado School of Mines. He spent a sabbatical at the University of Western Australia in Perth in 2002 as a Gledden Visiting Senior Fellow and was awarded a United States Fulbright award in 2007 to spend a semester at the Indian Institute of Science in Bangalore. Ivar is a past Basic Science Division Chair, and has been involved in the organization of numerous symposia. He was chair of the Meetings Subcommittee on Technical Programming in 2009 and he currently serves on ACerS Board of Directors. Ivar has authored or co-authored 110 refereed papers and five patents. Ivar currently has diverse research interests that include mechanical behavior of transparent materials, synthesis and processing of doped oxides and glasses, magnetometry of nanoscale ceramics for energy applications, and mechanical behavior of ceramics with unusual thermal physical properties.

Noel Clark (Professor and Director of the Soft Materials Research Center, Colorado School of Mines)
Tel: (303) 492-6420 Email: noel.clark@colorado.edu

Research in Professor Clark's group is directed toward understanding and using the properties of condensed phases, ranging from experiments on the fundamental physics of phase transitions, such as melting, to the development of liquid crystal electro-optic light valves. The primary experimental tools are laser light scattering, electrooptics, video microscopy and high resolution synchrotron X-ray scattering. Much of the research is on the physics of liquid crystals, phases of matter having structure intermediate to that of liquids and solids, and on the physics of colloids, suspensions of one material in another that exhibit order on large length scales. These materials have become important testing grounds for modern theories of phase transitions, which is the principal focus of research. The group recently made a fundamental discovery about the nature of the melting transition, showing it to be a condensation of "broken bonds." Applied research is in the area of liquid crystal electro-optics. Professor Clark's group has pioneered a major new liquid crystal electro-optic technology, employing ferroelectric liquid crystals to make high-speed bistable light valves. These devices, which can be configured into linear and matrix arrays, are of particular use in optical computing and are one of the principal technologies to be developed in the Center for Optoelectronic Computing Systems at the University of Colorado.

Frank Anderson (Vice President of R&D, CoorsTek Advanced Ceramics)
Email: FAnderson@CoorsTek.com

Frank Anderson is Vice President for Research and Development at CoorsTek, the global leader in technical ceramics. He earned his Ph.D. in chemical engineering at the University of California, Berkeley in 1985, and joined Cabot Ceramics shortly thereafter. In 1989, he joined CoorsTek in Golden, CO. In his more than two decades of work with CoorsTek, he has contributed to ceramic product and process development including multilayer ceramic packages for semiconductor devices, porcelain and traditional ceramics, microwave dielectric ceramics, structural ceramics (zirconia, ZTA), non-oxide ceramics (carbides, nitrides), optical & transparent ceramics, and others.

David Marshall (Retired Teledyne/Rockwell, now Research Professor, Colorado School of Mines)
Tel: (303) 492-9366 Email: David.Marshall@Colorado.edu

Before joining CU Boulder in 2016, David Marshall was a senior fellow at Teledyne Scientific Co. and Rockwell Science Center, where he worked with NASA, various Department of Defense agencies, universities and companies on developing high-temperature materials and structures for aerospace propulsion and thermal protection. While at Teledyne, he led the NASA/AFOSR-funded National Hypersonic Science Center for Materials and Structures and was an adjunct professor in the Materials Department at UC Santa Barbara. Previously, he held research positions at the UC Berkeley and the University of New South Wales, Australia. His graduate studies were at Monash University, Australia. His research interests include strengthening, toughening, reliability, microstructural design and processing of advanced materials, especially fiber-reinforced ceramic composites and structural ceramics. He was named Teledyne Scientific & Imaging Technologist of the Year in 2008. He is a member of the National Academy of Engineering, a member of the World Academy of Ceramics, and a distinguished life member of the American Ceramic Society.

