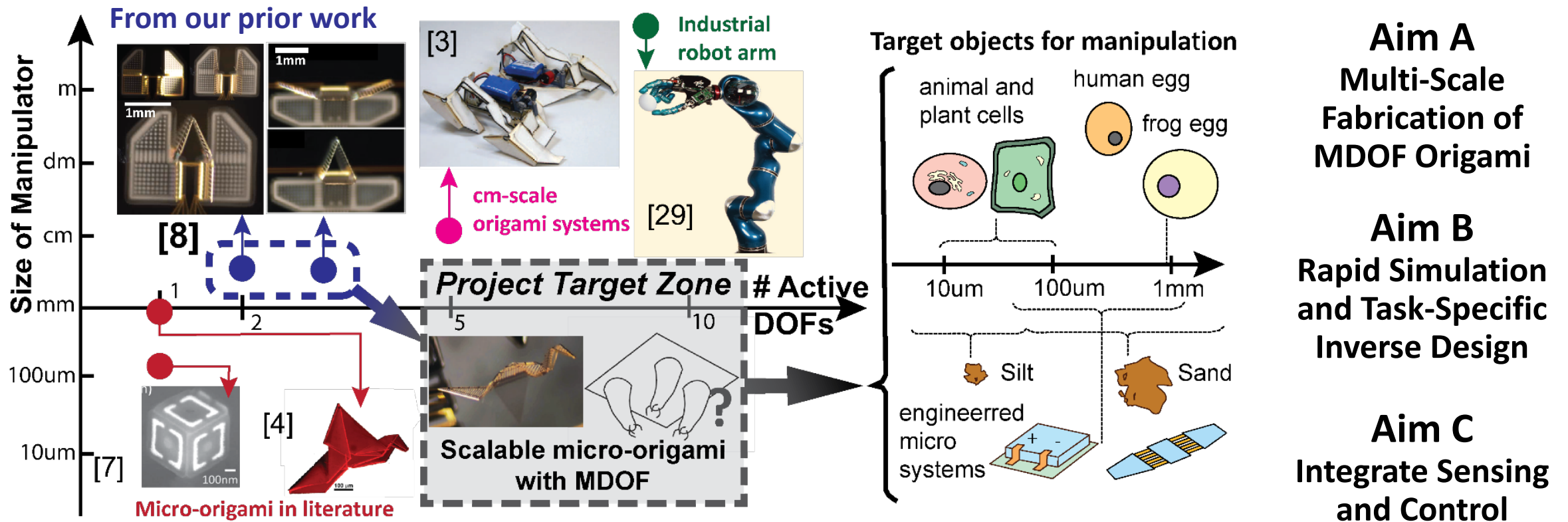


# Origami for Dexterity in Miniature Manipulation and Testing

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CMMI FRR#2054148  
Award Date: 05/11/2021

**Objective:** To establish an integrated methodology for fabrication, analysis, design, sensing, and control of multi-degree-of-freedom (MDOF) miniature origami for dexterous manipulation and testing of physical matter

