

Aleksey Volodchenkov

Department of Mechanical Engineering, Materials Science and Engineering Program
University of California, Riverside, CA 92521
Phone: (818) 826 1512; E mail: avolodchenkov@enr.ucr.edu

RESEARCH INTERESTS:

- Synthesis and processing of advanced functional materials for magnetic, thermal, optical and structural applications.
- Understanding the processing-microstructure-property relationship
- Developing novel processing techniques to optimize material performance.
- Plastic deformation of nano-grain Mg alloys
- Additive manufacturing (AM) through laser sintering
- Magnetic properties of high entropy alloys (HEA)
- Processing of thermodynamically unfavorable / metastable phases using non-traditional densification techniques.
- Synthesis of core-shell nano-particles using wet chemical techniques
- Linking microstructural defects (porosity, grain boundaries, secondary phases, etc) to phonon scattering in order to optimize thermal transport in permanent magnetic devices.
- Alignment of grains in materials in order to improve magnetic, thermal and optical properties.
- Development of bulk materials as well as thin films with perpendicular magnetic anisotropy for spintronic devices.

EDUCATION:

Ph.D. in Mechanical Engineering, University of California, Riverside June 2016
Materials Science and Engineering Program

Advisor: Dr. Javier Garay

Dissertation: Synthesis and Characterization of Oxide/Metal Exchange – Coupled Nano – Composite Materials for Permanent Magnetic Applications

M.S. in Mechanical Engineering, University of California, Riverside Aug 2012
Materials Science and Engineering Program

Advisor: Dr. Javier Garay

Dissertation: Synthesis and Characterization of Metal – Oxide Composite Materials for Permanent Magnetic Applications

B.S. in Aerospace Engineering, University of California, Irvine June 2010

B.S. in Materials Science and Engineering, University of California, Irvine June 2010

TECHNICAL EXPERIENCE

Visiting Researcher Aug. 2016 – Present
Mathaudhu Research Group
<http://www.smathaudhu.com/group.php>

Research Member Oct. 2014 – June 2016
Spin and Heat in Nanoscale Electronic Systems (SHINES)
Energy Frontier Research Center
<http://www.efrcshines.ucr.edu/>

Doctoral Researcher Sept. 2012 – June 2016
Materials Science and Engineering Program
Department of Mechanical Engineering
University of California, Riverside

Master of Science Researcher Sept. 2010 – Aug 2012
Materials Science and Engineering Program
Department of Mechanical Engineering
University of California, Riverside

AMPSLab Researcher Sept. 2010 – June 2016
Advanced Materials Processing and Synthesis (AMPS) Laboratory
University of California, Riverside
<http://www.engr.ucr.edu/~jegaray/>

Undergraduate Student Project Member Sept. 2009 – June 2010
Frame, body, aerodynamics
UCI Anteater Racing, Formula SAE
University of California, Irvine

Undergraduate Student Project Member Sept. 2007 – June 2009
Recovery system
UCI Rocket Project
University of California, Irvine

PUBLICATIONS: *(drafts of manuscripts in preparation are available upon request)*

A. D. Volodchenkov, Y. Kodera, and J. E. Garay, “Synthesis of strontium ferrite/iron oxide exchange coupled nano-powders with improved energy product for rare earth free permanent magnet applications”, *J. Mater. Chem. C*, 2016, doi:10.1039/C6TC01300G (*Impact Factor: 5.066*)

D. Gutierrez, H. Chiang, T. Bhowmick, **A. D. Volodchenkov**, M. Ranjbar, G. Liu, C. Warren, Y. Khivintsev, Y. Filimonov, J. Shi, J. Garay, R. Lake, A. Balandin, and A. Khitun, “Magnonic Holographic Imaging of Magnetic Microstructures,” *J. Appl. Phys*, under review

S. Ramirez, **A. Volodchenkov**, D.L. Nika, R. Samnakay, E. Uy, J.E. Garay and A.A. Balandin, “Thermal Transport in Nanostructured SrFe₁₂O₁₉,” to be submitted September 2016

