Available MSME projects

ME295A/ME299-I for Fall 2020

MSME project orientation meeting, 4/17/2020

Department of Mechanical Engineering, SJSU

Prof. Feruza Amirkulova, feruza.amirkulova@sjsu.edu

- Research Interests: Acoustic and elastic wave propagation and scattering, metamaterials, "invisibilty" cloak, dynamic material characterization
- Available projects: https://sjsu.zoom.us/rec/share/uMtLAp7ctUFLYs-T7VzjAe19HrTueaa8hCdLq6ENy08PlHHgn06rK_auYa1esUDB (Access Password: msme2020!)

Prof. Buff Furman, burford.furman@sjsu.edu

- Research Interests: Precision machine design, mechatronic systems, mechanical measurement
- Available projects: https://sjsu.zoom.us/rec/share/_MlVDu2hzE1IQKvt7HnCC7RxQ73qT6a82yEYrKBenkoCVLSbcXiDfgVQWLCHLRZz (Access Password: msme2020!)

Prof. Winncy Du, winncy.du@sjsu.edu

- Research Interests: Mechatronics, robotics, machine vision, pattern recognition
- Available projects: https://sjsu.zoom.us/rec/share/-8l1JOH96kJObK_G6wbVXbUZEMPjaaa81SEfq6EPzh1oPjNaAA16lMyWDlX0StkL (Access Password: c2^*9747)

Prof. Nicole Okamoto, nicole.okamoto@sjsu.edu

- Research Interests: heat transfer, HVAC, thermal management of electronic systems
- Available projects: https://sjsu.zoom.us/rec/share/6NNJLZ3M0l9LW7eWsXPRfJcrFdvdeaa81CdIrqYPmh0XTYDDu8HAksk1MeYY-PW4 (Access Password: msme2020!)

Prof. Crystal Han, crystal.m.han@sjsu.edu

- Research Interests: Application of microfluidics in biotechnology, on-chip diagnosis, sample purification, electrokinetics
- Available projects: https://sjsu.zoom.us/rec/share/tMlXfpbd-SBLTYWUygLEZoMKAaPieaa82nJN-vQJzUsRw6LQWJ2AolJ-XKIIhT7I (Access Password: msme2020!

Prof. Farzan Kazemifar, farzan.kazemifar@sjsu.edu

- Research Interests: Experimental thermal and fluid sciences, optical and laser-based diagnostic techniques, multiphase flow and transport in porous media, particle-based fluid velocity measurement techniques.
- Available projects: https://sjsu.zoom.us/rec/share/tOUsDJevsWdIRJ3UtWrxXPZmQoLGeaa813IWq_dbzEcxyx8pU3tTefTXiT-eYKyb (Access Password: msme2020!)

Prof. Amir Armani, amir.armani@sjsu.edu
- Research Interests: Design and Optimization, Additive Manufacturing, Structural Ceramics, Functionally Graded Materials, Smart Structures, and Sheet Metal Forming
- Available projects: https://sjsu.zoom.us/rec/share/xvZJMZLrzWJJZqP1uUryS_UlP6m-X6a8gXQd-foEzkhv_YThdh9J38GKi_qSTwMX (Access Password: msme2020!)

Prof. Vimal Viswanathan, vimal.viswanathan@sjsu.edu
- Research Interests: engineering design, new product development, design creativity and innovation, mechatronics systems design
- Available projects: https://sjsu.zoom.us/rec/share/wuxoI-H3zl9IeNLz7UjUXqkPGaL8aaa8hyVM_PQInR404myagWEaMhvCH2Lu7dRm (Access Password: msme2020!)

Prof. Raymond Yee, raymond.yee@sjsu.edu
- Research Interests: mechanical design, materials behavior, fracture mechanics, FEA/CAD, stress analysis
- Available projects: see slides below

Prof. John Lee, sang-joon.lee@sjsu.edu
- Research Interests: MEMS, microfluidics, microfabrication processes
- Available projects: see slides below

Prof. Fred Barez, fred.barez@sjsu.edu
- Research Interests: electronics packaging, magnetic recording, fiber optics
- Available projects: see slides below

Prof. Saeid Bashash, Saeid.Bashash@sjsu.edu
- Research Interests: Control Systems, Mechatronics, Power and Energy Systems, Internet of Things
- Available projects: see slides below

Prof. Tai-ran Hsu, tai-ran.hsu@sjsu.edu
- Research Interests: MEMS design & packaging, thermomechanics, fracture mechanics
- Available projects: see slides below

3 MSME Research Projects

Mechanical Engineering Department
ME295A
for Fall 2020
Professor Raymond K. Yee

Parametric Study of Metal 3D Printing Processes

Additive Manufacturing (AM) technology for metal parts also commonly known as “Metal 3D Printing” has been received a lot of attentions in recent years. Many industry sectors such as biomedical field and aerospace would like to use this technology for their applications, the AM process control and its effects on fabricated parts have not been well understood. It has been observed that AM metal parts have a number of material abnormalities such as lack of fusion, porosities, and micro-cracks formation from the process and its residual stress produces permanent deformation (distortion) upon release from the platform.

In a typical AM process, laser or electron-beam is used as a heating source to fuse metal powders together to form the geometry of a part. Several key AM process parameters such as metal powder feed rate, heat source power, heat source travel speed, heat spot size, travel pattern, and substrate temperature etc. may have strong influence on microstructure variability, material abnormalies, and strength of a fabricated part.

Project Objectives:

- To perform a parametric study of key AM process parametes (using finite element simulation)
- To quantify their effects on residual stresses and/or deformation in a simulated part.
- To identify the optimal process parameter values for titanium/stainless steel 3D printing
- To fabricate relevant samples, examine microstructural defects, examine part distortion and perform mechanical testing to characterize its performance (Experimental Study)

Knowledge Requirements:

(1) FEM (ANSYS), Thermal-mechanical interaction process.

(2) Fabrication, mechanical testing and sample characterization.

Metal 3D Printer (Sample)

Metal 3D print samples

Projects by Prof. Yee

raymond.yee@sjsu.edu

Collapsible Cup Design Refinement & Analysis

Objective: To develop a protable and collapsible cup for hot & cold beverages (coffee, tea etc.)

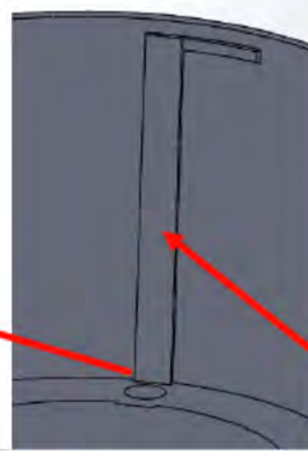
O-ring seal channel

Functional requirements: [Key features in design are highlighted in CAD]
Compact, reusable, 12 oz size, machine-washable, keep hot/cold drinks for at least 2hrs, eco-friendly, leak-proof, with magnetic locking.

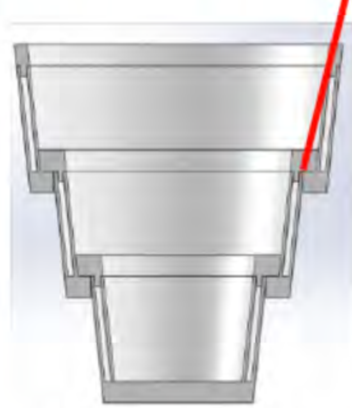
Project goals: Refine the existing design and perform transient thermal and O-ring fatigue analyses to achieve functional req'ts and specify its manufacturing.

Knowledge requirements: (1) Thermal simulation and fatigue evaluation. (2) manufacturing methods

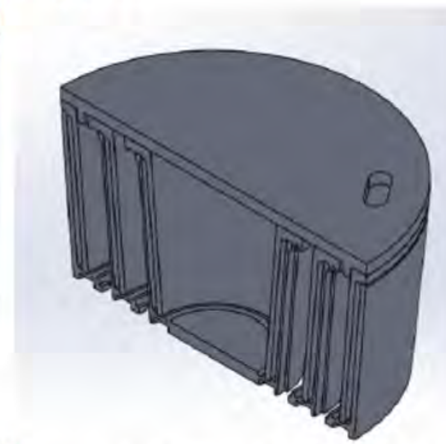
Magnet sites for locking



Sliding slot



Extended shape



Collapsed shape

Projects by Prof. Yee
raymond.yee@sjsu.edu

Crash Test Study Project (Industry sponsored)

High strain-rate deformation study

ATD Sled Experimental data for Numerical Simulation

Background: Calibration and verification of numerical models of Crash Test Dummy models, referred to as an anthropomorphic test device (ATD) is critical to using simulation for design of vehicles. There are many different size models to represent people based upon size. The 50th Percentile Hybrid III Male ATD is a standard model used for vehicle design both for personal and military vehicles. The IMPETUS 50th Percentile Hybrid III Male ATD has been verified for crash using the SAE J2856 automotive tests. Recently, the National Institute for Aviation Research (NIAR) provided the company with experimental data for a sled test that they performed with a Male ATD physical dummy. The project includes analyzing the experimental data and development of the corresponding numerical model of the sled test in conjunction with the IMPETUS ATD Model within the FE Progra[...] The final report will be included in the documentation for the IMPETUS ATD.

Main Tasks:

- Literature research on ATD's, sled tests and Explicit Finite Element.
- Study experiments from National Institute for Aviation Research.
- Develop FE Model of the applied sled test set-up at NIAR.
- Verification of the IMPETUS ATD for sled tests. Inverse engineering of mat[...]nstants if needed.

The student will learn about the IMPETUS Solver, Study Experimental Techniques and spend some time at CertaSIM's Saratoga Office to learn more about simulation technology.