Margaret Murnane (Fellow at JILA and a member of the Department of Physics and Electrical and Computer Engineering at the University of Colorado),
Tel: 303-492-7839 Email: murnane@jila.colorado.edu

Dr. Margaret Murnane is a Fellow at JILA and a member of the Department of Physics and Electrical and Computer Engineering at the University of Colorado. She received her B.S and M.S. degrees from University College Cork, Ireland, and her Ph.D. degree in physics from the University of California at Berkeley in 1989, and joined the faculty of physics at Washington State University in 1990. In 1996, Professor Murnane moved to the University of Michigan, and in 1999 she moved to the University of Colorado. She runs a joint research group and a small laser company with her husband, Prof. Henry Kapteyn. Prof. Murnane's research interests have been in ultrafast optical and x-ray science. Prof. Murnane is a Fellow of the American Physical Society and the Optical Society of America. In 1997 she was awarded the Maria Goeppert-Mayer Award of the American Physical Society, in 2000 she was named a John D. and Catherine T. MacArthur Fellow, in 2004 she was elected to the National Academy of Sciences, and in 2006 she was elected a Fellow of the American Academy of Arts and Sciences.

Amy Clarke (Director, CANFSA, CSM),
Email: amyclarke@mines.edu

Before joining Mines in June 2016, Clarke was a scientist at Los Alamos National Laboratory for seven years, and spent a year at Caterpillar Inc. as a senior engineer. She is the site director for the Center for Advanced Non-Ferrous Structural Alloys and affiliated with the Advanced Steel Processing and Products Research Center at Mines.

Melissa Krebs, (Assistant Professor, Chemical and Biological Engineering, Colorado School of Mines)
Tel: (303) 273-3983Email: mdkrebs@mines.edu

Dr. Krebs and her group are interested in the development of biopolymer systems that will allow the study of cells' interactions with their microenvironment and that can be used for both tissue regeneration and therapeutics. More specifically, we are investigating the controlled delivery of bioactive factors and therapeutics, the presentation of insoluble signals to cells, the effect of mechanical forces on cell behavior and tissue formation, and the influence that different cell populations have on one another. These advances will lead to improved biomaterial system design criteria. In addition to our tissue engineering research, we are also engineering biopolymer systems for controlled delivery of therapeutic molecules for the treatment of cancer. Ultimately, what we learn in our laboratory will help to improve patient therapies that are available in the clinic.

Angel Abbud-Madrid (Director, Center for Space Resources)
Tel: (303) 384.2300 Email: aabbudma@mines.edu

Angel Abbud-Madrid is the Director of the Center for Space Resources at the Colorado School of Mines, where he leads a research program focused on the human and robotic exploration of space and the utilization of its resources. He has more than 25 years of experience conducting experiments in NASA's low-gravity facilities, such as drop towers, parabolic-flight aircraft, the Space Shuttle, and the International Space Station. In 2004, he received the NASA Astronauts' Personal Achievement Award. He is also the President of The Space Resources Roundtable, an organization focused on bringing the space exploration community, the financial sector, and the mining and minerals industries to discuss issues related to lunar, asteroidal, and planetary resources. Abbud-Madrid holds a B.S.E. degree in Mechanical and Electrical Engineering from ITESM in Monterrey, México, and Master's and Ph.D. degrees in Mechanical and Aerospace Engineering from Princeton University and the University of Colorado at Boulder.

.

Sylvia Johnson (retired Chief Materials Technologist, Entry Systems and Technology Division at NASA)
Email: sylviamjohnson@hotmail.com

Dr. Sylvia Johnson came to NASA Ames Research Center in March 2000 and held the position of Chief of the Thermal Protection Materials and Systems Branch until 2009, where she was recognized for contributing to substantial technical and facility improvements. Currently, Dr. Johnson is the Chief Materials Technologist, of the Entry Systems and Technology Division. Before joining NASA, Dr. Johnson spent 18 years in research at SRI international, (SRI), where she held many positions, including the Director of Ceramic and Chemical Product Development. At SRI, she broadened her experience in materials research and development for a variety of materials and worked with industry, government, domestic and international clients. Dr. Johnson is a recipient of the 2011 James I. Mueller Award from the American Ceramic Society and was inducted into the World Academy of Ceramics in 2014. She presented the Edward Orton Jr. Memorial Lecture for the American Ceramic Society in October 2015 and is featured in the book, Women in Ceramics, (2015). In addition to many lectures she's given on technical and research topics, Dr. Johnson has published over 50 papers, edited two books, and received 6 U.S. patents. Dr. Johnson received a Bachelor of Science (Hons) in Ceramic Engineering from the University of New South Wales (Sydney, Australia), a Master of Science and a Doctorate in Materials Science and Engineering from the University of California, Berkeley. She is currently an Honorary Professor of Materials at the University of Birmingham, UK.