A. D. Volodchenkov, Y. Kodera and J. E. Garay, “Exchange Coupling in Bulk Strontium Ferrite / Cobalt Composite Materials”, to be submitted September 2016

CONFERENCE PRESENTATIONS

MEGSA Research Symposium, Riverside, CA *(oral presentation)* May 2016

- Synthesis and Characterization of Non-Equilibrium Exchange-Coupled Nano- Composite Materials for Permanent Magnetic Applications – oral presentation

International Nanotechnology Conference on Communication and Cooperation (INC 11), Fukuoka, Japan *(poster)* May 2015

- Characteristics of the Rare-Earth Free Nanostructured SrFe₁₂O₁₉ Permanent Magnets Synthesized for Renewable Energy Applications

Energy Frontier Research Center (EFRC) Symposium, Long Beach, CA *(poster)* Sept. 2015
Spin and Heat in Nanoscale Electronic Systems (SHINES)

- Characteristics of the Rare-Earth Free Nanostructured SrFe₁₂O₁₉ Permanent Magnets Synthesized for Renewable Energy Applications

Mechanical Engineering Colloquium, University of California, Riverside, CA *(invited oral presentation)* Oct. 2012

- Synthesis and Characterization of Metal-Oxide Composite Materials for Permanent Magnetic Applications

Materials Research society (MRS), San Francisco, CA *(poster)* Apr. 2012
New Trends and Developments in Nano-Magnetism

- Development of Nano-Crystalline Metal-Oxide Composites for Magnetic Applications

VISITING RESEARCHER

Aug. 2016 – Present

Mathaudhu Research Group

Department of Mechanical Engineering, Materials Science and Engineering Program

University of California, Riverside (*Advisor: Prof. Suveen Mathaudhu*)

Research Team Member

- Collaborated and contributed expertise to research projects including additive manufacturing through laser sintering, materials processing by spark plasma sintering (SPS), nano-grain Mg alloys and high entropy alloys (HEA).
- Designed custom cryomill modification for SPEX 8000 series mixer/mill using computer aided design (CAD).

RESEARCH MEMBER

Oct. 2014 – June 2016

Spin and Heat in Nanoscale Electronic Systems (SHINES)

Energy Frontier Research Center, University of California, Riverside (*Director: Prof. Jing Shi*)

Research Team Member

- Collaborated with faculty, project scientists, post-doctoral researchers and students from various departments and universities.
- Presented work progress through oral presentations on a quarterly basis in front of on-campus, and remote interdisciplinary audience.

Thermal Properties of Ceramic Permanent Magnets (collaboration with *Prof. Alexander Balandin*, UC Riverside Electrical Engineering Department)

- Investigated the effect of porosity and grain boundaries on phonon transport in ferrite materials.
- Synthesized materials with varying grain sizes and porosities.
- Collaborated on characterizing thermal conductivity using laser flash and hot disk methods.
- Showed anisotropic thermal properties due to alignment of flake like grains.
- Found optimal direction for heat evacuation in permanent magnetic materials for renewable energy applications.

Magnonic Holographic Imaging of Magnetic Microstructures (collaboration with *Prof. Alexander Khitun*, UC Riverside Materials Science and Engineering Department)

- Collaborated on investigating magnon propagation in ferrites and metals.
- Characterized samples by measuring magnetic properties and investigating microstructure.

Hexa-Ferrite Thin Films (collaboration with *Prof. Jing Shi*, UC Riverside Physics Department)

- Synthesized targets of hexa-ferrite material for Pulsed Laser Deposition (PLD).
- Deposited thin films were characterized and showed magnetic anisotropy with of out-of-plane easy direction of magnetization.