San Jose State University, Professor R. Yee, Ph.D.

CertaSIM, LLC, M. R. Jensen, Ph.D.

MS Project and Thesis
Proposed Topics by Dr. Fred Barez

Vehicles:

1. Design of an all-wheel steering system for improved maneuverability
2. Active driver monitoring and alert system using machine learning
3. Vehicle cabin noise reduction for passenger comfort
4. Cone of Silence: Sound directionality on-demand
5. Vehicle fuel consumption efficiency through wheel hubcap design

Electronics Packaging:

1. Thermal management of smart poles used in street vehicle connectivity
2. Thermal property characterization of 3D printed polymers
3. Thermal property characterization of plastic resins at low pressure

Projects by Prof. Barez
fred.barez@sjsu.edu

MS Project and Thesis Proposed Topics by Dr. Fred Barez

Autonomous Driving:

1. Design of a vehicle lane keeping and lane departure techniques
2. Design of an autonomous utility vehicle
3. Performance evaluation of solid state Radars and laser-based Lidars
4. Effects of vehicle charging station utilization on the grid

Design:

1. Design of a swivel, stowed away seat for mini vans
2. Application of exoskeleton techniques for an injury-free a production environment
3. Development of a Virtual Reality tool sets for Manufacturing 4.0

Projects by Prof. Barez
fred.barez@sjsu.edu

MS Project and Thesis
Proposed Topics by Dr. Fred Barez

Biomechanics and Health Care:

1. Application of wearable devices for human health monitoring and diagnostics
2. Design of simple and affordable ventilators

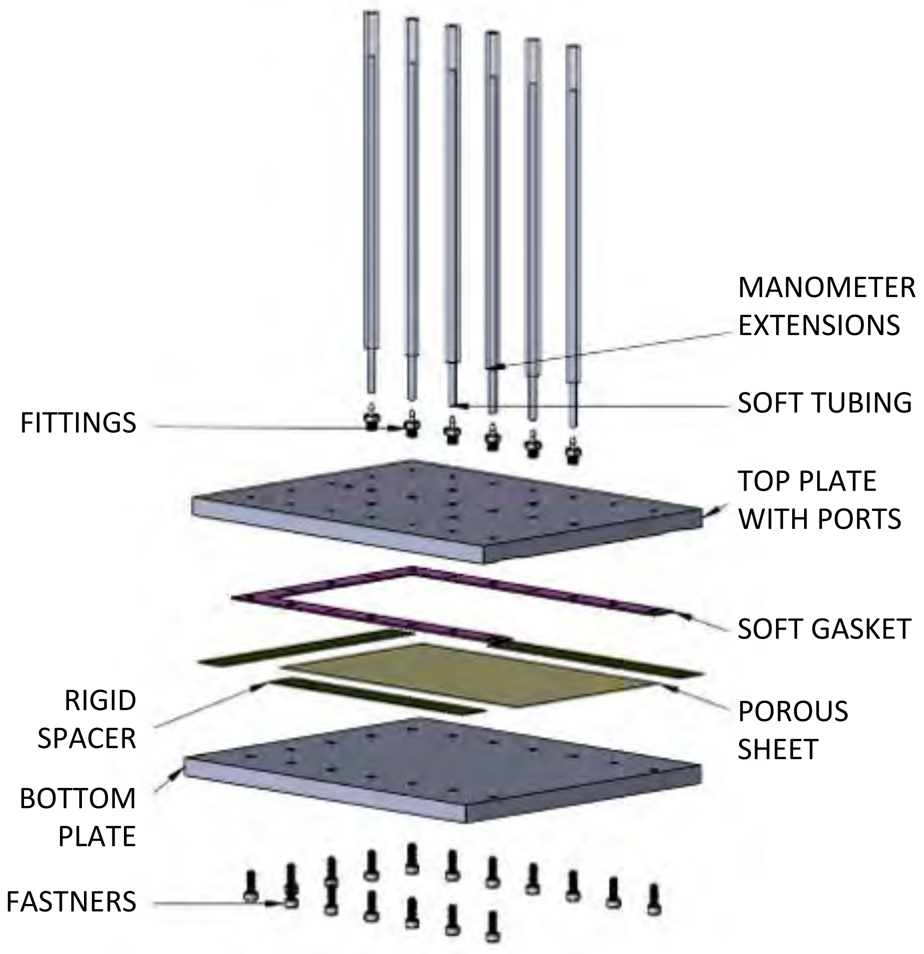
Projects by Prof. Barez
fred.barez@sjsu.edu

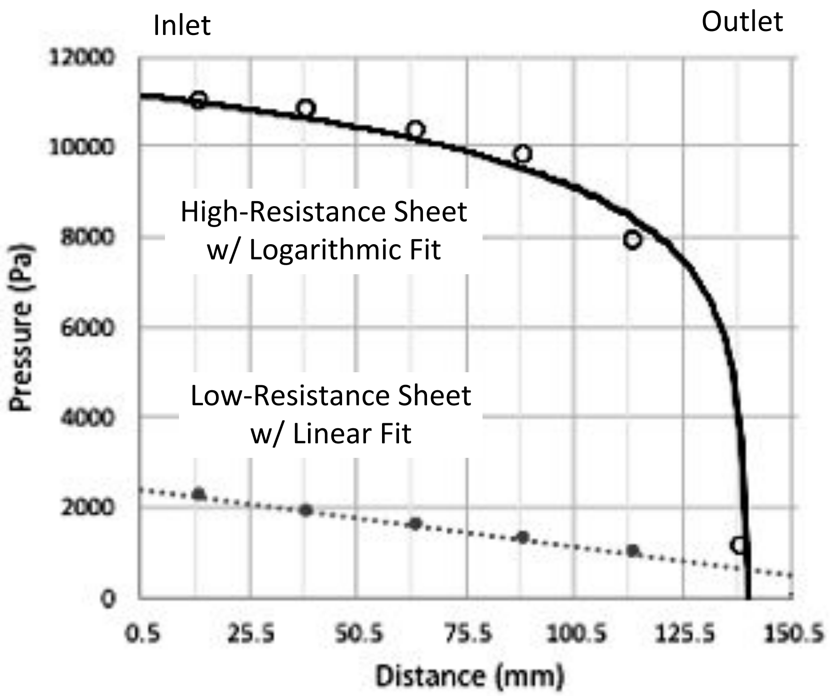
Recent Examples of Research in Microfluidics and Micromechanics

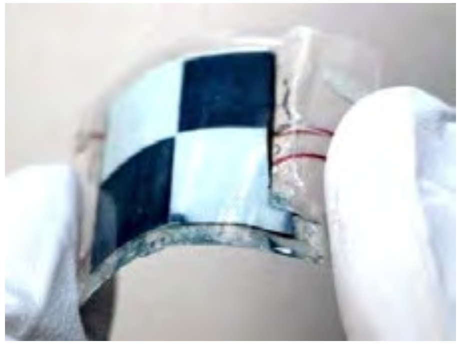
S. J. Lee
San Jose State University
2020 April 17

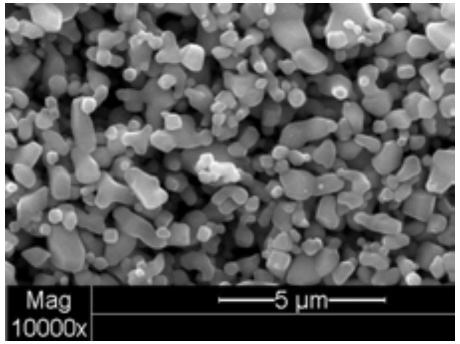
New opportunities for Summer 2020 and beyond would be next-level investigations applying microfluidics or micromechanics to similar applications in biomaterials characterization and energy storage.

Lateral hydraulic resistance in thin porous media





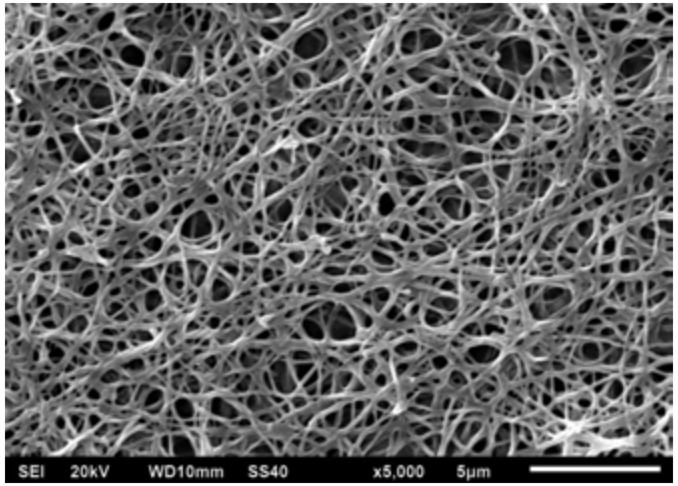


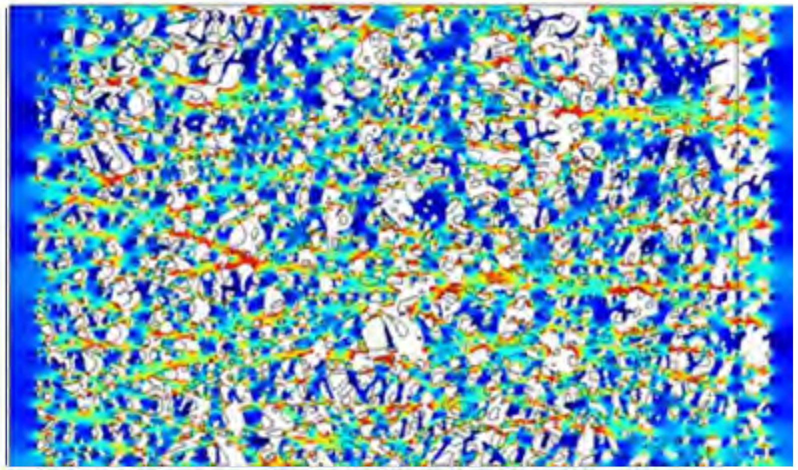


- For flow across a low-resistance sheet at a prescribed flow rate of 10 µL/min, the pressure gradient follows approximately linear behavior, consistent with Darcy’s law for porous media flow.
- For a sheet having high resistance at the very same 10 µm/min flow rate, the gradient becomes nonlinear as inertial resistance dominates over viscous resistance.