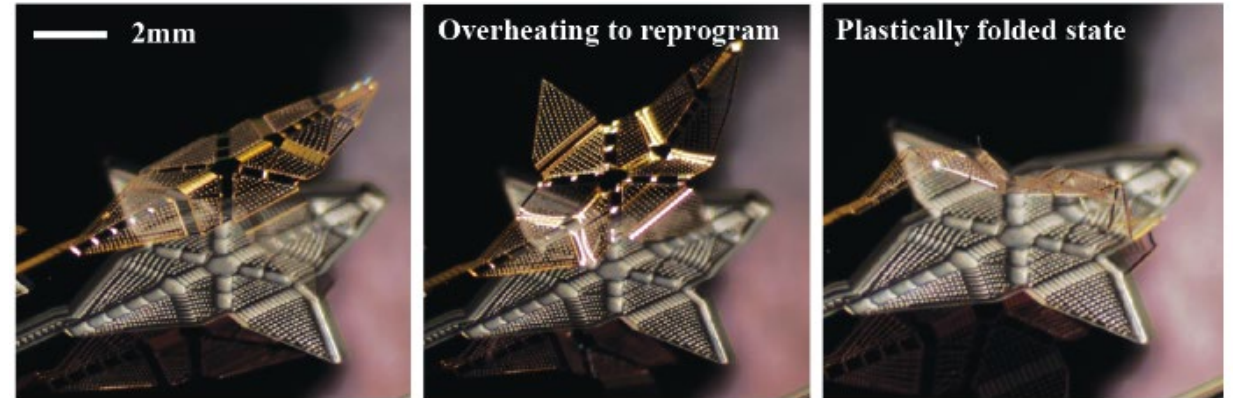
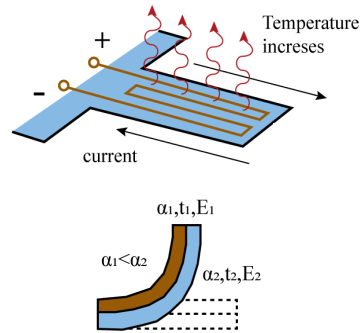
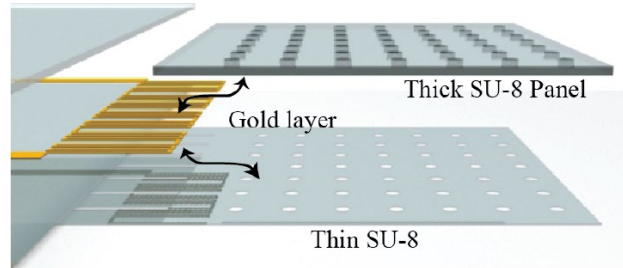


# Origami for Dexterity in Miniature Manipulation and Testing

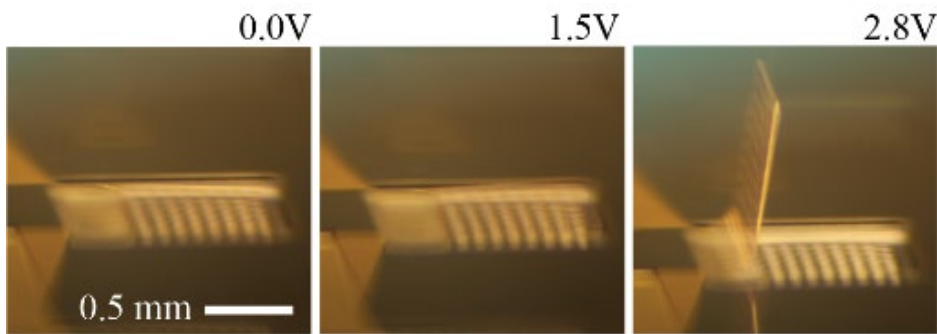
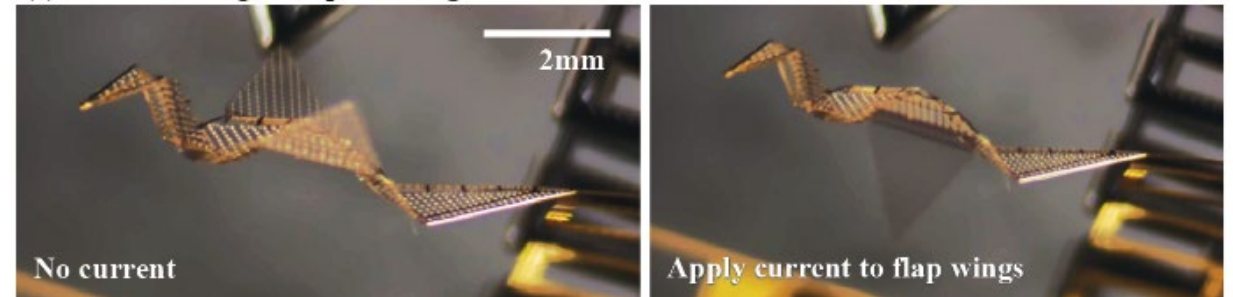
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## Electro-Thermal Micro-Origami with MDOF



