

JIANYI DU, Ph.D.

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SUMMARY

- MIT Ph.D. in Mechanical Engineering specialized in **rheology of soft matter** and **material characterization**.
- Currently a Postdoctoral Scholar at Stanford University specialized in **optimization of organ-scale and scaffold-free biofabrication for hiPSCs and cardiac tissues**.
- Developing research interest in leveraging soft matter mechanics to bring innovations for **automatic, scalable and optimized additive manufacturing and biotechnology**.

Extensive experience in

Soft matter mechanics & material science

- rheological modeling ■ polymer physics
- fluid mechanics ■ applied mathematics
- numerical computation (CFD: MATLAB, OpenFOAM; MD: lammps; LBM; etc)
- material characterization techniques (rheometer, DMA, Instron, FTIR, UV-Vis, DSC/TGA, spectroscopy, SEM/TEM, AFM, GPC, DLS)

Tissue engineering and biomanufacturing

- extrusion-based and stereolithography 3D printing
- organoid bioprinting ■ sacrificial printing
- tissue culturing (iPSC, cardiomyocytes, HNDF, etc)

Instrument design

- PCB design ■ soft photolithography (microfluidics)
- Internet of Things (IoT)

Programming

- software design (Python/C/C++/MATLAB/Node.js)
- data analysis (Python/MATLAB)
- image processing (Python/OpenCV/ImageJ)

Manufacturing

- manual/CNC machining ■ 3D printing
- laser cutting ■ water jetting
- hot stamping (fundamental research)

EDUCATION

Massachusetts Institute of Technology (MIT)

Ph.D. in Mechanical Engineering (GPA: 4.9/5.0)

Dissertation: Advanced Rheological Characterization of Nanofilled Materials for Automotive Applications

S.M. in Mechanical Engineering

Cambridge, MA, USA

Sept. 2018 – October 2021

Sept. 2016 - June 2018

Purdue University (PU)

B.S. in Mechanical Engineering, with *Highest Distinction* (GPA: 3.99/4.00)

West Lafayette, IN, USA

Sept. 2014 - May 2016

Shanghai Jiao Tong University (SJTU)

B.S. in Mechanical Engineering, with *Highest Distinction* (GPA: 3.82/4.30)

Shanghai, China

Sept. 2012 - June 2016

PROFESSIONAL EXPERIENCE

Postdoctoral Scholar @ Skylar-Scott Lab, Stanford University

Advisor: Prof. Mark A. Skylar-Scott

Biofabrication of Scaffold-Free Tissue Constructs at Scale Using Principles of Bioprinting and Rheology

May 2022 – Present

- **Developed a constitutive framework** based on the Herschel-Bulkley model with additional thixotropic terms to describe the flow dynamics of organoid-based bioinks from multiple cell types to **enable large-scale tissue bioprinting** that approaches the size and cell density of native human tissues. ^[2]
- **Developed a scaffold-free bioprinting method** to fabricate complex three-dimensional structures from organoid-based bioinks in biocompatible support baths with modified elasto-viscoplastic properties that simultaneously **promote the maturation of printed constructs**. ^[patent pending]
- **Developed a rapid vascularization method** for dense tissue constructs using principles of fluid dynamics and the yield-stress rheology of bioinks to achieve a perfusable vascular network that **spans from cm to sub-mm size** and adheres to physiological characteristics.
- **Developed a rapid and cost-effective method** for an organ-scale production of biocompatible microgels as support bath using principles of fluid dynamics for organoid-based biomanufacturing. ^[in progress]

- **Designed a capillary rheometer** comprised of 3D-printed and off-the-shelf components that enables measuring and visualizing complex flow behavior simultaneously under wireless Internet-of-Things protocols, appealing to **rapid, customizable and high-throughput** rheological assays under controlled environments (biosafety cabinets, fridge or CO₂ incubator).^[1]
- **Demonstrated the accuracy and applicability** of this instrument on a manufactured prototype with a range of benchmark **biological fluids**, including common Newtonian fluids, polymer solutions and granular suspensions that are widely used in biofabrication.
- Demonstrated the capability of **measuring hemodynamics** by inducing a secondary geometry (e.g., hyperbolic) inside the flow channel via **stereolithography printing**.
- Actively **maintaining an open-source repository** with designs and instructions.