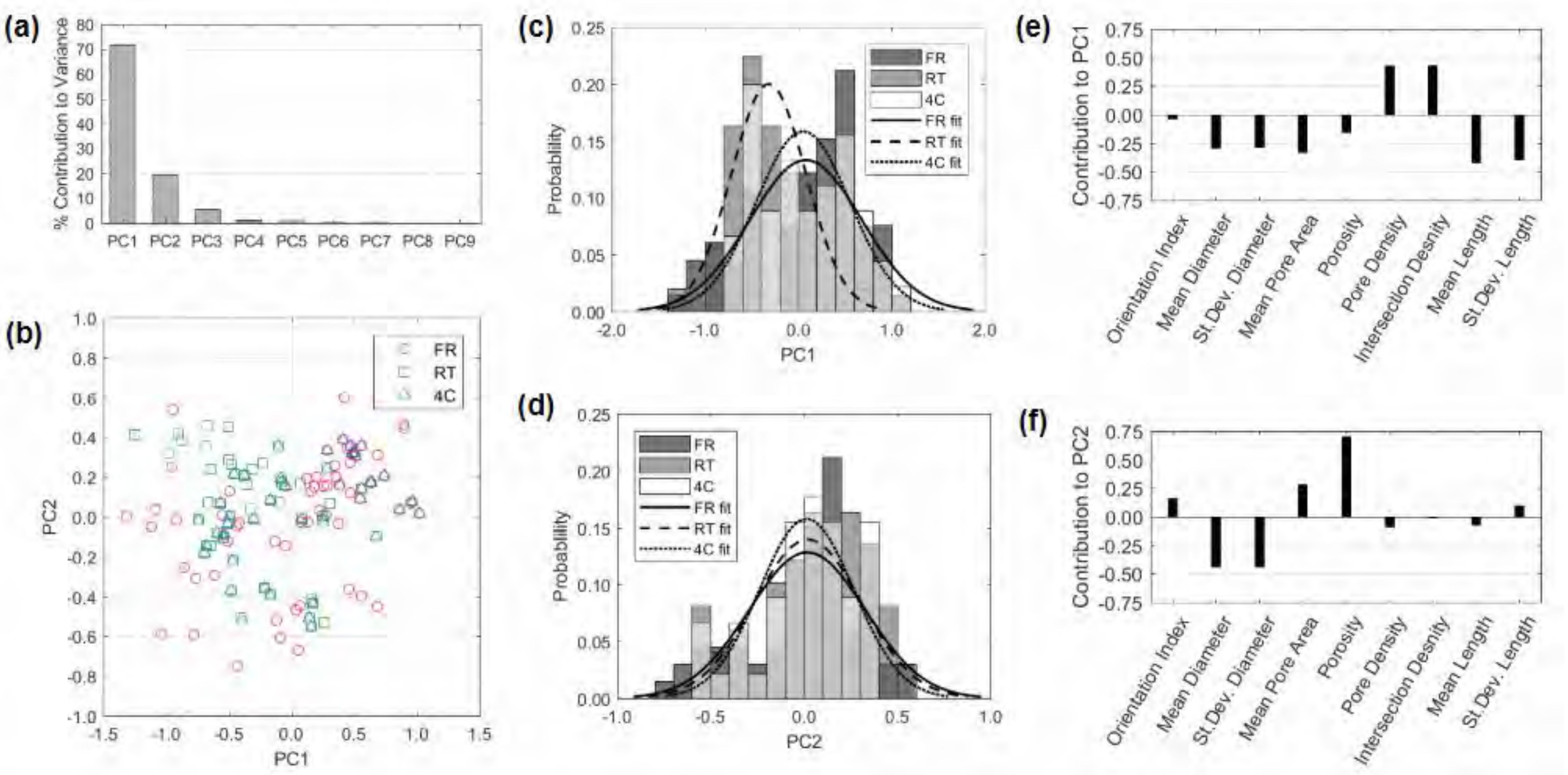
S. Doser and S. J. Lee, “In-plane hydraulic resistance through paper-thin porous media”,
Proc. of the ASME 2018 5th Joint US-European Fluids Engineering Summer Conference, July 2018, Montreal, Quebec, Canada, 2018, Paper FEDSM2018-83262.

Simulation of fibrin network mechanics





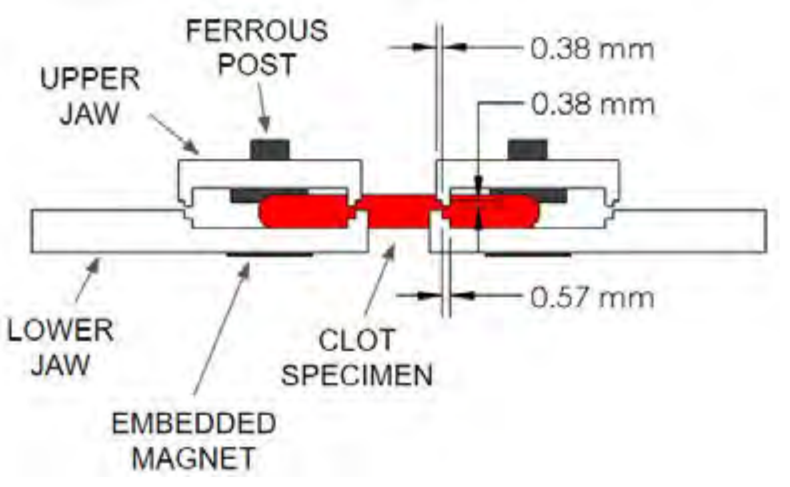
Simulated strain energy density, this example reaching 0.5 N/m² at 20% strain.

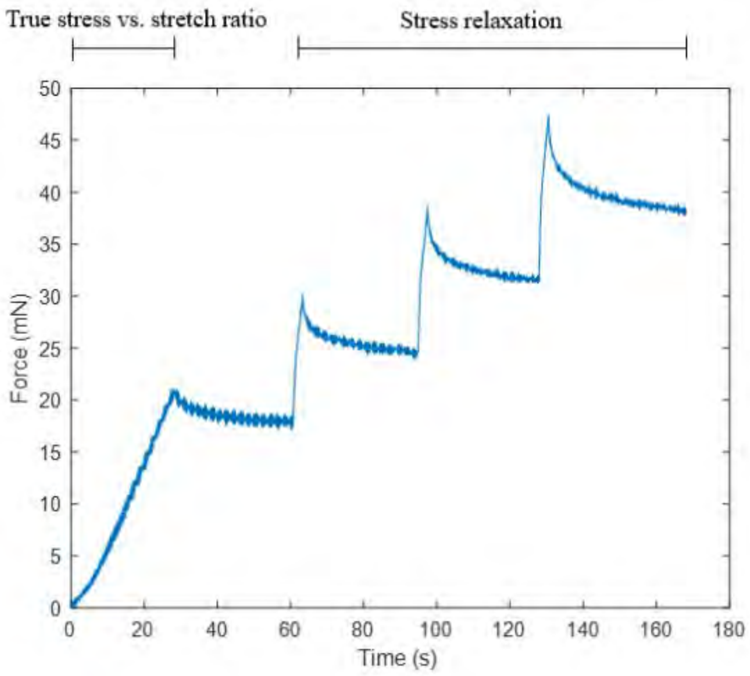


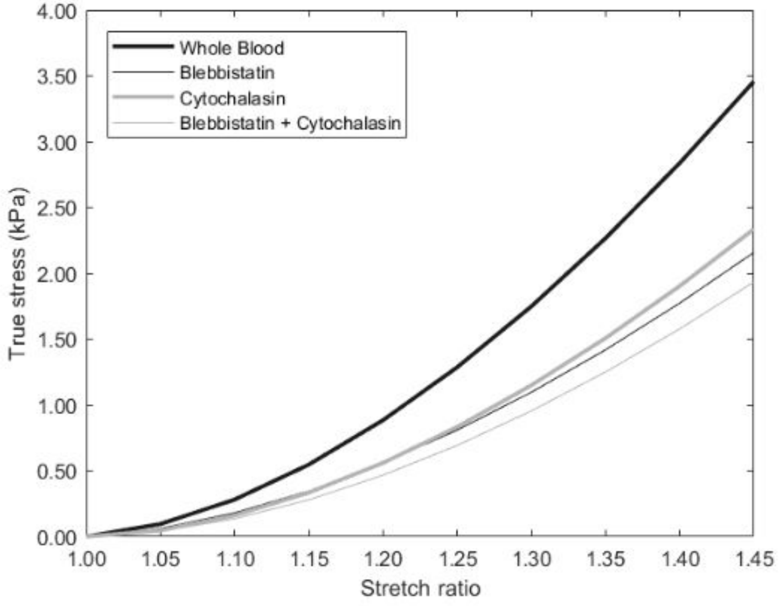
Influence of microstructural features on clot stiffness for clots having fresh platelets (FR) and platelets stored at room temperature (RT) or at 4 °C (4C). Principal component analysis (PCA) shows (a) contribution of PC; (b) biplot of PC1 vs. PC2; distribution of (c) PC1 and (d) PC2; and relative contribution of microstructural features to (e) PC1 and (f) PC2.

