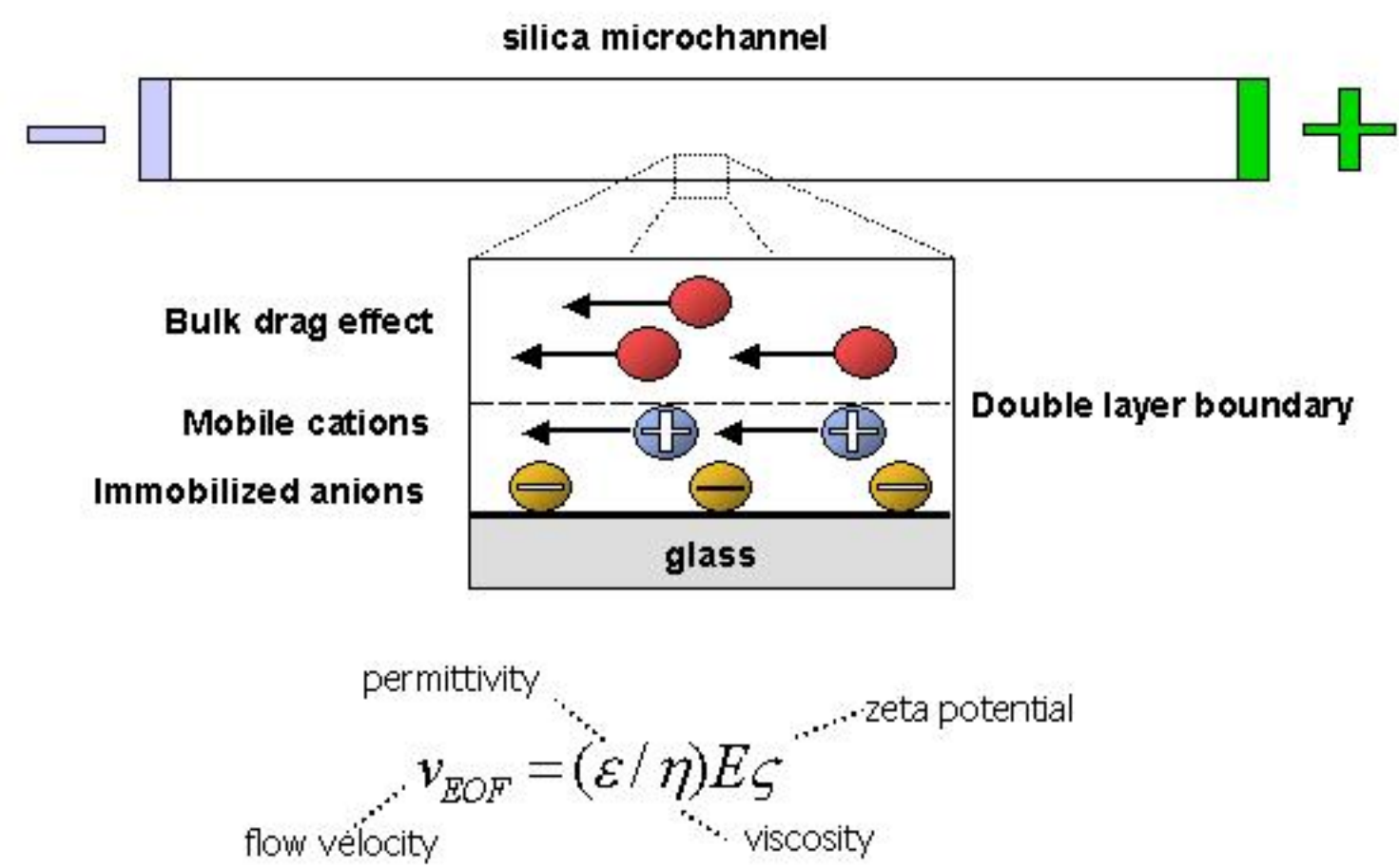


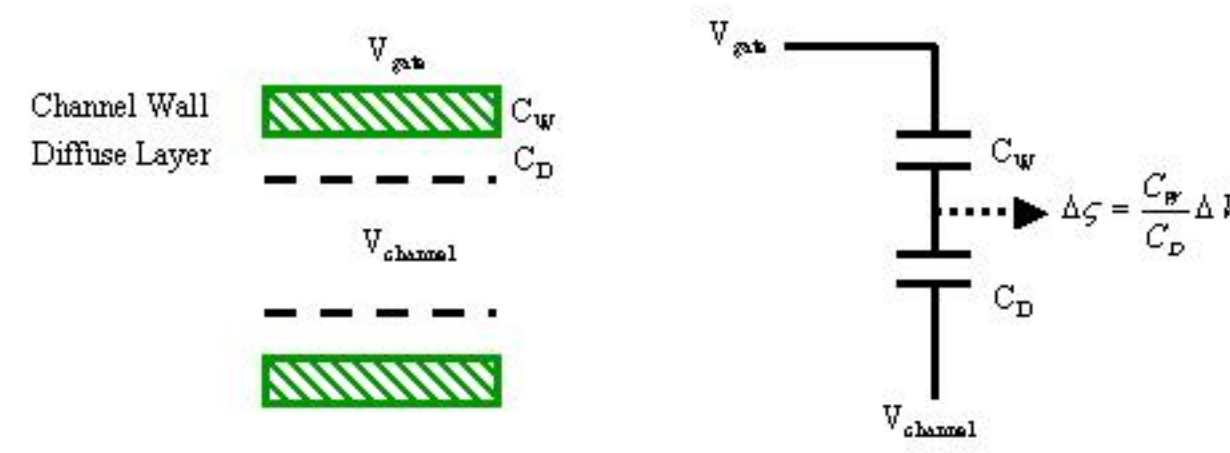
Nate Sniadecki, Cheng Lee, Don DeVoe

## Field-Effect Flow Control: FlowFETs

- FlowFET = electrical gating of electroosmotic flow
- Applications in valving, mixing, combinatorial synthesis, bioseparations, and other microsystems where fluid flow in complex microchannel networks is desired
- FlowFETs enables pumping within interconnected microchannel networks