Jim Fekete (Chief, Applied Chemicals and Materials Division, Material Measurement Laboratory, NIST)
Tel: (303) 497-5204 Email: james.fekete@nist.gov

Dr. Fekete has been Chief, Applied Chemicals and Materials Division in NIST's Material Measurement Laboratory since August 2014. He joined NIST in January 2010 as leader of the Division's Structural Materials group. Prior to joining NIST, he spent 15 years at the General Motors Company, ultimately achieving the position of Technical Fellow in the Vehicle Engineering Center, specializing in applications of advanced materials to vehicle structures. He joined GM after working 10 years in a series of technical and managerial positions in the steel industry. He holds a B.S. from Carnegie Mellon University, an M.S. from Case Western Reserve University and a Ph.D. from the University of Michigan, all in Metallurgical Engineering and Materials Science. He is a member of SAE International, ASTM and ASM International. He is also a Licensed Professional Engineer in the States of Colorado and Michigan.

Seth Miller (President, Heron Scientific)
Email: seth@heronscientific.com

Dr. Seth Miller, has a Ph.D. in chemistry from Caltech and a long history of invention, with over 75 issued US patents and over 200 US and international patent applications. Dr. Miller has worked in technology development for Texas Instruments, Inc. and the venture-funded semiconductor startup Zettacore, and has co-founded and raised funding for several new starts. His patented and trade-secret innovations have been embedded and shipped in billions of dollars of product worldwide, and have saved tens of millions of dollars by reducing process cost, eliminating reliability problems, and preventing schedule slip. Dr. Miller brings perspective from his work in a broad array of fields, including display technologies, semiconductors, medical infusion, battery materials, image recognition, and gas separation membranes. He has written for the MIT Technology Review, and served as an expert witness, including twice testifying at trials. On a project basis, Dr. Miller collaborates with a select group of extremely talented specialists in business development, marketing, and manufacturing, as well as technologists with modeling capability or deep expertise in physics, engineering, and mechanics.

Corinne Packard (Professor, Colorado School of Mines and National Renewable Energy Laboratory in the National Center for Photovoltaics)

Phone: (303)-273-3773 Email: cpackard@mines.edu

Dr. Packard is an Associate Professor in the George S. Ansell Metallurgical and Materials Engineering Department at the Colorado School of Mines and holds a joint appointment at the National Renewable Energy Laboratory in the National Center for Photovoltaics. Prior to appointment at Mines, Packard earned her Ph.D. in Materials Science & Engineering from MIT. Her research program applies experimental techniques commonly used to characterize mechanical behavior and properties in structural materials to solve problems in ceramics in predominantly energy-related applications. She has focused on elucidating the principles and mechanisms of deformation behavior in ceramics at the micro- and nano-scales. Specific examples include efforts to determine the role of chemistry in controlling the deformation behavior in rare-earth orthophosphates; engineering fracture in high-cost semiconductors to enable dramatic photovoltaic cost reduction through wafer reuse; mechanical property mapping in organic-rich shales (naturally occurring organic/ceramic composites); identifying fracture behavior and an associated accumulation of lithium in failing lithium ion battery cathodes; and using mechanical property information to design for durability in transparent conducting oxides for photovoltaics and flexible electronics. In 2014, she received a National Science Foundation Faculty Early Career Development (CAREER) Award and was selected as a TMS Young Leader. In 2017, she received the AIME Robert Lansing Hardy Award. To date, she has more than 30 archival publications, 3 issued patents, and has given over 40 invited and contributed talks.