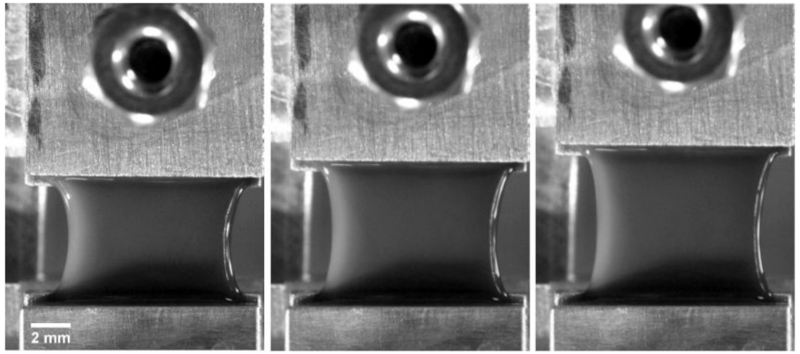
S.J. Lee, **D.M. Nguyen**, **H.S. Grewal**, C. Puligundla, A.K. Saha, P.M. Nair, A.P. Cap and A.K. Ramasubramanian, "Image-based analysis and simulation of the effect of platelet storage temperature on clot mechanics under uniaxial strain." Biomechanics and Modeling in Mechanobiology 19.1 (2020): 173-187.

Effect of inhibitors on mechanics of blood clots







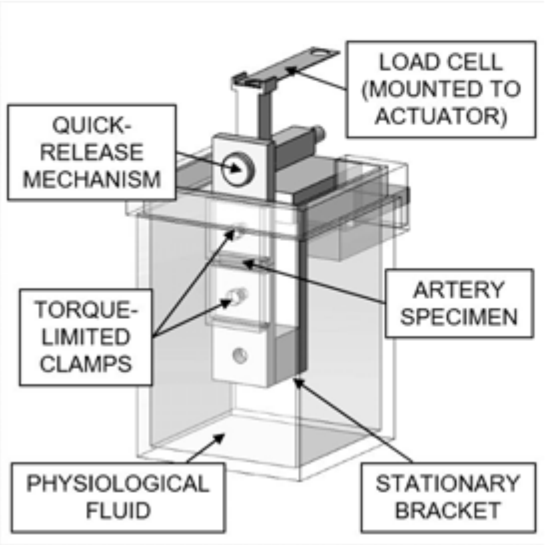


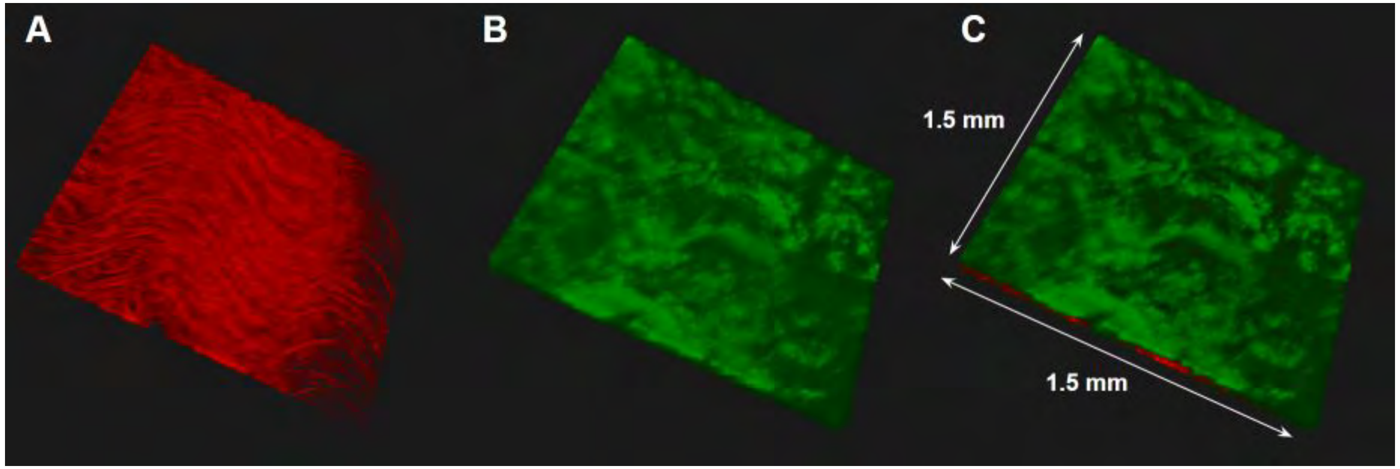
Top view of incremental stages in uniaxial extension of a blood clot up to 50% strain

- The effects of clot inhibitors (blebbistatin and cytochalasin D) on the stiffness and viscoelasticity of blood clots were examined by designing a low-force tensometer for direct tensile testing.
- Blebbistatin (which affects myosin II movement on actin) was observed to have a larger effect on weakening clots than cytochalasin D (which affects actin polymerization).

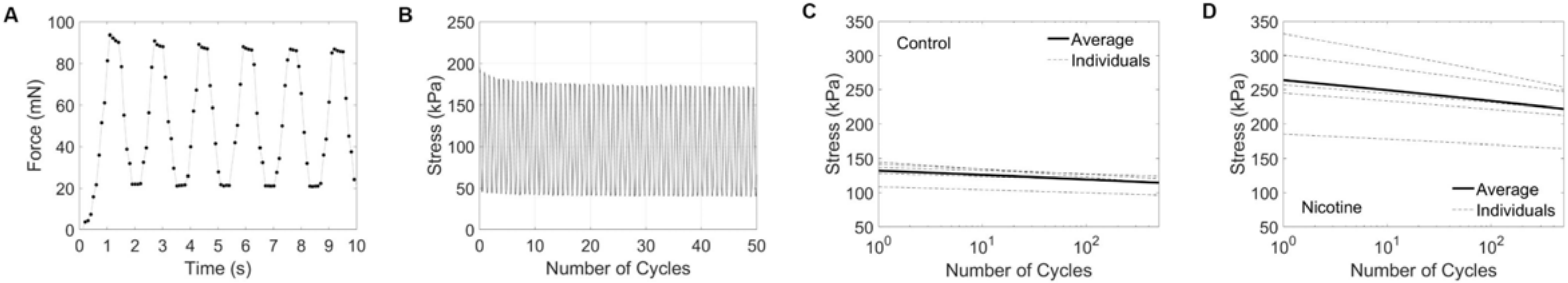
W. Eng, **M. Kim**, A. Ramasubramanian, S. J. Lee, "A modular test platform for micromechanical tensile testing of soft biomaterials", Proc. of the ASME 2018 International Mechanical Engineering Congress and Exposition, November 2018, Pittsburgh, PA, 2018, Pages V003T04A030-V003T04A030.

Effects of nicotine on arterial mechanics





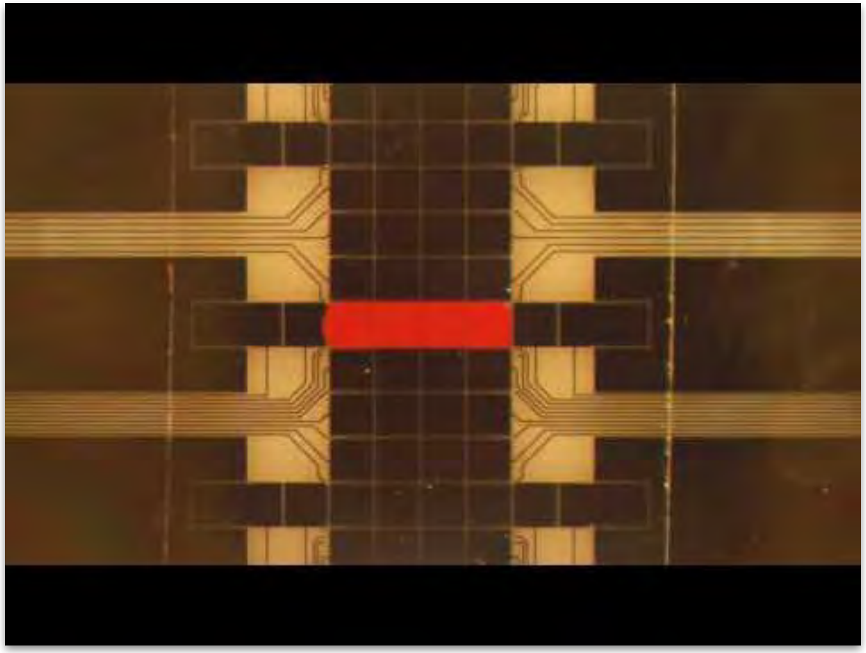
Multiphoton image stacks of elastin (A), collagen (B), and both superimposed (C).



