Vignesh Kannan

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Education

Johns Hopkins University
Ph.D., Mechanical Engineering (*2018*)
Advisor: Prof. K. T. Ramesh
Thesis title: Twinning and the dynamic behavior of magnesium and its alloys

Master of Science in Engineering (M.S.E), Mechanical Engineering (*2014*)

National Institute of Technology, Tiruchirappalli
Bachelor of Technology (B. Tech), Production Engineering (*2012*)

Research Interests

The mechanics of electroactive ferroelectrics
- Experimental methods for in-situ characterization of ferroelectric ceramics
- Kinetics of domain wall motion and its interaction with mechanical response

Mechanical metamaterials
- Deformation and wave propagation is architectured metamaterials

Dynamic behavior of materials
- Experimental characterization of high rate material behaviour
- Development of multi-scale measurement capabilities to bridge length and time scales

Micromechanics and material instabilities
- Micro-scale defect kinetics (e.g. deformation twinning) and corresponding macro-scale response
- Localization of deformation across length and time scales

Research skills

Experimental techniques
- High strain rate experiments: Conventional and desktop kolsky bars
- In-situ high speed imaging
- Microscopy: Optical microscopy, Scanning Electron Microscopy (Imaging), Electron Backscattered Diffraction Microscopy (EBSD)
- Specimen preparation techniques: proficient use of Electro Discharge Machining, Diamond wire saw, automatic polishers and lapping machines

Software skills
- Programming using Matlab, C++
- Image processing using Matlab (competent), Photoshop (competent)
- Post-processing and data visualisation using Matlab (competent), Kaleidagraph (basic)
- 3D CAD modeling using Creo (competent), AutoCAD (intermediate)
- Writing using LaTeX (competent)

Awards and Fellowships

People's Choice Best Poster Award *Mach conference, Annapolis, April 2017*

Poster title: The mechanics of twinning under high strain rates: Dynamics

APS-SCCM Student Travel Award *June 2015 and 2017*

Student travel award to attend the Shock Compression of Condensed Matter Conference held at Tampa (2015) and St. Louis (2017)

IIT Madras Summer Fellow *Summer 2011*

Awarded to pursue summer research with Prof. M. S. Sivakumar, Department of Applied Mechanics, Indian Institute of Technology, Madras

Project title: Non-linear analysis of discrete structures- Truss, Beam and Frame

Research Projects

Graduate Research (Advisor: Prof. K. T. Ramesh) *Summer 2013- present*

Department of Mechanical Engineering, Johns Hopkins University, Baltimore, MD

- *Set-up and instrumentation of a miniature kolsky bar*
  - Modified a desktop/ miniature kolsky bar to measure material response at very high strains rates ($O(10^4)\ s^{-1}$)
  - Installed high gage factor semiconductor strain gages on the bars.
  - Installed a normal displacement interferometer (NDI) to measure back surface displacements on the transmitted bar in-situ.

  Collaborator(s): Dr. D. Casem, US Army Research Laboratory, Aberdeen Proving Grounds

- *High strain rate behavior of magnesium alloys*
  - Measured the dynamic stress-strain response of a textured AZ31B magnesium alloy processed by Equal Channel Angular Extrusion in the strain rate range of $10^3 - 10^4\ s^{-1}$ using conventional (w/ in-situ imaging) and desktop kolsky bars.
  - Characterized the effect of strain rate on plastic flow (across 8 decades of strain rate) using complementary data at quasi-static strain rates.
  - Conducted recovery experiments at different strains and performed post-mortem electron backscattered diffraction (EBSD) microscopy to identify mechanisms active under dynamic loading. Transmission electron microscopy was performed by collaborators on recovered samples.

  Collaborator(s): Dr. N. Krywopusk, Dr. X. Ma, Prof. T. P. Weihs, Department of Materials Science and Engineering, JHU; Dr. L. J. Kesckes, US Army Research Laboratory, Aberdeen Proving Grounds.