(c) Elastic folding to flap the wings



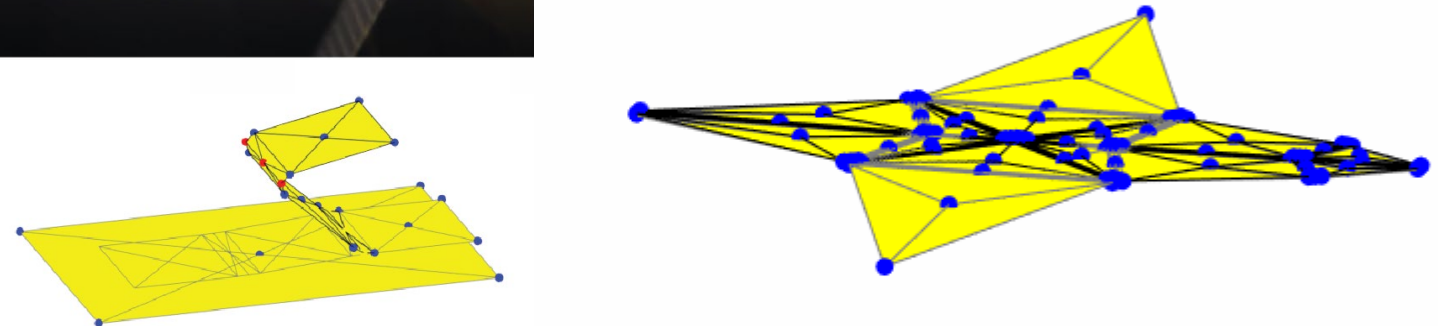
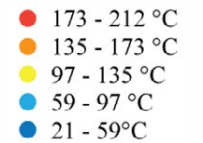
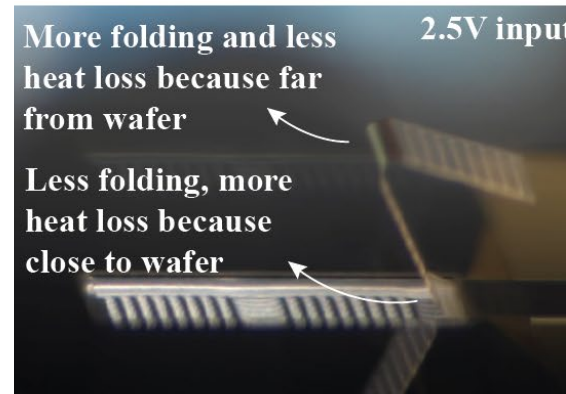
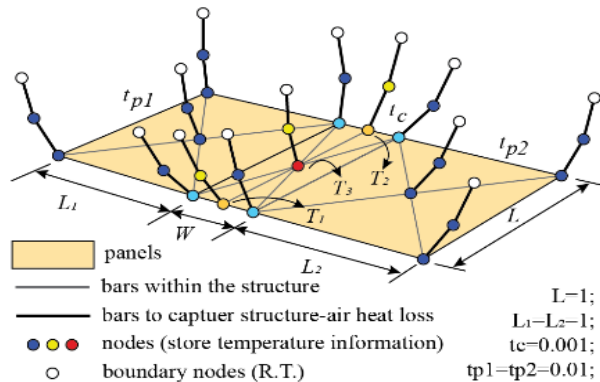
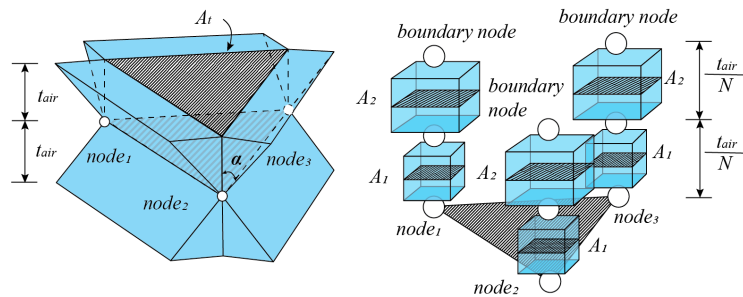
[1] Zhu, Birla, Oldham, and Filipov (2020) *Advanced Functional Materials*

