

JOSEPH THOMAS TOOMBS

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EDUCATION

PhD candidate, Mechanical Engineering
University of California, Berkeley, CA

Expected May 2024

B.S., Mechanical Engineering
University of Illinois, Urbana-Champaign, IL

May 2018

RESEARCH EXPERIENCE

UCB Dept. of Mechanical Engineering **2018 – Present**

PhD student in Design for Emerging and Nanoscale Manufacturing Lab of Prof. Hayden Taylor

- Constructed optomechanical system for volumetric additive manufacturing (VAM) of silica glass microstructures
- Optimized photochemistry with real-time FTIR spectroscopy and demonstrated 10× reduction in minimum feature size compared to prior VAM system in the lab
- Published work in *Science*
- Designed optical and mechanical systems for novel roll-to-roll microscale VAM system involving use of electrically tunable lens and galvanometer mirrors; validated resolution with optical design software
- Published work in *SPIE Advanced Lithography* and presented work at International Conference on Micro- and Nano-devices Enabled by R2R Manufacturing
- Engineered solid-state photosensitive gel material to enable 3D printing of large arrays of microstructures on flexible substrates with roll-to-roll microscale VAM system
- Published work in *Macromolecular Rapid Communications*
- Developed novel real-time tomographic refractive index optical metrology technique for observation of photopolymerization kinetics in resin-based 3D printing
- Published work in *SPIE LASE* and *ACM Symposium on Computational Fabrication*

UIUC Dept. of Mechanical Engineering **2015 – 2018**

Undergraduate Research (Manufacturing)

- Developed a low-cost process for manufacturing laminated flexure-based composite micro machines
- Designed and constructed 3-axis parallel kinematics stage capable of 1 μm resolution in a 4 mm radius
- Published work in *Journal of Manufacturing Processes*
- Researched precision machine design for single-point diamond turning for micro lens applications involving work with aerostatic and hydrostatic linear actuators, flexure stages, and interferometers

ADDITIONAL WORK EXPERIENCE

NASA Marshall Space Flight Center (MSFC), Huntsville, AL
Research Associate (Space Hardware and Robotics Academy)

Summer 2017

- Designed and developed a test bed for soldering investigations in microgravity on interdisciplinary team of 4 interns
- Published work in *Gravitational and Space Research*

LEADERSHIP AND TEAMWORK

UCB Dept. of Mechanical Engineering

- Berkeley student representative in NSF NASCENT ERC (UT Austin, Texas)
 - Secured a grant for \$400,000 for evaluation of VAM technology on a parabolic microgravity test flight
 - Led team of 2 undergraduate and 2 early-stage graduate students in the design and manufacturing phase of the microgravity project
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TECHNICAL SKILLS

Experimental: Optical: FTIR, UV-Vis spectroscopy, interferometry, confocal microscopy, optical system design, Mechanical: rheology, tension/compression/flexural testing, Micro/nanofabrication: basic photolithography and mask design, microfluidics

Computational: Programming: Python, Matlab, Optical simulation: Zemax Optic Studio, tomographic reconstruction, phase retrieval, CAD: Autodesk Inventor, Solidworks, AutoCAD, Autodesk Simulation Mechanical, Creo Parametric, Keyshot, Word/graphics processing: Microsoft Office, Adobe Illustrator

GRANTS/AWARDS

NASA Technology Advancement Utilizing Suborbital Flight Opportunities

Hayden Taylor and Joseph Toombs. (2021). Evaluation of Computed Axial Lithography for rapid, volumetric additive manufacturing under low-gravity conditions.

PUBLICATIONS

Joseph T. Toombs, Ingrid K. Shan, Hayden K. Taylor. (2023). Ethyl Cellulose-Based Thermoreversible Organogel Photoresist for Sedimentation-Free Volumetric Additive Manufacturing. *Macromolecular Rapid Communications* 44.

Quinten Thijssen, Astrid Quaak, **Joseph Toombs**, Elly De Vlieghere, Laurens Parmentier, Hayden Taylor, Sandra Van Vlierberghe. (2023). Volumetric Printing of Thiol-Ene Photo-Cross-Linkable Poly(ϵ -caprolactone): a Tunable Material Platform serving Biomedical Applications. *Advanced Materials*.