Research Assistant @ Non-Newtonian Fluid Dynamics Group, MIT

Advisor: Prof. Gareth H. McKinley

Recycling and Regeneration of Cellulosic Fabrics Using Ionic Liquids (IL) Through Fiber Spinning

(Jointly sponsored by MISTI-Spain)

Oct. 2019 – Oct. 2021

- Developed a constitutive framework featuring a grand time superposition law to **understand the dynamics of spinning dope**, i.e., cellulose fibers dissolved in IL solutions, and proposed guidelines of optimal spin parameters for the cellulose/IL solutions at varying concentrations, molecular weights and types of functional groups in the IL solvents.^[6]
- Developed a method that combines rheology, birefringent optics and structural analysis to **rapidly predict rheo-optic evolution** of cellulose fibers during spinning process under different spin parameters, an *in situ* configuration that paves the pathway to **an optimal scalable clothes recycling line**.^[3]
- Developed a **fabrication method** using spinning and 3D printing to weave fabrics with **spatially heterogeneous properties**, showcasing the production of highly customizable fabrics from recycled cellulose. ^[patent pending]

Advanced Rheological Characterizations for Inks Used in Fused Filament Fabrication Process

Oct. 2016 – Oct. 2021

- Designed and constructed a **Capillary Breakup Extensional Rheometer (CaBER)** to rapidly measure the extensional rheology of small-volume complex fluids (20 μ L) that **outperforms commercial equivalents** in operation, accuracy and customizability, with the addition of environment-control features that appeal to measurements of biomaterials under physiological conditions.^[4]
- Proposed a **unified constitutive framework for concentrated polymer solutions/melts**, representative of materials used in fused filament fabrication, to model their transient **mechanical responses under extrusion process** in order to evaluate and further optimize the manufacturing of different types of filaments.^{[3][7]}
- Developed a **computational fluid dynamics (CFD) method** to quantify the non-linear extensional rheology of complex viscoelastic fluids, addressing how even a weakly elastic term can **significantly modify the extrusion dynamics**, while the mechanical responses under pure shear flow are almost unaffected.^[5]
- Proposed a statistics- and machine-learning-based protocol to **automatically identify an optimal and properly regularized constitutive model** from the measurements of **an unknown complex fluid** to enable high-throughput screening of material properties.^[5]


Product Design Intern @ Ford Motor Company Greenfield Labs

Palo Alto, CA. June 2020 - Aug 2020

- Exploring **quantum-inspired algorithms to solve Navier-Stokes equation** using discrete fourth-order stream functions and transformed into an optimization problem, demonstrated with the **benchmark lid-cavity flow**.

SELECTED PUBLICATIONS & PRESENTATIONS

Journal papers (a full publication list can be found on Google Scholar)