- *Mechanics of dynamic twinning in single crystal magnesium*
  - Performed controlled in-situ high strain rate compression on single crystal magnesium crystals at strain rates of the $O(10^3\ s^{-1})$ to generate specific mechanisms called deformation twins.
  - Used time resolved high speed imaging with 200 ns temporal and 5 μm spatial resolution to capture the evolution of twins during deformation.
  - Developed image processing routines using Matlab to measure twin dynamics.
  - Post-mortem microscopy revealed the rate dependent activation of twin variants.

  Collaborator(s): Prof. K. Hazeli, University of Alabama at Huntsville.

- *In-situ x-ray diffraction during dynamic compression of magnesium*
  - Assisted in performing dynamic compression experiments with in-situ x-ray diffraction conducted at the Cornell High Energy Synchrotron Source (CHESS) and Advanced Photon Source (APS), Argonne National Laboratory on polycrystalline magnesium and its alloys.
  - *Core expertise*: Set-up, diagnostics and troubleshooting of the kolsky bar and its instrumentation. Setup in-situ optical imaging.

    Collaborator(s): C. J. Hustedt, Dr. P. K. Lambert, Prof. T. C. Hufnagel, Department of Materials Science and Engineering, JHU; Dr. D. Casem, US Army Research Laboratory, Aberdeen Proving Grounds; Prof. E. Retzlaff, Mechanical Engineering Department, United States Naval Academy.

- *In-situ x-ray phase contrast imaging of geologic materials*
  - Assisted in performing high strain rate experiments with in-situ x-ray phase contrast imaging at the Advanced Photon Source, Argonne National Laboratory to understand failure of geologic materials under dynamic loading.
  - *Core expertise*: Set-up, diagnostics and troubleshooting of the kolsky bar and its instrumentation. Setup in-situ optical imaging.
    Collaborator(s): Dr. A. F. T. Leong, Prof. T. C. Hufnagel, Department of Materials Science and Engineering, JHU

- *Dynamic response of single crystal copper (Ongoing)*
  - Characterizing single crystal Cu specimens for dynamic compression along different crystallographic axes.
  - Dynamic compression data will be used for validating dislocation dynamics simulations by collaborators.
    Collaborator(s): Prof. W. Cai, Stanford University; Dr. R. B. Sills, Sandia National Laboratories.

Undergraduate research (Advisor: Prof. M. S. Sivakumar) *Summer 2011*

Department of Applied Mechanics, Indian Institute of Technology, Madras

- *Non-linear analysis of discrete structures: Truss, Beam and Frame*
  - Developed a finite element code to analyse three types of structural members: truss, beam and frames in 2D and 3D.
  - Used the updated lagrangian formulation to analyse geometric non-linearity in structures involving each of these three structural elements.

Professional Service

Extreme Arts Programme *Fall 2016, Spring 2017*

Part of a collaboration between the Hopkins Extreme Materials Institute (HEMI) and Maryland Institute College of Art (MICA). Assisted Mr. Jay Gould, faculty, MICA in a project to visualize science using art.

Organizer, Mechanics and Materials Graduate Seminar *Fall 2015, Spring 2016*

Co-organized the graduate student seminar within the mechanics and materials focus group of the mechanical engineering department at JHU.

Peer-review *November 2015*

Peer-reviewed an article for the Journal of Dynamic Behavior of Materials.

Mentorship

Undergraduate students

- *Geordan Gutow, BS 2018* *2016-17*

  Dynamic compression of AZ31B using the desktop kolsky bar.
  Recovery fixture fabrication for desktop kolsky bar experiments
  Specimen and jig fabrication for synchrotron experiments

- *Alex Doran, BS 2019* *Summer 2017*

  Dynamic compression of AZ31B using conventional and desktop kolsky bars. Analysis of experimental data

Graduate students

- *Caleb. J. Hustedt, MSE 2017*

  Assisted and trained student on specimen preparation and instrumentation, analysis and operation of kolsky bars for use in a synchrotron experiment (in-situ X-Ray diffraction during dynamic loading of magnesium)

Teaching Experience

Teaching Assistant, Mechanical Engineering, JHU

- Mechanical Engineering Freshman Lab *Spring 2013*

  Basic undergraduate level laboratory course designed to teach basics of mechanical engineering (Instructor: Prof. S. Belkoff)
  Responsibilities: Setup of laboratory experiments, running laboratory sessions and grading lab reports.