Joseph T. Toombs, Manuel Luitz, Caitlyn C. Cook, Sophie Jenne, Chi Chung Li, Bastian E. Rapp, Frederik Kotz-Helmer, and Hayden K. Taylor. (2022). Volumetric Additive Manufacturing of Silica Glass with Microscale Computed Axial Lithography. *Science* 376.

Charles M. Rackson, **Joseph T. Toombs**, Martin P. De Beer, Caitlyn C. Cook, Maxim Shusteff, Hayden K. Taylor, and Robert R. McLeod. (2022). Latent Image Volumetric Additive Manufacturing. *Optics Letters* 47.

Chi Chung Li, **Joseph Toombs**, Sui Man Luk, Martin De Beer, Johanna Schwartz, Maxim Shusteff, and Hayden Taylor. (2022). Computation optimization and the role of optical metrology in tomographic additive manufacturing. In *SPIE LASE: Advanced Fabrication Technologies for Micro/Nano Optics and Photonics 2022*. Best paper award.

Joseph Toombs, Chi Chung Li, Hayden Taylor. (2021). Design of a Tomographic Projection Lithography System and Material for Roll-to-Roll Fabrication of 3D Microstructures. In *Proceedings of the 2021 International Conference on Micro- and Nano-devices Enabled by R2R Manufacturing*.

Joseph Toombs and Hayden K. Taylor. (2021). Design of a tomographic projection lithography process for roll-to-roll fabrication of 3D microstructures. In *SPIE Advanced Lithography: Novel Patterning Technologies 2021*.

Indrasen Bhattacharya*, **Joseph Toombs***, and Hayden Taylor. (2021). High fidelity volumetric additive manufacturing. *Additive Manufacturing* 47.

William S. Harley, Chi Chung Li, **Joseph Toombs**, Cathal D. O'Connell, Hayden K. Taylor, Daniel E. Heath, and David J. Collins. (2021). Advances in biofabrication techniques towards functional bioprinted heterogeneous engineered tissues: a comprehensive review. *Bioprinting* 23.

Charles M. Rackson, Kyle M. Champley, **Joseph T. Toombs**, Erika J. Fong, Vishal Bansal, Hayden K. Taylor, Maxim Shusteff, and Robert R. McLeod. (2021). Object-space optimization of tomographic reconstructions for additive manufacturing. *Additive Manufacturing* 48.

Kevin Coulson, **Joseph Toombs**, Magnus Gu, and Hayden Taylor. (2021). Adaptive voxelization for rapid projection generation in computed axial lithography. In *Solid Freeform Fabrication 2021: Proceedings of the 32nd Annual International*, Austin, Texas.

Chi Chung Li, **Joseph Toombs**, and Hayden Taylor. (2020). Tomographic color Schlieren refractive index mapping for computed axial lithography. In *Proceedings - SCF 2020: ACM Symposium on Computational Fabrication*.

Shannen Daly, Micah Hardyman, James Ragan, **Joseph Toombs**, Tracie Prater, and Richard N. Grugel. (2017). MMaJIC, an Experimental Chamber for Investigating Soldering and Brazing in Microgravity. *Gravitational and Space Research* 5, 2.

Jorge E. Correa, **Joseph Toombs**, Nicholas Toombs, and Placid M. Ferreira. (2016). Laminated micro-machine: Design and fabrication of a flexure-based Delta robot. *Journal of Manufacturing Processes* 24.

* indicates equal contribution

CONFERENCE PRESENTATIONS

Joseph Toombs, Chi Chung Li, Hayden Taylor. (2021). Design of a Tomographic Projection Lithography System and Material for Roll-to-Roll Fabrication of 3D Microstructures. In *2021 International Conference on Micro- and Nano-devices Enabled by R2R Manufacturing*.

Hayden Taylor, **Joseph Toombs**, Chi Chung Li, Sui Man Luk, Weisa Wang, Ingrid Shan, Vishal Bansal, and Alexander Watson. (2021). Emergence of Multi-Material Volumetric Additive Manufacturing—Overprinting and Particle Inclusion. In *MRS SF02: Additive Manufacturing—From Material Design to Emerging Applications*.

Hayden K. Taylor, **Joseph Toombs**, Sui Man Luk, Samira Feili, Hossein Heidari, Chi Chung Li, Vishal Bansal, Kevin Coulson, and Elyas Goli. (2021). Modeling of light propagation in computed axial lithography with photopolymers. In *SPIE OPTO: Emerging Digital Micromirror Device Based Systems and Applications XIII*.