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## Simulation of Electro-Thermo-Mechanical Coupling in Micro-Origami



[2] Zhu and Filipov (2021) *Int. J. Mech. Sciences*

[3] Zhu and Filipov (2021) *ASME IDETC*

<https://drsl.engin.umich.edu/software/swomps-package/>

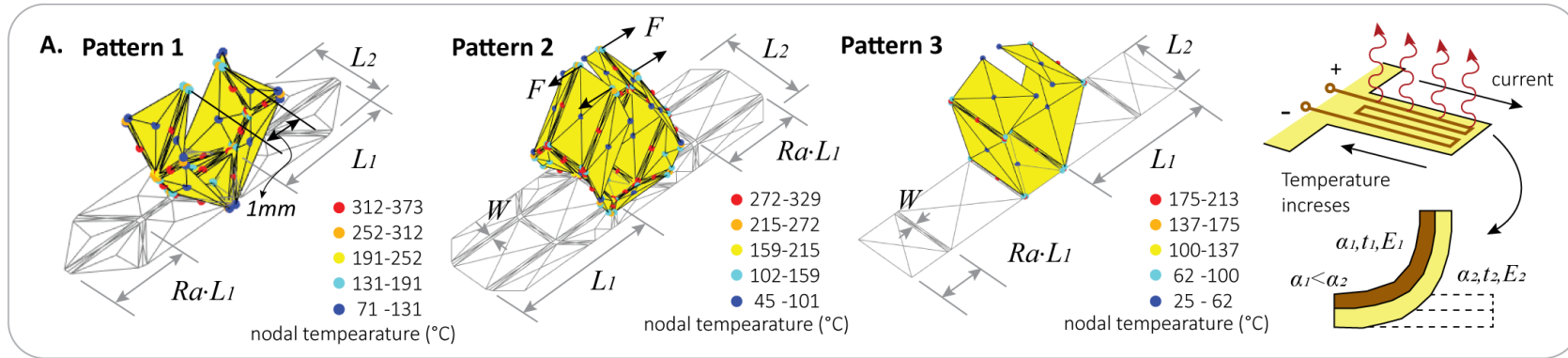


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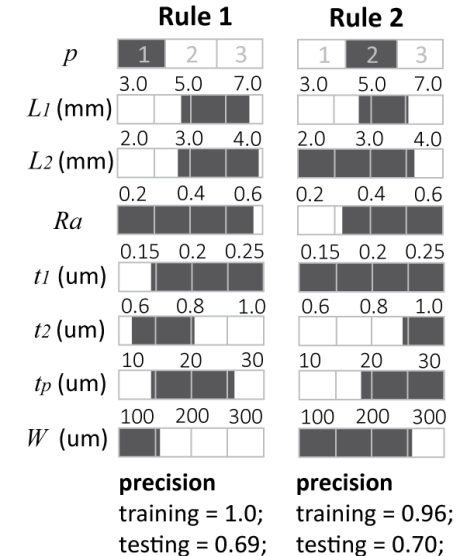
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## Machine Learning for Inverse Design of Active Origami

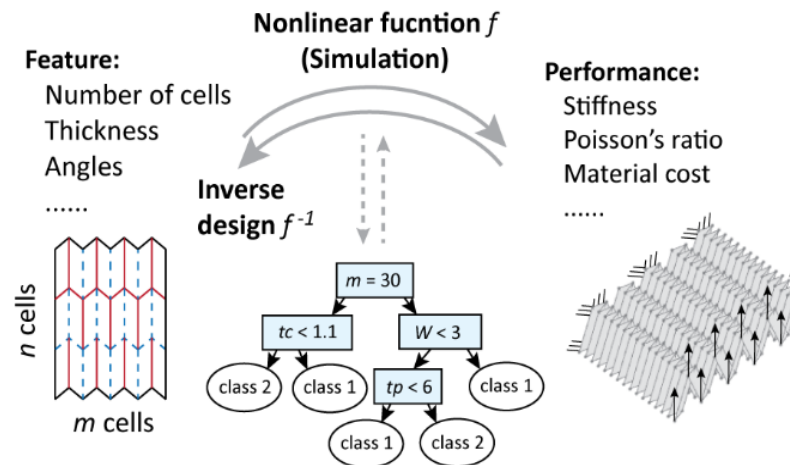


### D. Target 3 (12% of total datapoints)

$35\text{Hz} < \text{freq} < 50\text{Hz}$ ;  
 $0.3\text{W} < \text{heating power } Q$ ;