DOCTORAL RESEARCHER

Sept. 2012 – June 2016

Department of Mechanical Engineering, Materials Science and Engineering Program

University of California, Riverside (*Advisor: Prof. Javier Garay*)

Densification of Bulk Advanced Functional Materials

- Consolidated nanoscale and microscale powders through in-house built non-conventional hot-press: Current Activated Pressure Assisted Densification (CAPAD), commercially known as Spark Plasma Sintering (SPS) in order to synthesize non-equilibrium/metastable phases.
- Achieved intermixing of oxide and metal phases at the nano-scale in bulk coin-size materials in order to show improved properties as a result of exchange-coupling in rare-earth free permanent magnets.
- Controlled processing parameters such as pressure, temperature and time in order to investigate the effect of processing on properties and to tailor material performance.

Synthesis and Processing of Nano-Scale and Micro-Scale Powders

- Precipitated monodispersed colloids through decomposition of urea in metal salt solution.

- Processed the resulting nano-powders in reducing atmospheres (varying temperature as well as partial pressures of oxygen and reducing agents), forming metallic phases with improved magnetic properties.
- Calcined magnetically hard particles in order to improve magnetic properties as a result of optimized grain size.
- Adapted homogeneous precipitation to coat magnetically hard micron size powder with nano-scale layer of magnetically soft precursor particles.
- Morphed soft phase precursor particles into metallic soft phase in order to synthesize oxide/metal core-shell exchange-spring composite powder with improved properties compared to single phase constituents.

Alignment and Texturing of Grains

- Used magnetic field to align particles prior to consolidation in order to achieve improved remanence (M_r), coercivity (H_c) and energy product (BH_{max}) in bulk samples.
- Adapted alignment techniques to collaborating projects and aligned rare-earth doped nitride and oxide nano-rods for achieving improved optical transmission and thermal conductivity.

MASTER OF SCIENCE RESEARCHER

Sept. 2010 – Aug 2012

Department of Mechanical Engineering, Materials Science and Engineering Program
University of California, Riverside (*Advisor: Prof. Javier Garay*)

Top Down Approach to Exchange-Coupled Rare-Earth Free Permanent Magnets

- Led the project to lower the reliance on environmentally damaging, corrosive and expensive rare-earth based permanent magnets.
- Investigated the effect of processing parameters of high energy ball milling (i.e: rpm, powder:ball mass ratio, etc) and densification (i.e: temperature, pressure, hold-time) on the properties of composite materials.
- Identified problems, such as non-ideal mixing using the top down approach and reaction between oxide and metal phases.
- Found solutions using kinetics to trap thermodynamically unfavorable phases; synthesized materials showed improved properties.

AMPSLab RESEARCHER

Sept. 2010 – June 2016

Advanced Materials Processing and Synthesis (AMPS) Laboratory
University of California, Riverside (*Advisor: Prof. Javier Garay*)

General Researcher

- Developed collaborations and good working relationships between the principal investigator, post-doctoral staff, graduate students and myself.
- Worked closely with other researchers to develop standard operating procedures for laboratory equipment.
- Disposed of waste in accordance with Environmental Health and Safety (EH&S).
- Built custom parts and maintained laboratory equipment.
- Trained other laboratory members on the proper and safe use of equipment.
- Present technical research summaries to laboratory members of different backgrounds on quarterly basis.

PROJECT MEMBER – ANTEATER RACING

Sept. 2009 – June 2010

Department of Mechanical and Aerospace Engineering,
University of California, Irvine (*Advisor: Prof. Michael McCarthy*)

Frame, Body and Aerodynamics Team Member

- Selected materials, designed and built body/skin structure for a racecar participating in the formula SAE competition
- Tested and optimized aerodynamics of a scale body model fabricated through additive manufacturing (3D printed at *Mazda*) resulting in low drag coefficient and improved racing performance

Department of Mechanical and Aerospace Engineering,
University of California, Irvine (*Advisor: Prof. Kenneth Mease*)

Recovery System Team Member

- Collaborated on the design and engineering of a parachute recovery system for a solid-fuel rocket built to reach 10,000 ft.
- Manufactured a high stiffness, light weight composite nose cone to house the recovery system using wet layup.
- Competed against other universities and dominated the competition with a flight apogee within 8 ft of desired altitude.

