1.5 Valving and Sensing Technologies for Microfluidics: Electrostatic Microvalves

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**Goals**

Develop and characterize a microvalve that is actuated with electrostatic forces and easily integrated into microchemical systems.

**Mapping to Center’s Objectives**

- Enable fluid routing and pumping on nano-manufacturing toolbit.
- Simplify ancillaries and interfacing needed to operate toolbit.

**Research Plan**

- Model microvalve to identify critical design parameters and predict effective design space to minimize actuation potentials.
- Develop a fabrication process utilizing soft-lithographic techniques.
- Optimize microvalve for operation in nano-manufacturing toolbit.

**Fundamental Questions / Challenges**

How to integrate electrodes into microvalve architecture using only simple fabrication techniques at ambient pressure/temperature?

**Research Results**

Modeling using semi-analytical approach:

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Order of dependency</th>
<th>Design range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter, ( D )</td>
<td>-2</td>
<td>300-1000 ( \mu ) m</td>
</tr>
<tr>
<td>Membrane thickness, ( t_m )</td>
<td>2.5</td>
<td>10-50 ( \mu ) m</td>
</tr>
<tr>
<td>Electrode gap, ( g )</td>
<td>0.5</td>
<td>1.5-15 ( \mu ) m</td>
</tr>
<tr>
<td>Dielectric constant of fluid, ( \epsilon_{\text{fluid}} )</td>
<td>0.5</td>
<td>--</td>
</tr>
</tbody>
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```

Parameters identified by model with greatest effect on actuation potentials.

Microvalve actuation and characterization:

- Test valve with relevant printable fluids.
- Construct microvalve array to pump and route fluids on print head.

**Broader Impact**

- Microfluidic interface for E-Jet printing.
- Fluidic components integrated with optical sources for sensing.

**Interaction with Other Projects**

- Point-of-care diagnostics
- Portable lab-on-a-chip
- Automated high-throughput screening
- Wireless chemical monitoring

**Future Efforts**

- Test valve with relevant printable fluids.
- Construct microvalve array to pump and route fluids on print head.