Mohammad S. Saleh

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EDUCATION

Carnegie Mellon University — Pittsburgh, PA

Doctor of Philosophy in Mechanical Engineering — Grad date: Dec, 2018

- Thesis title: "*3D Micro-Additive Fabrication of Biomedical, Microelectronic, and Structural Devices and Systems: Process Development and Application Demonstration*"
- GPA: 3.85/4.0
- Selected Coursework: Thin Films, Nano-science and nano-technology, Additive Manufacturing Processing and Product Development, Mechanical properties of material

Washington State University — Pullman, WA

Enrollment in Ph.D. of Mechanical Engineering — Jan, 2015-Aug, 2017

University of Tehran — Tehran, IRAN

Master of Science Mechanical Engineering — Nov, 2013

- Thesis title: Stress ratio effect on Ti-6Al-4V Turbojet Engine blade high cycle fatigue life
- Selected Coursework: Topology Optimization, Non-Destructive testing, Advanced Control, Advanced Vibration, Fracture Mechanics, Experimental stress analysis, Smart Materials

Bachelor of Science Mechanical Engineering — Sep, 2007

SKILLS

Fabrication and Characterization:

- Micro Electrode Arrays fabricarion: Aerosol Jet printing, Tool path generation, Machine language control by SPii coding, high level automated CAD slicer programing, Maintenance and troubleshooting
- Micro-fabrication techniques: E-Beam Lithography, Photolithography, FIB micro machining, Dicing, Polishing
- Thin film deposition: PVD (Parylene C coating), Sputtering (RF and DC), ALD, Spinning (PDMS, PAA and PLA)
- Etching: RIE, Chemical wet etching, Plasma etching
- Characterization: Microprobe station, Triboindentation, 3D Profilometery
- Microscopy: Light microscopy, Fluorescence microscopy, Electron microscopes (SEM / TEM)
- Mechanical component testing: high cycle fatigue (HCF), Modal analysis of MIMO and SISO systems, Endurance testing in resonance search-track-and-dwell mode (RSTD), Strain gauge installation, triangulation laser displacement measurement, Fractography, and failure analysis
- NDT: Ultrasonic probe inspection, Guided waves (SHM), Smart structures with embedded Piezoelectric actuators
- Data acquisition and signal processing by major commercially available hardware platform (NI, B&K, LDS)
- Fluid properties measurement: Rheology, contact angle, and surface tension measurement
- 3D Printing (Metal): AerosolJet Printing, LPBF, Binderjets
- 3D Printing (Polymer): SLA Form 2, Aerosol Jet printing (Polyamide, PDMS, Loctite Epoxy, Dielectric Materials)

Computational and Engineering Software:

- FEA software for structural stress and thermal analysis: ABAQUS, ANSYS, COMSOL Multi-Physics
- CAD design and engineering: SOLIDWORKS, AutoCAD, MathCAD, Fusion 360
- Material research: ImageJ, CES Edu-pack
- Vibration analysis: B&K Pulse, LDS Shaker controller, LabView NI Vibration, MathCAD
- DAQ and instrument control: LabView, MATLAB
- Coding languages: MATLAB, Auto-LISP, Mathmatica, SPii,
- Statistical data analysis and DOE: Origin Lab Pro – ANOVA, T-test,

THESIS, Ph.D., Carnegie Mellon University

Thesis title: 3D Micro-Additive Fabrication of Biomedical, Microelectronic, and Structural Devices and Systems: Process Development and Application Demonstration

- Utilized design of experiment (DOE) and statistical control process (SPC) approached to study the micro 3D fabrication quality by Aerosol-Jet technique and optimize the gas flow, process temperature and speed to improve feature size to 15um diameter in 3D structures
- Invented a new fabrication strategy based on droplet dynamics to fabricate highly intricate structures (Patented)
- Developed a theoretical model to predict the necessary process conditions and restriction in micro 3D printing process, published in prestigious journal of Science Advances
- Designed and fabricated a custom made micro-compression test mechanism to extract mechanical properties of printed micro-lattice materials resulted in observation of unpredicted complex material behavior
- Utilized COMSOL/MATLAB to predict and simulate the manufacturing processes involving solvent evaporation and nano-particle sintering and solidification in multi-physics frame work to fabricate micro-lattice materials
- **Implemented the novel 3D micro-fabrication technique to create 3D Micro Electrode Arrays (MEAs) with aspect ratio as high as 60 (height to diameter), 120um pitch, and 15um tip diameter**
- Developed and programmed a custom made tool path generator and a slicing algorithm using Autocad/Auto-LISP to control and optimize the pointwise 3D-printing micro-fabrication process resulted in 30% printing time reduction
- Designed and fabricated innovative optical observation, measurement, and fabrication apparatuses for direct micro droplet formation and evaporation recording
- Utilized ABAQUS explicit (3D stress) solver to analyze mechanical performance of micro-lattice materials

PROFESSIONAL EXPERIENCE

Lead Project Engineer, AKSys 10/2012-12/2014 Tehran, IRAN

- Supervised the project accomplishment by delivering the high cycle fatigue tests on high pressure turbine blades resulting in cost reduction of preventive maintenance inspections
- Provided technical oversight to FEA team and offered inputs to the test operators and monitored budget compliance and offered alternative suppliers to improve reliability and decrease cost of operation
- Supervised the design and performed failure analysis and redesigned the test fixtures to eliminate ferreting fatigue
- Conducted several brain storming sessions for experimental boundary condition and gripping mechanism implementation resulted in an innovative solution to achieve the operational conditions