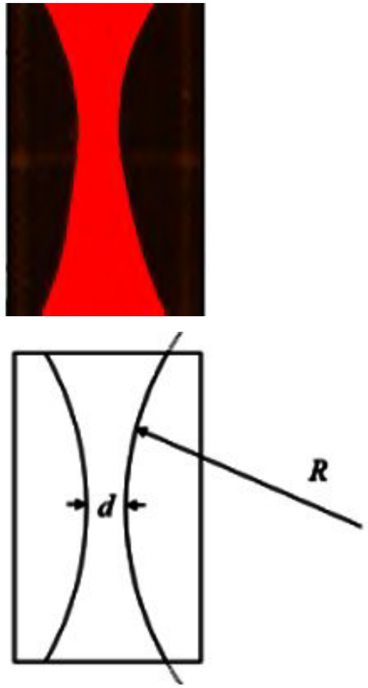
Fatigue response, showing force measurements on murine aorta specimens (A) during the first 10 seconds and calculated stress values (B) over the first 50 cycles for one control specimen. Fatigue over the full 500-cycle duration is compared for (C) control and (D) nicotine-treated aortas.

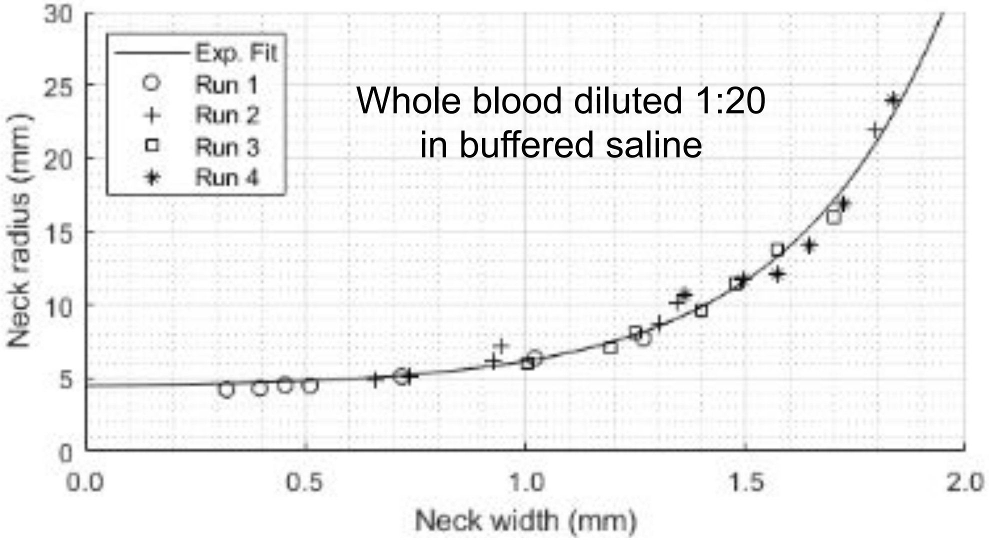
S. J. Lee, **E. Ho**, J. Mulorz, **S. Nyshadham**, **J. Wong**, M. U. Wagenhäuser, P. S. Tsao, A. K. Ramasubramanian,
"Effect of nicotine on stiffness, viscoelasticity, and fatigue of murine thoracic aortas", submitted in March 2020 to the Journal of Biomechanics.

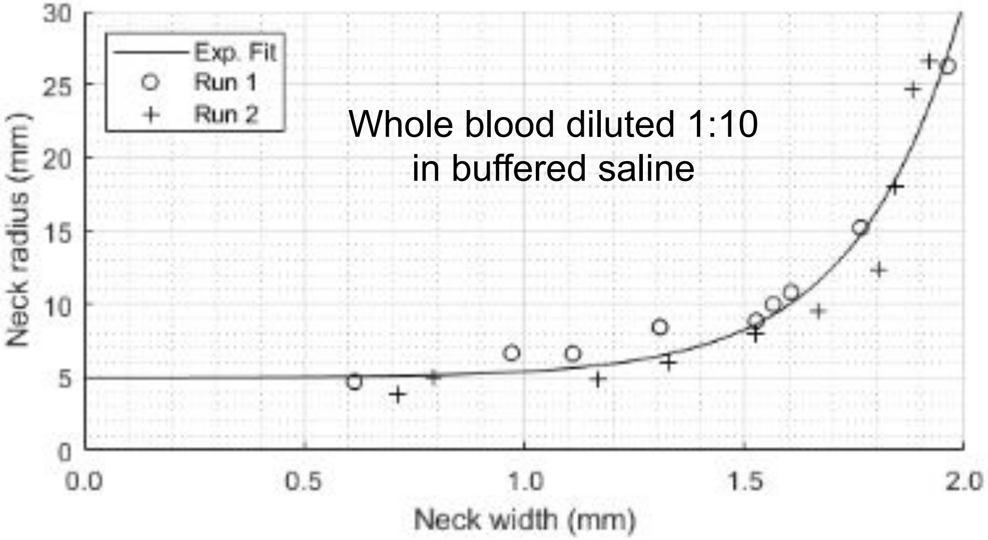
Deformation of blood by electrowetting forces



https://youtu.be/PyI5zMvvrLw



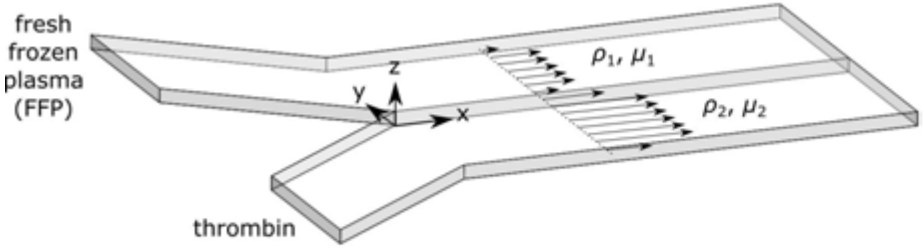


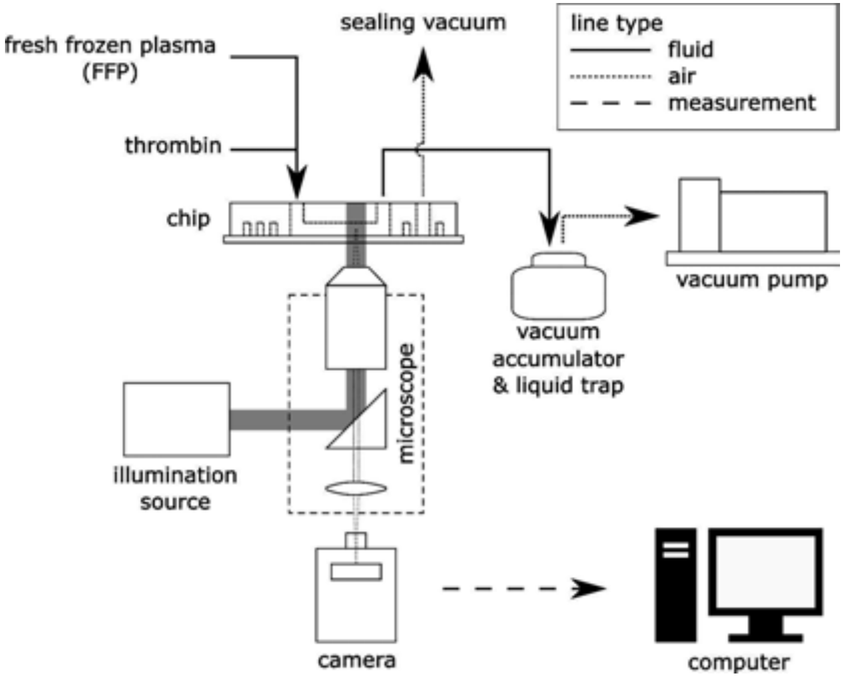


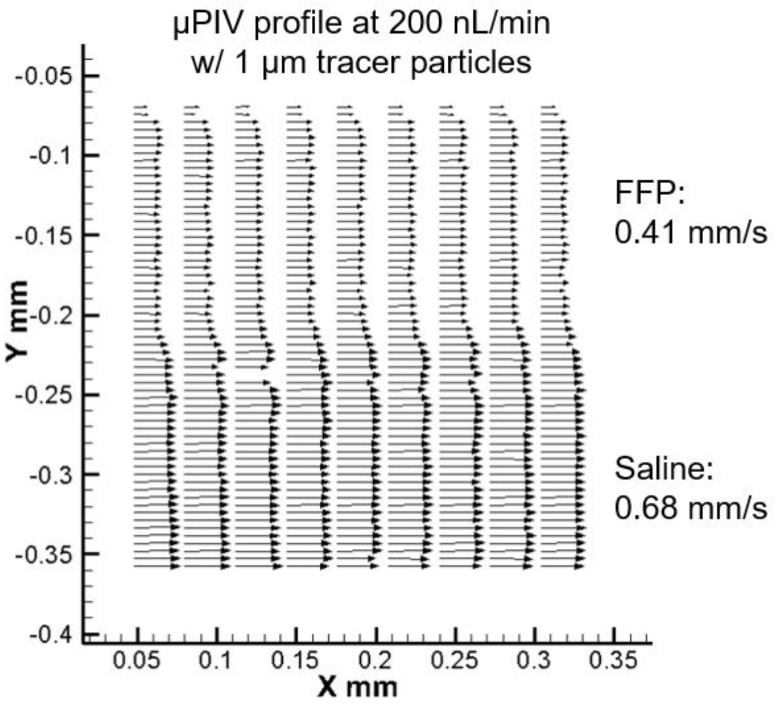
- Digital microfluidic chips were used to apply electrowetting forces to manipulate small volumes (~5 μL) of blood.
- Blood exhibited a characteristic necking profile according to concentration, with higher concentration having wider neck.
- Even though the rate of necking varied widely from site to site, the shape was consistent and time-invariant.