through local modulation of an electrical gate voltage, similar to electron flow control in CMOS FETs. Based on electroosmotic flow (EOF):



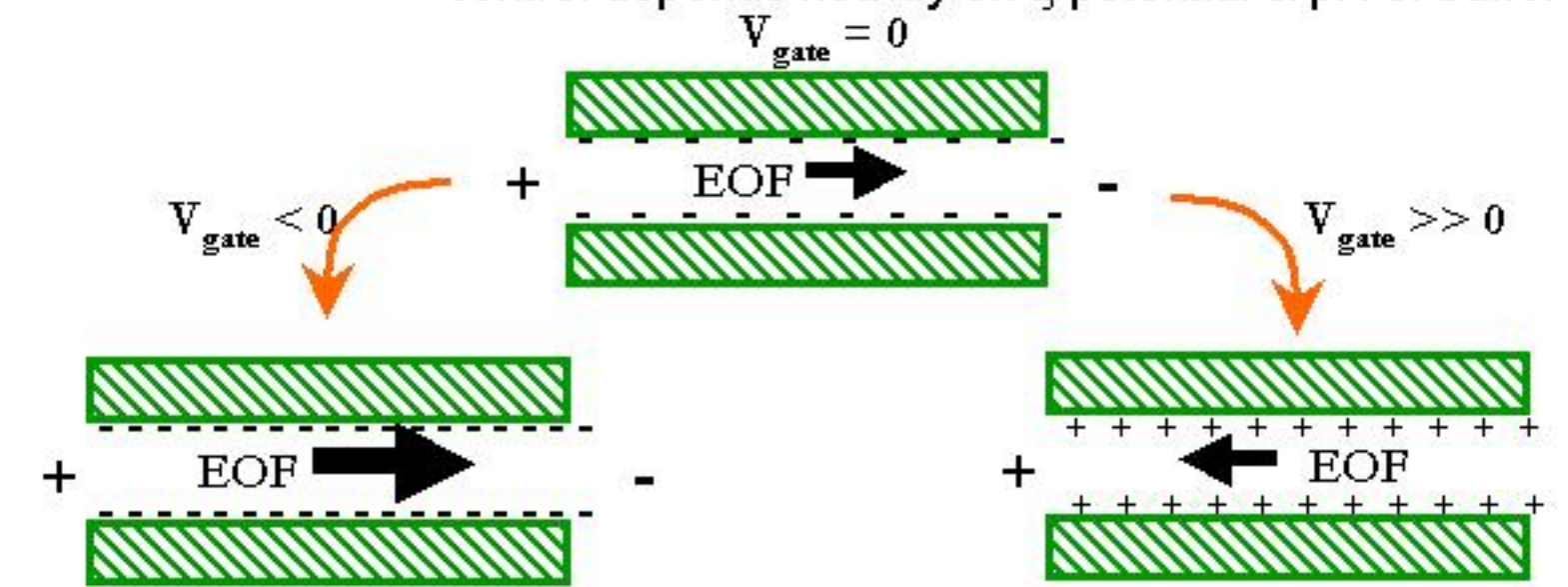
- EOF uses a longitudinal field for electrokinetic pumping, but.
- $\zeta$  potential can be controlled using a transverse electric field
  - capacitive divider network formed by dielectric wall ( $C_w$ ) & electrical double layer within channel ( $C_D$ )