- Mechanics of Solids and Materials II *Spring 2016*

  Graduate level course in solid mechanics (Instructor: Prof. J. El-Awady)
  Responsibilities: Running office hours, preparing homework solutions and grading homeworks and exams.

- Mechanics Based Design *Spring 2017*

  Undergraduate course on the basics of engineering design using mechanics (Instructor: Prof. K.T. Ramesh).
  Responsibilities: Making homework problem sets and solutions, running office hours and teaching bi-weekly recitation sessions.

Publications (Accepted)

V. Kannan, K. Hazeli *&* K. T. Ramesh, The mechanics of dynamic twinning in single crystal magnesium, *Journal of the Mechanics and Physics of Solids (2018) Special issue in honor of Ares J. Rosakis on the occasion of his 60th birthday*

M. Zhao, **V. Kannan** *&* K. T. Ramesh. The dynamic plasticity and dynamic failure of a magnesium alloy under multiaxial loading, *Acta Materialia (2018)*

C.J. Hustedt, P. K. Lambert, **V. Kannan** et al., In-situ time resolved measurements of extension twinning during dynamic compression of polycrystalline magnesium, *Journal of Dynamic Behavior of Materials (2018)*

Lambert et al. Time-resolved x-ray diffraction techniques for bulk polycrystalline materials under dynamic loading, *Rev. Sci. Instruments 85, 093901 (2014)*

Publications (Sub judice)

V. Kannan, X. Ma, N. M. Krywopusk, L. J. Kecskes, T. P. Weihs *&* K. T. Ramesh, The effect of strain rate on the mechanisms of plastic flow and failure of an ECAE AZ31B magnesium alloy

Conference presentations/ posters

V. Kannan, K. T. Ramesh and K. Hazeli, Twinning in single crystal magnesium under high strain rates: Dynamics, *Society for Experimental Mechanics Annual Conference and Exposition, Indianapolis (2017)*

V. Kannan, K. T. Ramesh and K. Hazeli, The dynamics of twinning in magnesium at high strain rates, *Society of Engineering Science 54th Annual Technical Meeting, Boston, MA (2017)*

V. Kannan, K. T. Ramesh and K. Hazeli, The mechanics of twinning under high strain rates: Dynamics, *Mach Conference, Annapolis MD (2017)*
(Peoples' Choice Best Poster Award)

V. Kannan, N. Krywopusk, K. T. Ramesh, T. P. Weihs, L. Kesckes and D. Casem, Strength and strain localization in an AZ31B Mg alloy: Strain rate effects, *Society of Engineering Science 53rd Annual Technical Meeting, College Park, MD (2016)*

K. T. Ramesh, M. Zhao, **V. Kannan**, N. Krywopusk, T. P. Weihs, L. Kesckes and C. Williams, Dynamic plasticity in the magnesium alloy AZ31B, *17th International Conference on Experimental Mechanics, Greece (2016)*

V. Kannan, N. Krywopusk, L. Kesckes, T. P. Weihs and K. T. Ramesh, Dynamic heterogeneous failures in polycrystalline AZ31B magnesium, *Society for Experimental Mechanics (International student paper competition), Orlando, FL (2016)*

V. Kannan, N. Krywopusk, L. Kesckes, D. Casem, T. P. Weihs and K. T. Ramesh, Dynamic plasticity in a magnesium alloy: Microstructural and continuum effects, *APS Shock Compression of Condensed Matter, Early Career and Student Symposium, Tampa, FL (2015)*

Co-curricular Activities

Head, Design of transmission systems, BAJA SAE INDIA *2011-2012*
Designed, fabricated and tested two All-Terrain Vehicles

Extra-curricular activities

Member, JHU Badminton club *2016-present*

National Cadet Corps Air Wing (B certificate) *2008-2009*

Languages

English (fluent), Tamil (native), Hindi(basic)

References

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