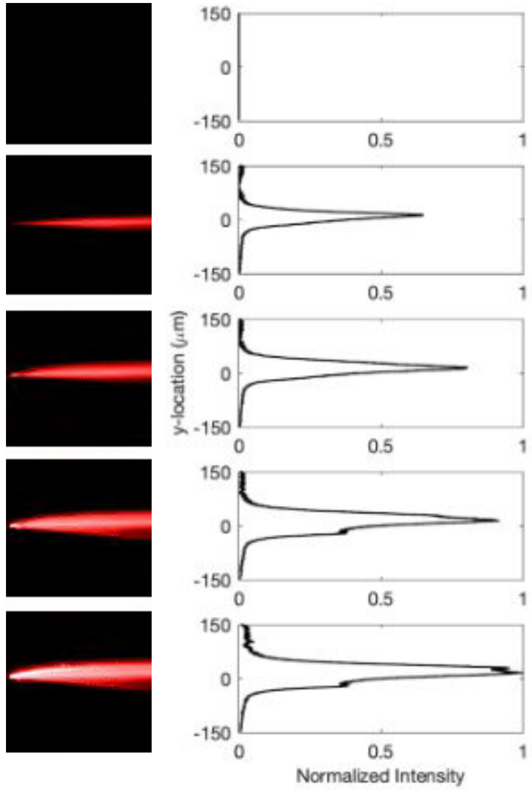
C. Young, A.K. Ramasubramanian, M. Simon and S.J. Lee, "Time-Invariant Deformation of Blood During Necking on an Electrowetting Digital Microfluidic Platform,“ in ASME-JSME-KSME 2019 8th Joint Fluids Engineering Conference, 2019.

Blood clot analogs using co-flow microfluidics





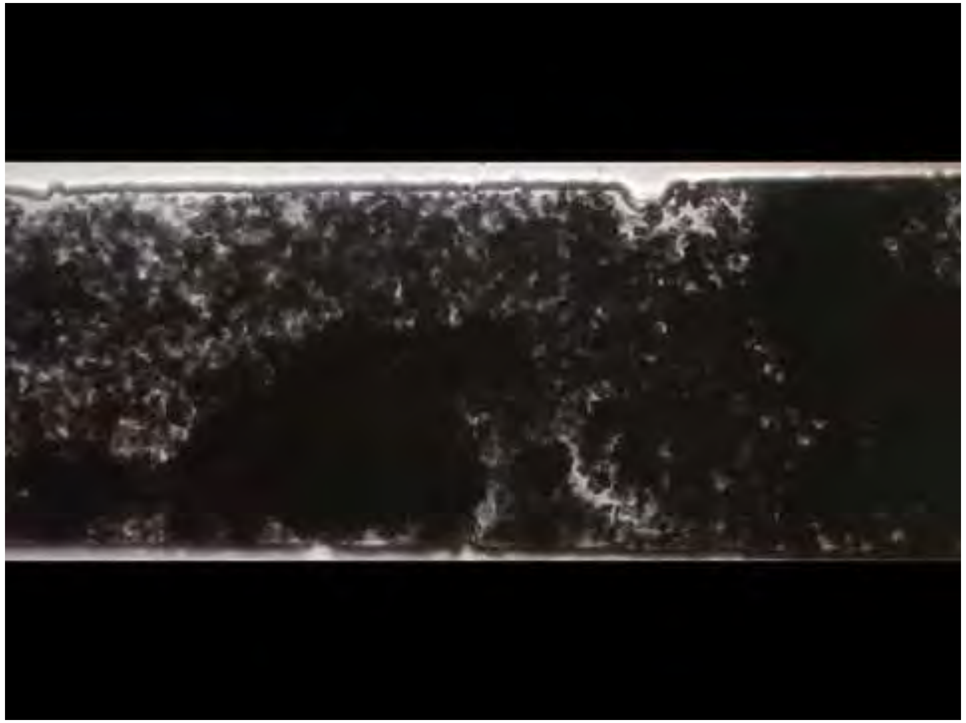




- A microfluidic device was engineered to synthesize clot analogs and using fluorescence microscopy (shown in red above) to observe formation of fibrin clots at the shear boundary between co-flow streams.
- Clot shape and density distribution can be dynamically manipulated to mimic heterogeneity and time evolution in real blood clots, enabling more realistic conditions than possible using stationary clot synthesis.

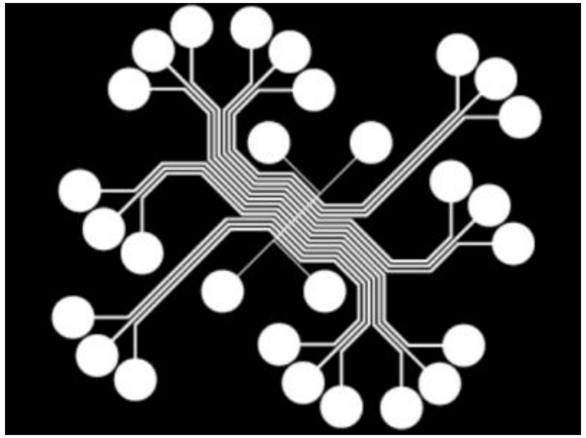
S. Saw, A.K. Ramasubramanian, M. Simon and S.J. Lee, "Formation of Clot Analogs Between Co-Flow Fluid Streams in a Microchannel Device,“ Proc. of ASME-JSME-KSME 2019 8th Joint Fluids Engineering Conference, 2019.

Thrombosis in deformable microchannels

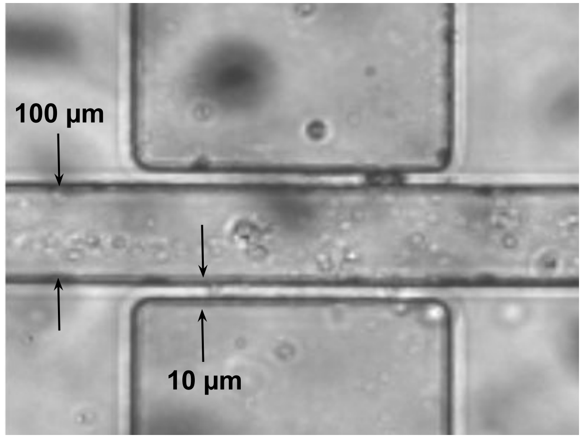


https://youtu.be/yJW8onDHi8M

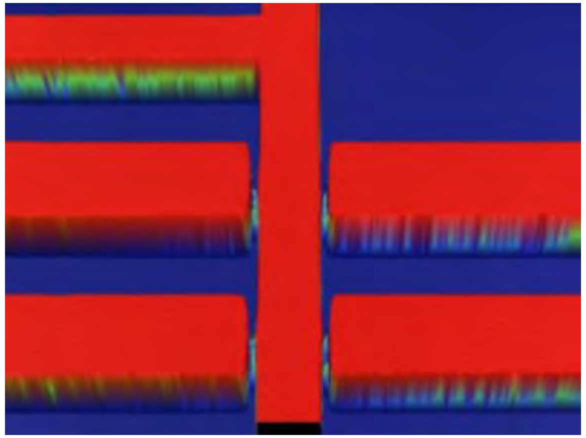
This investigation uses fluid-structure interaction (FSI) in microchannels to study how shear strain and wall compliance affect the formation and dissolution of clots in small blood vessels.



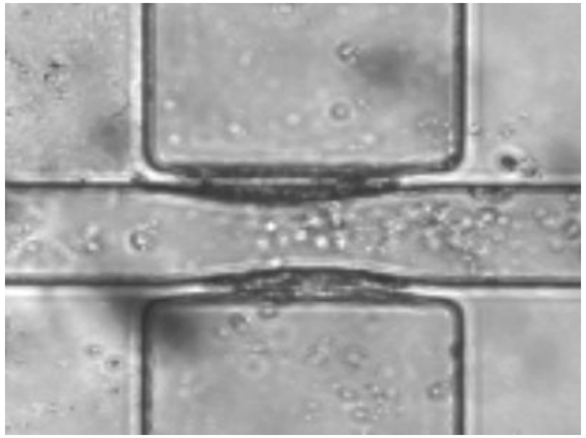
Photolithography mask design with 12 pairs of side chambers



Relaxed microchannel with 10 µm thick side walls



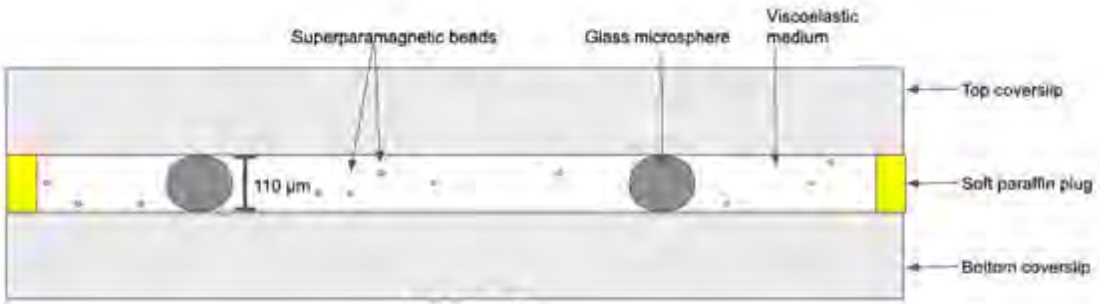
Fabrication process inspection by 3-D optical profilometry



Wall deformation by pneumatic pressure in side chambers

Thesis investigation in progress by Max Kim

Magnetic bead rheometry of soft biomaterials



Cross-sectional view of prepared specimen. Glass microspheres separate the two coverslips and achieve a height of 110 µm