Nicole M. Smith (Assistant Professor, Colorado School of Mines)
Phone: 303-273-3634 email: nmsmith@mines.edu

Nicole Smith is an Assistant Professor in the Mining Engineering Department at the Colorado School of Mines. She is a cultural anthropologist with research interests in livelihoods, artisanal and small-scale mining, corporate social responsibility, indigenous peoples, community development, and engineering education. Prior to her position in the Mining Engineering Department, she was a post-doctoral scholar in the Humanitarian Engineering Program at Mines. She has also held a position as a research fellow at the Centre for Social Responsibility in Mining at the Sustainable Minerals Institute at the University of Queensland. Her work there focused on health and safety in artisanal and small-scale mining. She is currently the PI for a U.S. Department of State funded project and an EPA funded project; both of which address mercury use among artisanal and small-scale gold miners in Latin America. Dr. Smith has a PhD in Anthropology and a certificate in Development Studies from the University of Colorado at Boulder where her research focused on Maasai gemstone traders in northern Tanzania. She holds a master's degree in anthropology from Colorado State University and a bachelor's degree in anthropology with a biology minor from the University of Minnesota.

Reginald "Reggie" Stilwell (Head of Innovation and Development, Allosource)
Phone: (720)-873-0213 Email: rstilwell@allosource.org

AlloSource, located in Centennial, CO is a nonprofit organization founded in 1994 to honor and respect the gift of human tissue donation by responsibly developing, processing and distributing life-saving and life-enhancing allografts. Reggie is Head of Innovation Deployment at AlloSource. He has over two decades of experience in the field of materials science engineering. Most of that experience has dealt with developing biomaterials for medical and surgical uses. He was with the tissue engineering groups in the Johnson and Johnson companies for a number of years and now works at AlloSource serving as a "futurist", helping to identify nascent technologies that advance the AlloSource mission of "honoring the gift of donation". His work entails closely working with university technology transfer offices to engage projects that have potential to enhance allograft tissue transplantation.

Geoff Brennecka (Assistant Professor, Metallurgical and Materials Engineering, Colorado School of Mines)
Phone: 303-384-2238 Email: geoff.brennecka@mines.edu

Geoff Brennecka received BS and MS degrees in Ceramic Engineering from the University of Missouri-Rolla (now Missouri S&T) in 2001 and 2002 and a PhD in MatSE from the University of Illinois in 2006. He spent 8 years as technical staff at Sandia National Laboratories before joining the Colorado School of Mines in 2014. Geoff currently serves on the Board of Directors for the American Ceramic Society (ACerS), as Chair of the ACerS Electronics Division, and on the Administrative Committee of the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society. He is a Fellow of ACerS and serves as an Editor of the Journal of the American Ceramic Society. Geoff is a recipient of the NSF CAREER award, Young Alumnus awards from both Missouri S&T and the University of Illinois, the IEEE Ferroelectrics Young Investigator Award, Du-Co Ceramics Young Professional Award, and Karl Schwartzwalder Professional Achievement in Ceramic Engineering award. His group's research focuses on processing and applications of ferroelectric, piezoelectric, and related ceramic materials in bulk and thin film forms.

Craig A. Brice (Research Scientist, Lockheed Martin)
Email: craig.a.brice@lmco.com

Craig Brice has been a materials research engineer within the Advanced Materials and Processing Branch at NASA Langley Research Center. From 1999 to 2010, Brice led the metallic material research and development activities within the Materials and Manufacturing Exploration Laboratory at the Lockheed Martin Aeronautics Company. He was responsible for managing multiple concurrent projects, both internally and externally funded, with a total annual budget between $500K and $2.5M. Craig Brice worked to develop novel advanced manufacturing techniques and create unique alloy configurations with targeted properties. He was the technical team lead for electron beam additive manufacturing implementation project for the F-35 Program where he developed the technical transition plan for a supplier base for additive manufacturing and assisted in the development of coupon allowable design values. Brice has a B.S. degree in Metallurgical Engineering from Missouri University of Science & Technology and a M.S. degree in Materials Science & Engineering from Ohio State University. Has been awarded six patents and has multiple patents pending.