- [1] **Jianyi Du**, Stacey Lee, Soham Sinha, Fredrik S. Solberg, Debbie L. L. Ho, Joshua P. Sampson, Qiuling Wang, Tony Tam, Mark A. Skylar-Scott. “A Visual, In-Expensive, and Wireless Capillary Rheometer for Characterizing Wholly-Cellular Bioinks”, *Small*, 2023, 20, 17.
 <https://github.com/dujyanyi/viewr-repo.git>
- [2] Debbie L. L. Ho, Stacey Lee, **Jianyi Du**, Jonathan D. Weiss, Tony Tam, Soham Sinha, Danielle Klinger, Sean Devine, Art Hamfeldt, Hope T. Leng, Jessica E. Herrmann, Mengdi He, Lee G. Fradkin, Tze Kai Tan, David Standish, Peter Tomasello, Donald Traul, Noushin Dianat, Rukmini Ladi, Quentin Vicard, Kishore Katikireddy, Mark A. Skylar-Scott. “Large-Scale Production of Wholly Cellular Bioinks via the Optimization of Human Induced Pluripotent Stem Cell Aggregate Culture in Automated Bioreactors”. *Adv. Healthcare Mat.* 2022. 2201138.
- [3] **Jianyi Du**, Javier Páez, Pablo Otero, Pablo B. Sánchez. “Rapid in situ quantification of rheo-optic evolution for cellulose spinning in ionic solvents”. *Carbohydrate Polymers*. 2023. 320, 121229.
- [4] **Jianyi Du**, Hiroko Ohtani, Crystal E. Owens, Lenan Zhang, Kevin Ellwood, Gareth H. McKinley. “An improved Capillary Breakup Extensional Rheometer to characterize weakly rate-thickening fluids: Applications in synthetic automotive oils”. *J. Non-Newtonian Fluid. Mech.* 2021. 104496.
- [5] **Jianyi Du**, Hiroko Ohtani, Kevin Ellwood, Gareth H. McKinley. “Capillarity-driven thinning and breakup of weakly rate-thickening fluids”. *J. Non-Newtonian Fluid. Mech.* 2024. 105294.
- [6] Crystal E. Owens*, **Jianyi Du***, Gareth H. McKinley, Pablo B. Sánchez. “Understanding dynamics of cellulose dissolved in an ionic solvent under shear and extensional flow”. *Biomacromolecules*. 2022. 23, 5, 1958–1969. (*contributed equally)
- [7] **Jianyi Du**, Hiroko Ohtani, Alper Kiziltas, Kevin Ellwood, Gareth H. McKinley. “Capillarity-driven thinning dynamics of entangled polymer solutions”. *Macromolecules*. 2025. 5c00782.
- [8] Jingyu Pei, Lenan Zhang, **Jianyi Du**, Xiaoshun Zhuang, Zhaowei Zhou, Shunkun Wu, and Yetian Zhu. A model of tool wear in electrical discharge machining process based on electromagnetic theory. *Int. J. Mach. Tools Manuf.* 2017; 117:31-41.
- [9] Lenan Zhang, **Jianyi Du**, Xiaoshun Zhuang, Zhiliang Wang, and Jingyu Pei. Geometric prediction of conic tool in micro-EDM milling with fix-length compensation using simulation. *Int. J. Mach. Tools Manuf.* 2015; 89:86-94.

Research Conferences:

Jianyi Du, Stacey Lee, Debbie Ho, Soham Sinha, Mengdi He, Mark A. Skylar-Scott. “Tuning the Rheology of Wholly-Cellular Bioinks for Bioprinting” (April 21, 2023). *Society for Biomaterials 2023 Annual Meeting*. San Diego, CA USA.

Jianyi Du, Pablo B. Sanchez, Crystal E. Owens, Gareth H. McKinley. “Characterization of the spinnability of cellulose/ionic liquid spinning dopes during a dry-jet wet-spinning process through in-situ rheo-optic techniques” (November 15, 2021). *2021 AIChE Annual Meeting (virtual)*. Boston, MA USA.

Jianyi Du, Hiroko Ohtani, Kevin Ellwood, Gareth H. McKinley. “Exploring the origins of the distinct relaxation times measured in shear and extensional rheometry for concentrated polymer solutions” (October 11, 2021). *Society of Rheology 92nd Annual Meetings*. Bangor, ME USA.

Jianyi Du, Hiroko Ohtani, Kevin Ellwood, Gareth H. McKinley. “Characterizing the extensional rheology of weakly elastic fluids using capillary breakup technique: an experimental and numerical study” (October 21, 2019). *Society of Rheology 91st Annual Meetings*. Raleigh, NC USA.

Jianyi Du, Hiroko Ohtani, Gareth H. McKinley, Kevin Ellwood. “Characterizing the weakly elastic rheological behaviors of automotive lubricants through an improved Capillary Breakup Extensional Rheometer” (October 15, 2018). *Society of Rheology 90th Annual Meetings*. Houston, TX USA.

Symposia:

Jianyi Du, Gareth H. McKinley. “Rheological Characterizations of Weakly Elastic Automotive Lubricants Using Capillary Breakup Extensional Rheometer (CaBER)” (April 2019). *MIT Polymer Day 19*. Cambridge, MA.