RESEARCH EXPERIENCES

Graduate Research Assistant, Washington State University 1/2015-6/2017 Pullman, WA

- Prepared printable thermoelectric ink and fabricated thermoelectric generator (TEG) using aerosol-jet printer

Graduate Research Assistant, University of Tehran 2011-2013 Tehran, Iran

- Conducted Research on accelerated fatigue testing methods and strategies in HCF regime which led to development of new testing apparatus for accelerated fatigue testing
- Designed and experimentally implemented a robust signal processing method for structural health monitoring based on wavelet decompositions of ultrasonic guided waves

SELECTED CONFERENCES

[1] “Mechanical Behavior of Microscale Polycrystalline Silver Pillars” M. S. Saleh, M. Hamid, H. M. Zbib, R. Panat, TMS2018 Spring Meeting

[2] “Additive Nanoparticle Assembly for Hierarchical 3D Micro Architected Materials and Their Mechanical Behavior” M. S. Saleh, C. Hu, S. Nesaei, A. Gozen, J. Park, and Rahul Panat, MRS2017 Spring Meeting

PUBLICATIONS

[1] M. S. Saleh, C. Hu, R. Panat, "Three-dimensional micro-architected materials and devices using nanoparticle assembly by pointwise spatial printing" Science Advances, 3 E1601986 (2017)
[2] M. S. Saleh, J. Li, J. Park, and R. Panat "3D printed hierarchically-porous micro-lattice electrode materials for exceptionally high specific capacity and areal capacity lithium ion batteries" Additive Manufacturing, July 18,
[3] M. S. Saleh, M. H. Vishkasougheh, H. Zbib, R. Panat, "Polycrystalline micropillars by a novel 3-D printing method and their behavior under compressive loads" Scripta Materialia, Volume 149, May 2018, Pages 144-149,
[4] R. Danaei, M. Ahmadzadeh, M. S. Saleh, C. Owen, J. McCloy, Y. Zhang, R. Panat "Ultrafast Fabrication of Flexible Thermoelectric Films by Pulsed Light Sintering of Colloidal Nanoparticles" *submitted to ACS Nanoscale*
[5] M. S. Saleh, M. Nicholas, E Yttri, R. Panat, "**3D printed flexible ultra-dense micro electrode arrays**" In progress
[6] R. Garg, M. S. Saleh, S. Rastogi, R. Panat, T. Cohen Karni, "Micro crafted nano structure over templated three-dimensional fuzzy graphene" In progress
[7] M. S. Saleh, R. Bezbaruah, R. Panat, "Slicing algorithm for efficient lattice structure 3D printing" In progress
[8] M. S. Saleh, S. Bajaj, M. Forssell, G. Fedder, R. Panat, "Customized 3D printed flexible electronics" In progress
[8] M. Kordbacheh, A. Yousefi-Koma, M. S. Saleh, and H. Soorgee, "Application of wavelet transformation as a signal processing method for defect detection using lamb wave signals", ISME Journal, V15-1-P4 (2014)
[9] M. S. Saleh, A. Yousefi-Koma, and M. Barimani, "Modification of The Natural Frequency Pattern of a Cantilever Beam Using Topology Optimization Method", X-Mech Conf, Vol.1, pp-49 (2013)

PATENTS, NATIONAL AWARDS, AND RECOGNITIONS

- R. Panat, M. S. Saleh "Additive manufacturing of porous scaffold structures", (U. S. Patent Application # 14/957,849)
- T. Cohen Karni, R. Panat, R. Garg, M. S. Saleh, S. Rastogi, "Nanowire templated three-dimensional fuzzy graphene" (CMU dockets: 2017-154 and 2018-142 Patent Application)
- R. Panat, E. Yttri, M. S. Saleh "3D Printed Microelectrode Array (CMU Array) (CMU dockets: 2017-133)
- Patent No. A/89 038302 Long range ultrasonic health monitoring system for gas pipelines 2013
- Winner of "Dr. Chamran's National Award for Innovation and Entrepreneurship 2012
- Silver medal winner of Annual Al-Khwarizmi Young Mathematicians Festival 2004

TEACHING EXPERIENCE

Carnegie Mellon University, Lecturer Pittsburgh, PA

- Introduction to MATLAB for graduate students 2018

Washington State University, Teaching Assistant Pullman, WA

- Design for Manufacturing and Modern Manufacturing (ME.474) Engineering design (ME.415) 2017
- Integrated CAD -SolidWorks- (ME.216) CAD and Visualization (ME.116), Sys Design (ME.316) 2016
- Machine Element Design (ME.414) 2015

MEDIA APPREANCES

2017: Research on 3D micro-fabrication was highlighted in several tech magazines

- Materials Today: "Novel 3D printing method goes up and down the scale"
- 3-D Printing Industry: Groundbreaking advance in nanoparticle 3D printing mimics natural construction in the desert
- Science Daily: "Novel 3-D manufacturing leads to highly complex, bio-like materials"
- Yahoo News: "Scientists create ultra-light, super strong new material based on wood and bone"

2018: Research on 3D printed microlattice batteries

- *** Forbes: "See How This New 3D Printing Method Could Make Your Smartphone Last Longer"
- CMU news: "3D printing the next generation of batteries"
- New Atlas: "3D-printed electrodes add a whole new dimension to lithium batteries"
- AZOMaterials: "A Revolutionary Method to Fabricate Battery Electrodes Using Aerosol Jet 3D Printing"
- GEEK: "3D-Printed Batteries Could Mean Lightweight, Longer-Lasting Electronics"
- AMazing: "3D Printing the Next Generation of Batteries"