Arrelaine Dameron (Director of R&D, ForgeNano)
Email: adameron@forgenano.com

Dr. Arrelaine Dameron is the Director of research and development at Forge Nano, a materials manufacturing company in Louisville, CO. She is a world expert in thin film deposition, nanoscale assembly and interface engineering, specializing in energy generation and storage applications. Arrelaine has over 15 years of experience in materials science and chemistry, has produced more than 50 publications and several patents. In her capacity at Forge Nano, she works with and manages a diverse group of scientists, engineers and technicians. Arrelaine has a Ph.D. in Chemistry from Pennsylvania State University and a B.S. in Creative Studies from University of California Santa Barbara.

Jerry Martin (CEO, Synthio Chemicals, LLC)
Phone: number (303) 915-7230 Email: jerry.martin@synthiochem.com

Dr. Martin is a serial entrepreneur and a co-founder of four high technology companies (Mesoscopic Devices, LLC, DellaTech LLC, Boulder Ionics Corporation and Synthio Chemicals, LLC). Since 1999, he has formed and led the growth of four companies in the energy and chemical fields. His technical expertise lies at the intersection of heat transfer, fluid mechanics, chemical engineering and materials.
Prior to founding Synthio Chemicals, Dr. Martin was the co-founder of Boulder Ionics Corporation, a venture-capital funded firm that developed electrolyte technology for ultracapacitors and batteries. Boulder Ionics developed unique process intensification technology for making electrochemical-grade ionic liquids and specialty lithium salts such as LiFSI. Boulder Ionics was acquired in 2014 by CoorsTek Specialty Chemicals. Previously, Dr. Martin was co-founder and President of Mesoscopic Devices, a portable fuel cell company, where he led the development of compact solid oxide fuel cells, including miniature fuel reformers. Mesoscopic Devices was acquired in 2009 by Protonex, and is now part of Ballard Power Systems. He has also held various technical and leadership roles at Battelle–Pacific Northwest National Laboratory, Superconducting Core Technologies, and Creare Inc. where he developed a variety of technologies and products including miniature active devices (pumps, compressors and valves) and cryocoolers.
Dr. Martin received his B.S., M.S. and Ph.D. degrees in Nuclear Engineering from the Massachusetts Institute of Technology, and has ten patents or pending patents in the fields of chemical synthesis, heat transfer and energy systems.

Karin Payne (Lab Director, Regenerative Orthopedics Laboratory ,CU-Denver)
Email: Karin.payne@ucdenver.edu

Research taking place in the Regenerative Orthopedics Laboratory focuses on harnessing the regenerative potential of stem cells for bone and articular cartilage tissue engineering. We are particularly interested in optimizing and controlling the osteogenic and chondrogenic differentiation of mesenchymal stem cells (MSCs) and induced pluripotent stem cells (iPSCs) by using different growth factors, scaffolds, and physicochemical cues. Our long-term goal is to translate these research efforts into the clinic to enhance bone fracture repair, improve spine fusion, and treat articular cartilage defects early. In the area of pediatric orthopedics, we have a collaborative research project on growth plate tissue engineering.

Andriy Zakutayev (Staff Scientist, NREL)
Email: andriy.zakutayev@nrel.gov

Andriy Zakutayev is a scientist working in the field of renewable energy technologies. The applied direction of his work includes development of new materials and devices for solar cells, Li-ion batteries, fuel cells, and other renewable energy technologies using materials-by-design methods. The basic direction involves research on non-equilibrium synthesis of metastable materials, discovery of previously unreported materials, as well as fundamental surface and interface science. Zakutayev uses high-throughput combinatorial approaches to thin-film synthesis, characterization, and data analysis in his work.

Zakutayev is an author of more than 70 peer-reviewed publications and a reviewer for more than 30 scientific journals. He has received an EMRS Young Scientist Award and other professional recognition. Zakutayev has been a principal investigator on a $1.5 million project funded by the Department of Energy (DOE) and a thrust leader in a $16 million Energy Frontier Research Center funded by DOE. He supervises graduate students, postdoctoral researchers, and exchange visitors, and actively collaborates with theorists and data scientists.

Zakutayev received his Ph.D. in Physics in 2010 from Oregon State University (Prof. Janet Tate) working on wide-bandgap p-type semiconductors. His postdoctoral advisor at NREL was David Ginley.