Manufacturing Science & Technology
Room Ballroom A - Session MS-ThP

Manufacturing Science & Technology Poster Session

MS-ThP-1 Landing-Pad Geometry Engineering for Contact-Access Margin in Scaled Semiconductor Manufacturing*, Dong Kyun Lim,* Department of Semiconductor and Display Engineering, Sungkyunkwan University (SKKU), Suwon, Republic of Korea

As memory-cell dimensions continue to shrink, the connection between capacitor lower electrodes and landing-pad structures becomes increasingly sensitive to local overlay error, landing-area loss, CMP/topography variation, and contact-interface geometry. This poster presents a public-disclosure-based manufacturing framework for landing-pad geometry engineering in scaled semiconductor memory integration. The framework is based on a landing-pad structure in which a lower landing pad, an upper landing pad with a cavity, and a conductive pattern in the cavity form additional contact-access geometry for a capacitor lower electrode.The objective is to treat landing-pad geometry as a process-margin design variable rather than only as a static interconnect feature. The proposed analysis maps key integration risks: capacitor-electrode shift from the landing pad, reduced effective contact area, contact-resistance increase, CMP-induced topography variation, and leakage/capacitance distribution spread. A qualitative failure-mode and effects analysis compares a conventional landing-pad contact scheme with a geometry-assisted landing-pad concept, identifying expected observable signatures and required metrology for each risk.The proposed validation path combines cross-sectional SEM/TEM, CD and overlay metrology, landing/contact-area extraction, capacitor contact-resistance monitoring, leakage and capacitance distribution, and optional process/device simulation. This work does not claim unpublished process recipes, product implementation, measured yield improvement, or node-specific dimensions. The intended contribution is a manufacturing-science poster framework showing how local landing-pad geometry can link process margin, contact accessibility, and device-level electrical robustness in scaled memory structures.

MS-ThP-2 Design of Ultra-Low Flow Microfluidic Peristaltic Pump for Neural Probe Based Drug Delivery with Refillable Reservoir*, Haowei Ma,* *Allison Hess-Dunning, Melinda Lake-Speers,* Case Western Reserve University

Localized neurotherapeutic delivery requires compact microsystems that can store therapeutic agents, support repeated replenishment, and deliver small fluid volumes through a stable neural interface. Here, we present a tubing-based refillable microfluidic peristaltic pump for integration with a mechanically adaptive neural probe to deliver fluid at 0.15 microliters/hour. The device combines drug storage, tubing guidance, motor alignment, and rotary actuation within a compact footprint.

The pump was designed in SolidWorks as an integrated assembly containing a refillable reservoir, tubing groove, actuator chamber, and motor interface. A flexible microbore tube forms the fluid pathway and is seated within the groove to define the pumping region. The reservoir connects to the tubing inlet, while the outlet can be coupled to a downstream neural probe or other delivery module. A motor-driven rotary actuator periodically compresses the tubing to generate peristaltic displacement. The geometry maintains actuator-tubing alignment, limits tubing migration, and supports reproducible compression during low-speed rotation.

Housing and actuator components were fabricated from Anycubic Bio Resin by high-resolution resin-based 3D printing. Printed parts were washed in isopropyl alcohol, UV-cured, and inspected to confirm clearance in the tubing groove, rotor chamber, reservoir interface, and motor alignment region. During assembly, microbore tubing was manually seated into the printed pathway and connected between the reservoir and outlet. The geared micromotor was positioned in the alignment region and coupled to the rotary actuator for low-speed operation.

Preliminary proof-of-concept testing evaluated the mechanical and fluidic function of the assembled device. The pump was driven by a benchtop power supply at 0.5 to 3 V while the tubing compression region and outlet segment were observed under microscopy. Evaluation focused on actuator rotation, periodic tubing deformation, structural stability, fluid containment, and visible directional movement of liquid or air bubbles. These observations confirmed that the printed housing, flexible tubing, motor, and actuator can function together as a compact peristaltic pumping module.

This work demonstrates a modular tubing-based refillable pump architecture for localized neurotherapeutic delivery. Future work will quantify empirical flow rate to meet the target, low-speed stability, leakage resistance, and long-term operation, supporting integration with wearable neural probe interfaces for chronic localized therapy.

MS-ThP-3 Distal Electrofabrication of Chitosan Membranes on Printer Paper: A New Manufacturing Paradigm*, Phuc Long Duong,* *Xiaolong Luo,* Catholic University of America

Traditional fabrication of biopolymer membranes relies heavily on solution casting or direct electrodeposition onto electrode surfaces. These methods restrict production scalability and limit control over the resulting material properties. This work introduces a novel macroscale manufacturing paradigm: distal electrofabrication of freestanding chitosan membranes directly onto a low-cost printer paper scaffold. By separating the fabrication site from the physical electrodes, this system enables membrane growth that is independent of electrode size, unlocking a highly scalable pathway for thin-film manufacturing.

The manufacturing setup utilizes two 3D-printed fluidic chambers containing a 0.5% w/v chitosan solution (pH 5.5) and a companion buffer solution. A regular piece of printer paper is sandwiched between the chamber apertures to serve as a porous interfacial matrix. By applying a direct current across the sandwiched fluidic chambers via remotely located platinum electrodes, a uniform chitosan thin film assembles directly on the paper surface. Crucially, the process offers precise controllability over the membrane's physical properties. Adjusting the current density (5 - 60 A/m^2) and deposition time (10 – 60 minutes) allows fine-tuning of the membrane thickness (a few hundred microns).

Material characterization confirms that the electrofabrication process microaligns the biopolymer's internal structure as compared to traditional casting. Electrochemical impedance spectroscopy (EIS) and tensile testing reveal that molecular alignment alters internal porosity, mechanical properties, and ionic pathways. This versatile, paper-supported fabrication technique provides a cost-effective, controllable blueprint for manufacturing high-performance biopolymer thin films for energy and electromechanical systems.

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