TECHNICAL SKILLS

6+ years hands-on experience in advanced sample synthesis, preparation, characterization and analysis

Powder synthesis

- Wet chemistry techniques such as homogeneous precipitation to synthesize colloids of oxides and hydroxides
- Mechanical alloying (high energy planetary ball milling and low energy tumble milling) of melts and powders into fine particles with varying crystallite size (10nm - 10 μ m)

Ceramic, metal and ceramic/metal composite processing

- Sintering using Current Activated Pressure Assisted Densification (CAPAD), commercially known as Spark Plasma Sintering (SPS)
- Processing of precursor particles in vacuum, box and tube furnaces, in atmosphere, vacuum and reducing environments

Sample preparation

- Handling atmosphere-sensitive, highly-reactive materials in a glovebox environment
- Preparing materials for analysis through surface grinding, cutting, polishing, etching (chemically and thermally), etc.

Physical and mechanical characterization

- Density measurement: geometric and Archimedes methods
- Tensile testing using an Instron load frame
- Hardness testing: Vickers and Rockwell methods

Microstructure and composition characterization

- Optical microscopy
- Electron Microscopy
 - Secondary Electron (SE) detection for microstructure analysis
 - Back-Scattered Electron (BSE) detection for phase distribution analysis
 - Energy Dispersive X-Ray Spectroscopy (EDS) for semi-qualitative phase analysis
- X-Ray Diffraction (XRD)
 - Composition determination of single phase and multiphase/composite materials
 - Scherrer method for crystallite size analysis

Magnetic property characterization

- Magnetic Property Measurement System (MPMS)
- Vibrating Sample Magnetometer (VSM)
- Magnetic property analysis from the hysteresis loop
 - Saturation magnetization (M_s)
 - Remnant magnetization (M_r)
 - Coercivity (H_c)
 - Energy product (BH_{max})

Exchange-coupling characterization

- δm method for determining magnetic interactions within composite permanent magnet
 - Isothermal remanence curve

- Demagnetization remanence curve
- Recoil loop analysis
- First Order Reversal Curve (FORC)

Thermal transport and reaction kinetics/thermodynamics determination

- Differential thermal analysis (DTA)
- Differential scanning calorimetry (DSC)
- Thermogravimetric analysis (TGA)
- Hot disk
- Laser Flash

Software experience

- Matlab
- Solidworks
- FORCInel
- ImageJ
- Origin
- MS Excel, Word and PowerPoint

Machine shop experience

- Manual lathe machining
- Manual mill machining
- Precision surface grinding
- Band saws
- Grinders

Equipment maintenance

- Densification equipment (CAPAD)
- Magnetic measurement equipment (VSM, MPMS)
- Vacuum pumps
- Glovebox
- Furnaces (box, tube)

TEACHING EXPERIENCE

Department of Mechanical Engineering

University of California, Riverside (*Faculty Advisor: Prof. Marko Princevac*)

Guest Lecturer for Lessons on Magnetic Materials

Fall 2011, Fall 2012

Introduction to Materials Science and Engineering (ME 114), Prof. Javier Garay

- Prepared and taught several (4) 1.5 hour lectures on the basics of magnetism, magnetic properties and classes of magnetic materials
- Independently managed class size of over 100 students

Teacher Assistant

Sept. 2010 – June 2013

- Prepared and taught lectures in discussion sessions to further improve student understanding
- Conducted review and office hour sessions to help students understand and solve homework problems
- Collaborated with professor and other teaching assistants to improve student learning
- Administered exams, wrote quizzes, and created solutions as well as grading rubrics
- Maintained class website, posted homework and exam solutions
- Collected Accreditation Board for Engineering and Technology (ABET) statistics and analyzed student performance

Courses Taught:

- Spring 2013 *Machine Design (ME 174)*
- Winter 2013 *Mechanics of Materials (ME 110)*
- Fall 2012 *Introduction to Materials Science and Engineering (ME 114)*