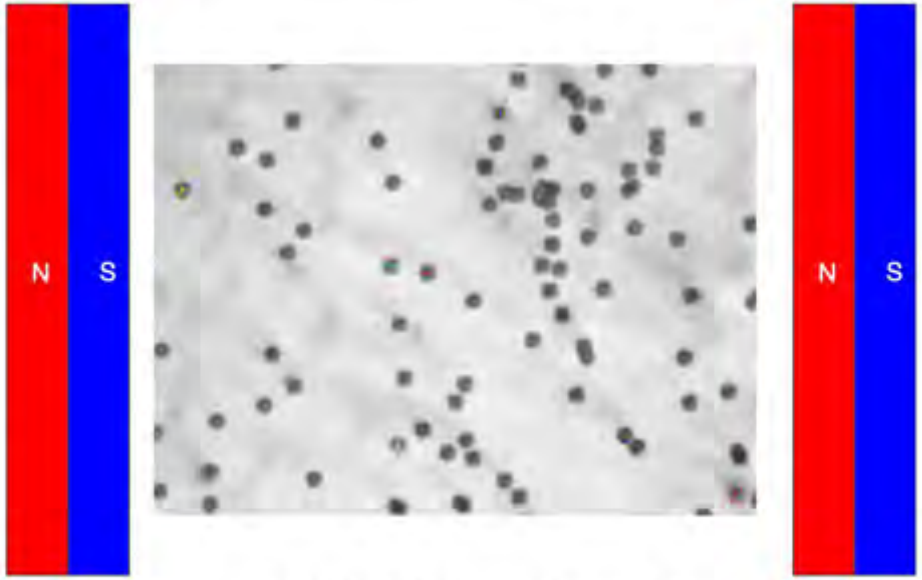
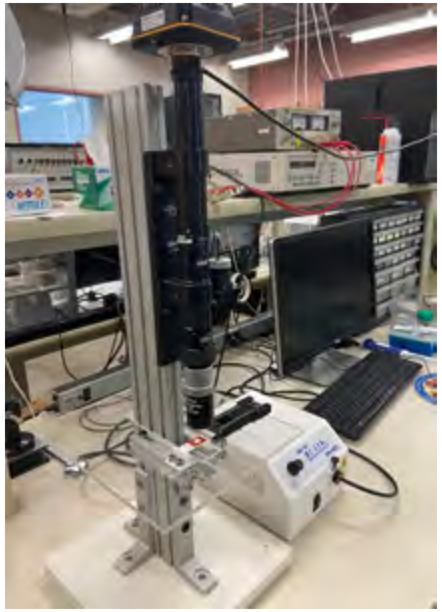


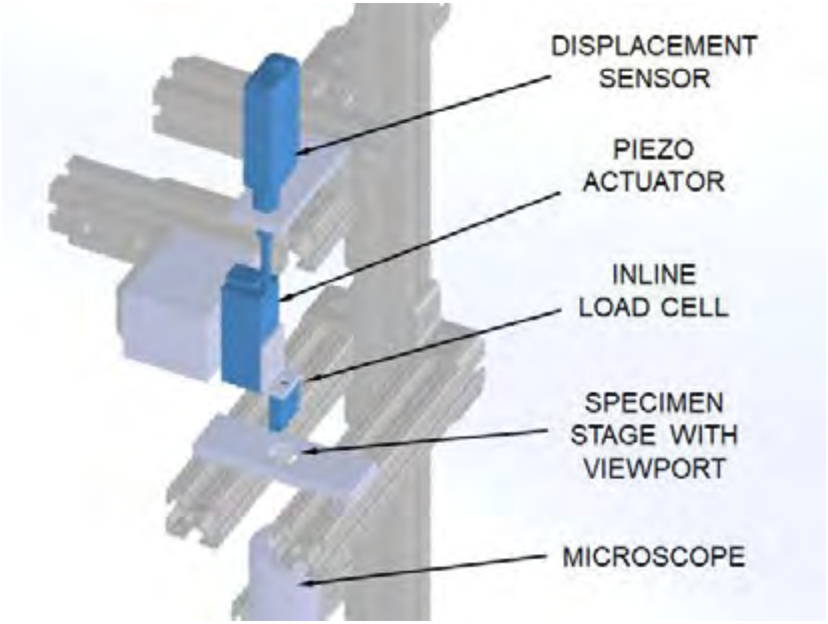
Figure 2. The superparamagnetic beads are magnetized from left to right, as the region of interest is closer to the right magnet.



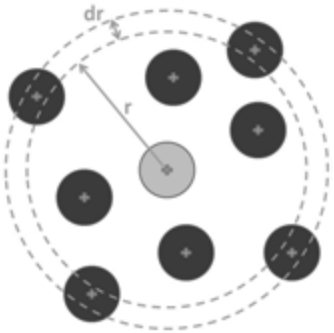
- This investigation uses mobility of small magnetic beads to discern compositional factors that affect spatial heterogeneity in the stiffness and viscosity of soft biomaterials.
- The work first requires establishment of a predictable model for mobility of the magnetic beads in a viscous medium under an imposed magnetic field gradient.
- Preliminary velocity measurements reveal approximately constant velocity, indicating that viscous drag in the medium balances magnetic force on the particles.

Thesis investigation in progress by Mahmoud Issa, with support from Marcus Freitas (BSME)

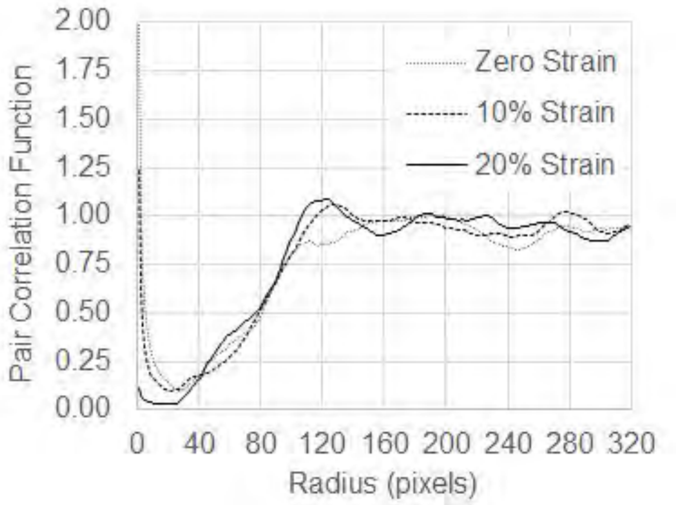
Particle distribution in solid composite electrolytes

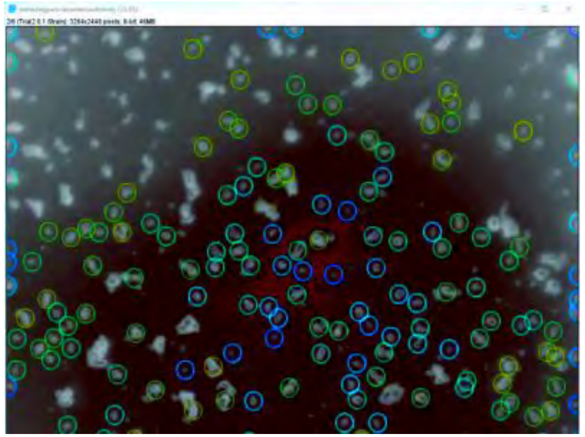


- This investigation quantifies ceramic particle redistribution within a thin polymer gel layer, in response to deformation caused by compression.
- The compression mimics volumetric changes that occur during charge and discharge cycles in lithium-ion battery.

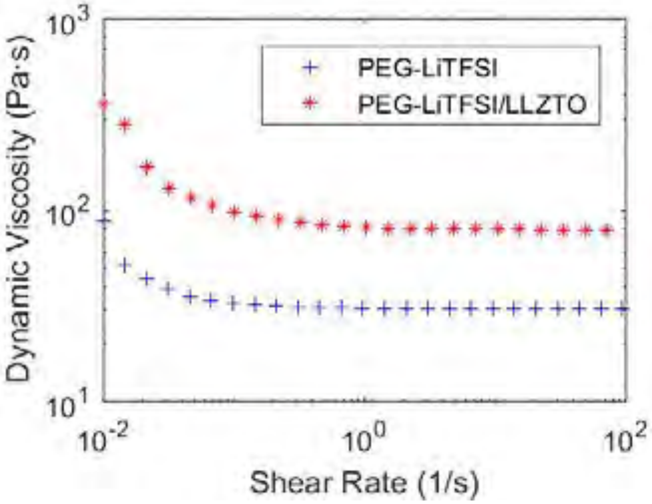


Quantification of spatial arrangement of particles by pair correlation function





Identification of 5 μm particles and extraction of center positions



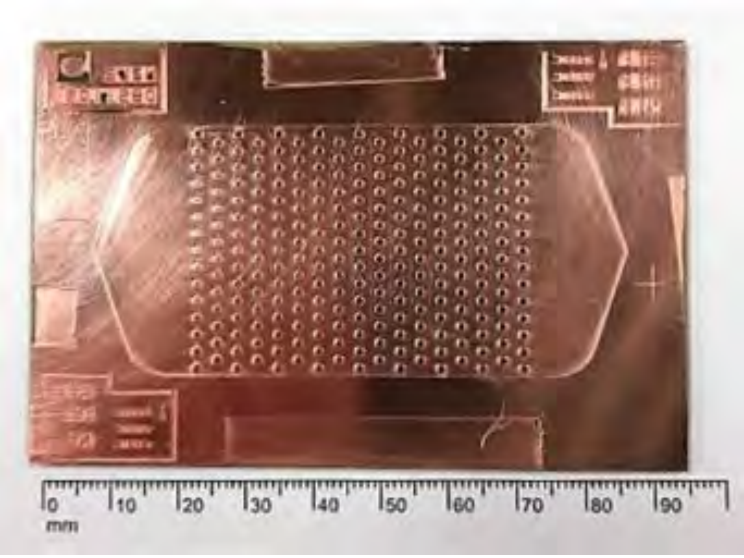
Thesis investigation in progress by Izzat Halabi, with contributions from Yousef Barati (BS MatE), Marcus Freitas (BSME), and Scott Lienhart (BS MatE)