[4] Yi Zhu, Evgueni T. Filipov, 2022, Origami Feature Design and Pattern Selection with Interpretable Machine Learning. (In Preparation)

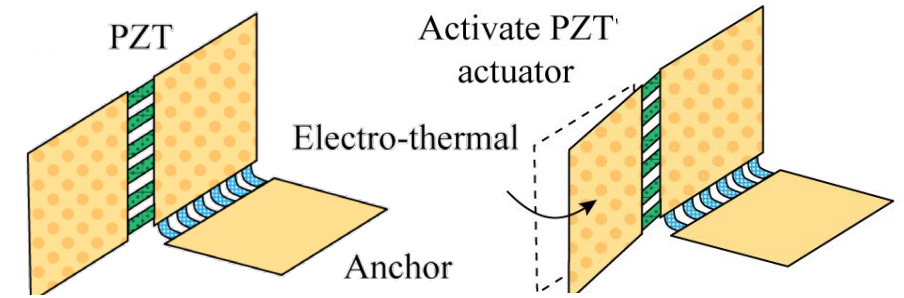
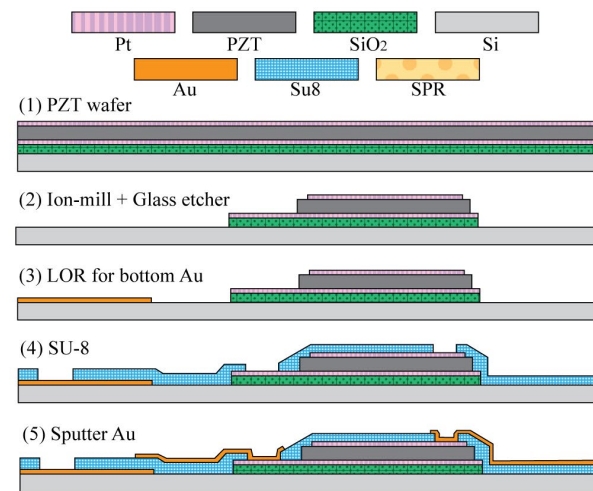
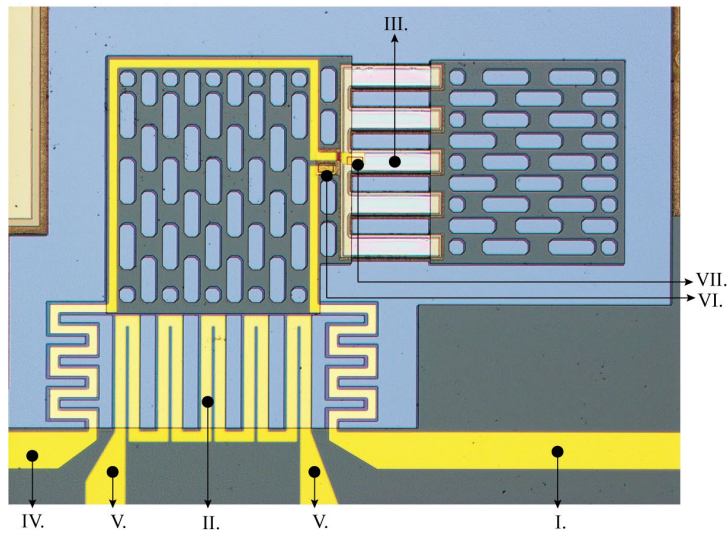


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## Integration of PZTs for Mechanical Sensing and Control



[5] Yi Zhu, Joonyoung Yu, Kenn R. Oldham, Evgueni T. Filipov, 2022, Folding 3D Thin-Film PZT Micro-Systems Using Electro-Thermal Actuation. (In Preparation)

