Tooling and Integration for Processes: E-Jet, Transfer Printing and S4

Goals

- Develop toolbits for use in high throughput, flexible direct-write processes such as large-area contact stamping and transfer printing.
- Use MEMS technologies to fabricate integrated micro devices such as E-jet nozzles and nanopositioning stages.
- Address the integration and testing of these devices in a manufacturing process environment.

Research Results

E-jet Multiple Nozzles

- Overall design
- Fabrication
- Results

Large Area Superionic Stamping

- Embossed Ag\(_x\)(AgPO\(_3\))\(_{1-x}\) glass
- High ionic conductivity
- New Stamp Material: Ag\(_x\)(AgPO\(_3\))\(_{1-x}\) glass
  - Transparent for thru-stamp overlay alignment.
  - Faster etching rates due to increased conductivity.
  - Low \(T_g<100\)°C for easier production of large area stamps through thermal imprinting.
  - Glassy material removes grain boundary defects.

Interactions with Other Projects

- Transfer Stamping for Heterogeneous Integration
- Solid State Superionic Stamping for Metal Nanomanufacturing
- Electrohydrodynamic Jet Printing

Fundamental Questions/Challenges

- Use of instrumentation to sense and detect printing from individual nozzles of the toolbit.
- Active alignment between the toolbit and the substrate.
- Create nanoscale patterns with large planar superionic stamps.

Research Plan

- Develop a highly parallel process for fabrication of massively large nozzle arrays.
- Develop S4 printing with low \(T_g\) ionic conductive glass stamp.
- Combine 6-DOF positioning system with active stamping technologies.
- Demonstrate printing with multiple nozzles simultaneously.

Mapping to Center’s Objectives

- Provides a scalable approach towards fabricating large scale nozzle arrays.
- Enables future integration of 2 or 3-DOF nanopositioning stages with the nozzle arrays and superionic stamping.

Broader Impact

- REU program participation with 2 students.
- IAB presentation and poster to industry
- Use actuable and static ‘smart’ stamps for printing on unusual materials such as plastic, paper, or fabrics.
- Demonstrate printing with more than one nozzle simultaneously.
- Print a humidity sensor.
- Increase glassy S4 stamp resolution and area.

Future Efforts

- Automated transfer printing tool used to build large scale, geometrically expanded devices out of diverse materials.

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