- Spring 2012 *Vibrations (ME 122), Machine Design (ME 174)*
- Winter 2012 *Fluid Mechanics (ME 113)*
- Fall 2011 *Introduction to Materials Science and Engineering (ME 114)*
- Spring 2011 *Machine Design (ME 174)*
- Winter 2011 *Mechanics of Materials (ME 110)*
- Fall 2010 *Introduction to Materials Science and Engineering (ME 114)*

MENTORING

University of California, Riverside

Graduate Division Student Mentor

Sept. 2010 – June 2015

(Advisors: Dean Joseph Childers, Dr. Giulia Hoffmann, and Dr. Margaret Gover)

- Mentored 2 to 3 incoming graduate students per year
- Areas of mentoring included professional development, academic success, advancing research as well as mental, physical and financial health as a graduate student

Research Mentor

Eric Hyman *currently at Blue Microphones*

Dec. 2011 – July 2012

- Eric worked with me on the processing of composite hexaferrite – cubic ferrite powder using mechanical milling. We were able to achieve the desired phases in the composite powder.

Martin Manuel *currently at UTC Aerospace System*

Sept. 2013 – June 2015

- I led Martin in research over the course of several years. I taught him numerous analytical techniques such as determining composition using XRD and measuring the average grain size using ImageJ. Martin and I were successful in showing improved properties in exchange-coupled composite powder, compared to single phase constituents.

Rish Shah *currently pursuing B.S. degree in Mechanical Engineering*

Sept. 2015 – Present

- I trained Rish to become an undergraduate expert in wet chemistry technique of homogeneous precipitation. Rish and I were successful in synthesizing composite powder with very clean nano-scale interphases of oxide and metal phases.

LEADERSHIP

Department of Mechanical Engineering

University of California, Riverside

Vice President, Mechanical Engineering Graduate Student Association

Sept. 2014 – June 2015

- Led an association of 7 officers and 40+ members in accomplishing volunteer projects on and off campus
- Managed meetings, assigned tasks, solved problems, determined budget availability, etc.
- Organized a student led symposium with guest speakers from industry and academia

LANGUAGES

- English – fluent
- Russian – fluent
- Spanish – elementary

AWARDS

Sept. 2013 - June 2014 *Deans Distinguished Fellowship Award*, full tuition compensation and stipend

Sept. 2012 - June 2013 *Deans Distinguished Fellowship Award*, full tuition compensation and stipend

PROFESSIONAL AFFILIATIONS

- ASME - American Society of Mechanical Engineers
- ACerS - The American Ceramic Society
- AIST - Association for Iron & Steel Technology
- ASM International - The Materials Information Society
- TMS - The Minerals, Metals and Materials Society

Volodchenkov 7
Curriculum Vitae

REFERENCES

Prof. Javier Garay

University of California, San Diego, Mechanical and Aerospace Engineering, Professor

jegaray@eng.ucsd.edu

951-827-2449

Relationship: Ph. D. advisor and mentor for 5 years

Prof. Suveen Mathaudhu

University of California, Riverside, Mechanical Engineering, Assistant Research Engineer

smathaudhu@engr.ucr.edu

951-827-4414

Relationship: Research Advisor < 1 year, mentor for 2 year

Prof. Jing Shi

University of California, Riverside, Physics and Astronomy, Professor

jing.shi@ucr.edu

951-827-1059

Relationship: Dissertation committee member, collaborator for 2 years

Prof. Marko Princevac

University of California, Riverside, Mechanical Engineering, Associate Professor

marko@engr.ucr.edu

951-827-2445

Relationship: Teaching assistant advisor for 2 years

Prof. Alexander Balandin

University of California, Riverside, Electrical and Computer Engineering, Professor

balandin@ece.ucr.edu

951-827-2351

Relationship: Collaborator for 2 years

Prof. Alexander Khitun

University of California, Riverside, Electrical and Computer Engineering, Professor

akhitun@ece.ucr.edu

Relationship: Collaborator for 1 years

Mr. Martin Manuel

UTC Aerospace Systems, Materials and Process Engineer

mmanu002@ucr.edu

760-315-1689

Relationship: Research colleague / assistant