Multi-Nozzle E-Jet Process Development

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Goals
Use MEMS and microfluidic technologies to fabricate multiple nozzle E-jet arrays.
Address integration, testing, and characterization of the devices.

Research Results
Fabrication:
(i) Microfabricated Si layer
- Electrodes on nozzle side of die.

(ii) PDMS microfluidic layer for ink delivery
- Plasma-bonded or vacuum-sealed to toolbit layer.
- Inlet and outlet channels for individually addressable nozzles.

Printing:
(i) Meniscus formation:
- Meniscus forms Taylor cone shape.

(ii) 1-D printing:
- Line width decreases from 30 µm to 30 µm by increasing substrate speed.
- Lines uniform along length.

(iii) 2-D printing:
- Printed spot sizes are consistent ~ 30 µm.
- Substrate is at angle with respect to nozzles.

Mapping to Center’s Objectives
- Provides a scalable approach towards fabricating large scale MEMS nozzle arrays.
- Enables future integration of 2 or 3-DOF nanopositioning stages with the nozzle arrays.

Fundamental Issues
- Integration of microfabrication, microfluidics and electromagnetics into a viable E-jet manufacturing technology.
- Indexing and simultaneous printing from multiple nozzles.
- Use of instrumentation to sense and detect printing from individual nozzles of the toolbit.

Research Plan
- Develop a highly parallel process for fabrication of large scale MEMS nozzle arrays.
- Demonstrate printing with multiple nozzles simultaneously.
- Characterize process parameters for different inks.

Interaction with Other Projects

1. Toolbit Layer
2. Fluidic Layer
3. Instrumentation and Control
4. Simulation and Modeling

Challenges
- Alignment between toolbit and substrate
- Affects printing frequency.
- Nozzle and channel clogging
- Cleaning dies to remove residue.

Future Efforts
- Demonstrate printing with more than one nozzle simultaneously - print a humidity sensor.
- Characterization of process parameters.
- Fabricate Kapton fluidic layer to enable organic media.
- Current sensors to detect jetting.