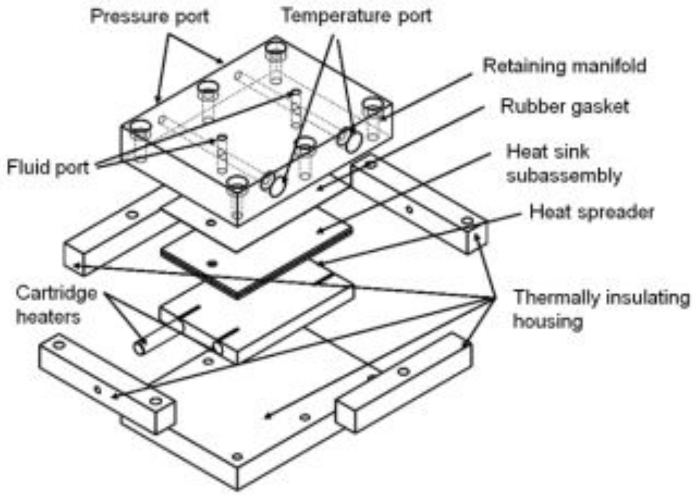
Interdisciplinary collaboration and community

Spring 2020 team meeting among faculty and student researchers in blood clot mechanics.

Summer 2019 recreation picnic with members of Han (ME), Lee (ME) Parent (EE), Ramasubramanian (ChE), and Rosenfeld (ChE) research groups.

Liquid cooling of PCB substrates w/ micro pin fins





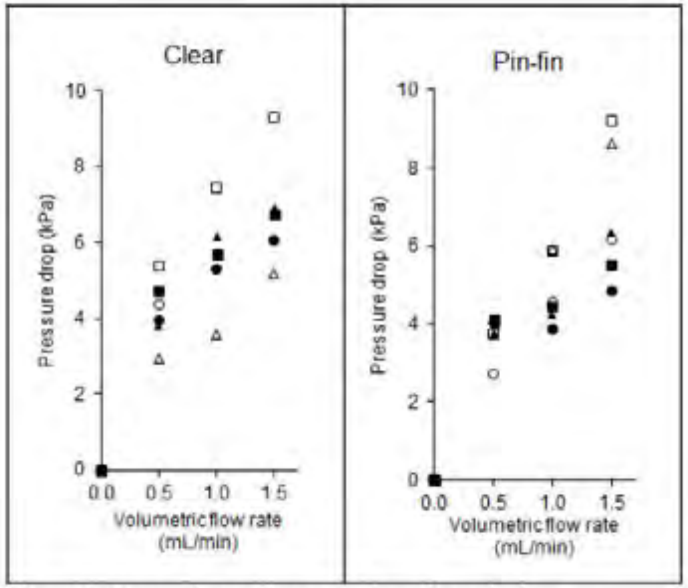


Figure 7. Comparison of pressure drop through clear microchannels and pin-fin microchannels, as a function of volumetric flow rate. Each plot shows two distinct specimens (unfilled vs. filled markers) and three runs per specimen (○ △ □ and ● ▲ ■, respectively).

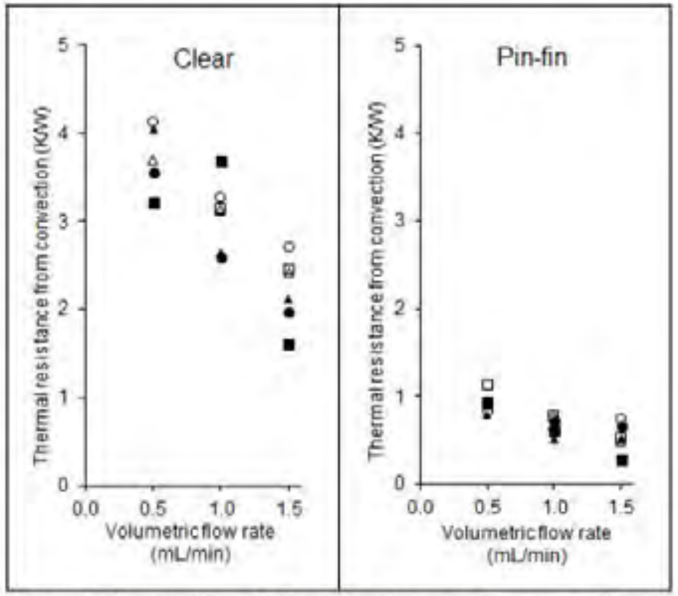


Figure 8. Comparison of thermal resistance from convection of clear microchannels and pin-fin microchannels, as a function of volumetric flow rate. Each plot shows two distinct specimens (unfilled vs. filled markers) and three runs per specimen (○ △ □ and ● ▲ ■, respectively).

- Micro scale pin-fins were etched in the copper-clad layer of printed circuit board substrates to investigate trade-offs in liquid cooling.
- Experiments flowing water across pin fins vs. a clear open channel showed that it is possible to achieve substantially lower thermal resistance for cooling benefit without adversely affecting overall pressure drop.

Y. Lam, N. Okamoto, Y. Shabany, S. J. Lee, “Experimental investigation of liquid cooling through shallow copperclad cavities with etched pin-fin arrays”, Proc. of the ASME 2018 5th Joint US-European Fluids Engineering Summer Conference, July 2018, Montreal, Quebec, Canada, 2018, Paper FEDSM2018-83265.

MS Projects for Fall 2020
Professor Saeid Bashash

1 or 2 spots for projects related to control systems

Projects by Prof. Bashash
saeid.bashash@sjsu.edu

Two MS Projects Offered by Professor T.R. Hsu for Fall 2019

Specialty: Green technologies. Contact E-mail: Prof. Tai-Ran Hsu at: tai-ran.hsu@sjsu.edu

Topic 1: On the Sustainability of Electric Vehicles:

This project involves "paper research" only. It is on a critical issue of whether electric vehicles (EVs) are indeed the ultimate solution to environmentally sustainable means for (urban) ground transportation.

Many perceive EVs to be eco-environmentally sustainable because they are free of emissions of toxic and greenhouse gases to the environment.

However, hasty replacing gas-powered vehicles by EVs will prompt sudden boost in demands for electricity generations, with approximate 60% of the e-power generated by fossil fuels in this country today.

The present project will update the statistical data in an unpublished paper presented by Prof. Hsu in an invited presentation in 2013 [1]. It will also investigate the impacts of converting almost all gas-powered vehicles to electricity-driven vehicles as advocated by several countries in the world. For instance, The Chinese government and the Swedish auto maker, Volvo company have announced that they will stop producing gas-powered vehicles after year 2040.

This research will also involve the negative environmental impact of **another** major contributor to the climate change that involves using electricity in producing millions of batteries that would be required to power EVs, and the eco-environmental impacts of recycling vast number of the spent batteries of the EVs.

To justify it a 2-semester project, the student will also offer his (her) outlook on the required electricity generated by clean renewable energies, such as solar and wind power for all EVs in 2040.

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[1] Hsu, T.R. "On the Sustainability of Electrical Vehicles," Presented at the 2013 IEEE Green energy and systems
conference, CSU at Long Beach, CA, November 25, 2013

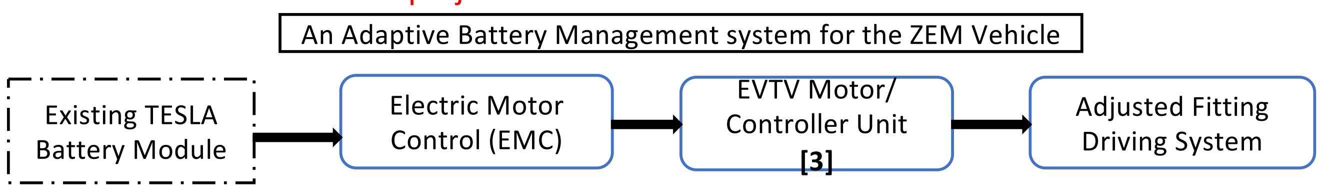
Project 2: Battery Management Systems for Mobile Devices-with special application to the ZEM vehicle [2]

The ZEM vehicle project is an ongoing senior design project. The last student group working on the ZEM vehicle project in 2017 left with the installment of a proper battery management system (BMS) involving TESLA battery packs unfinished in their prototype vehicle. The proposed project requires using this prototype for the student's BMS project.

This project involves the study of BMS specifically for mobile devices and machines such as: industrial Robots, EVs including automated guide vehicles (AGV) for automated manufacturing and warehouse operations, and large drones. This particular research area has become important aspects of the design of these mobile machines.

The proposed research project will begin with literature review of currently available technologies for the topical applications, to be followed by specific BMS for practical application to the three aforementioned devices. This project will end with the specific application of connecting the existing TESLA battery pack to the ZEM prototype vehicle in the lab (see the illustration below), and also with a review of prospect of future battery management system with possible AI and expanded applications such as deep-sea unmanned submarines.

Limited funds are available for this project.



[2] Hsu, T.R., "Performance and Required E-Power Estimate for High Performance ZEM Vehicle," Internal document, 2016
[3] "EVTV Motor/controller for TGESLA Model S Battery Modules, June 2017

Projects by Prof. Hsu
tai-ran.hsu@sjsu.edu