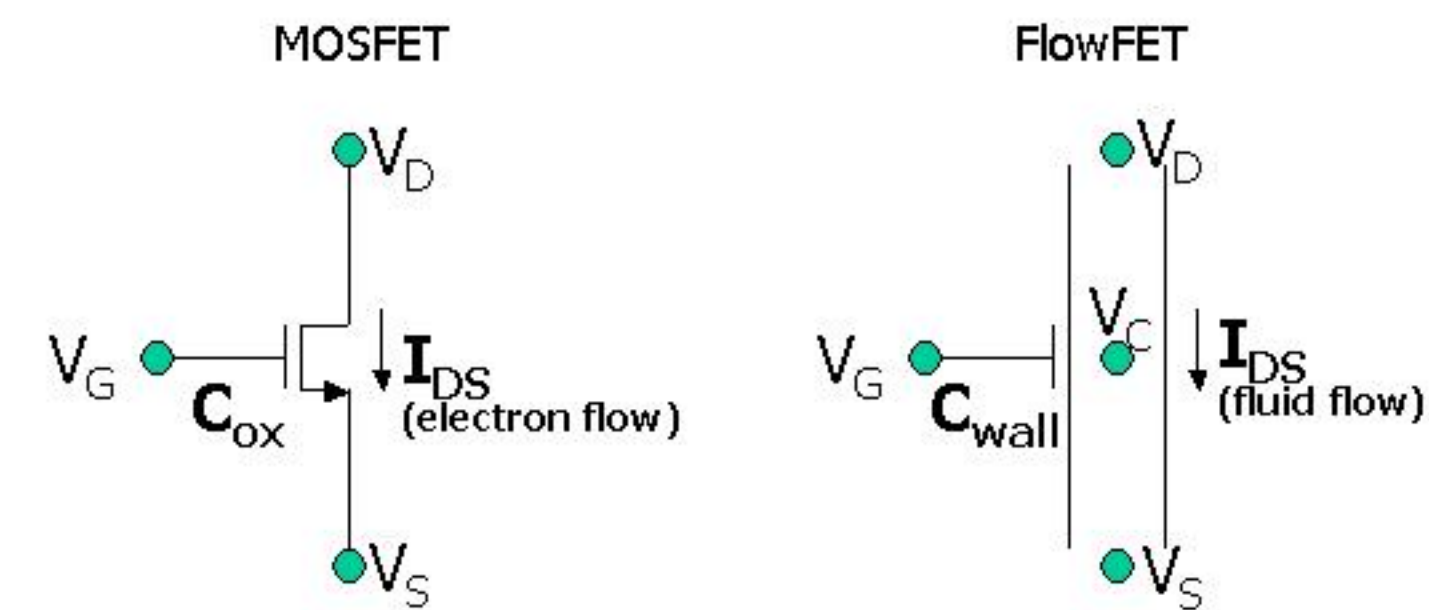
Applications:

- Electrokinetic valving
- Micro/Nanochannel pumping
- Combinatorial synthesis

- $V_G$  modulates the ionization charge density at the wall
  - velocity may be modified without altering EOF field
  - control depends heavily on  $\zeta$  potential & pH of buffer

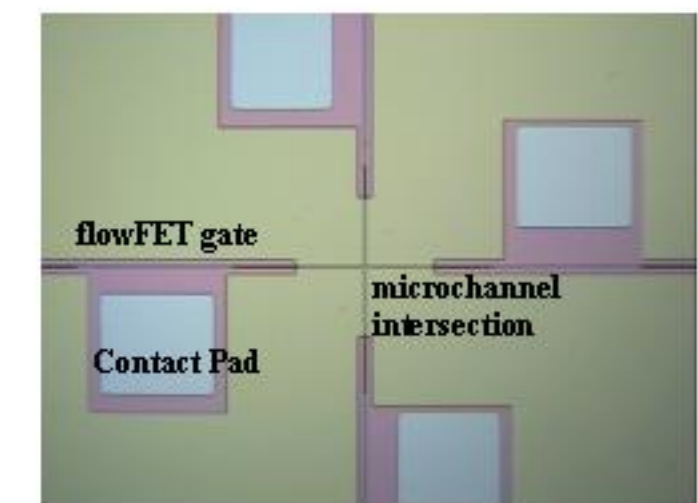
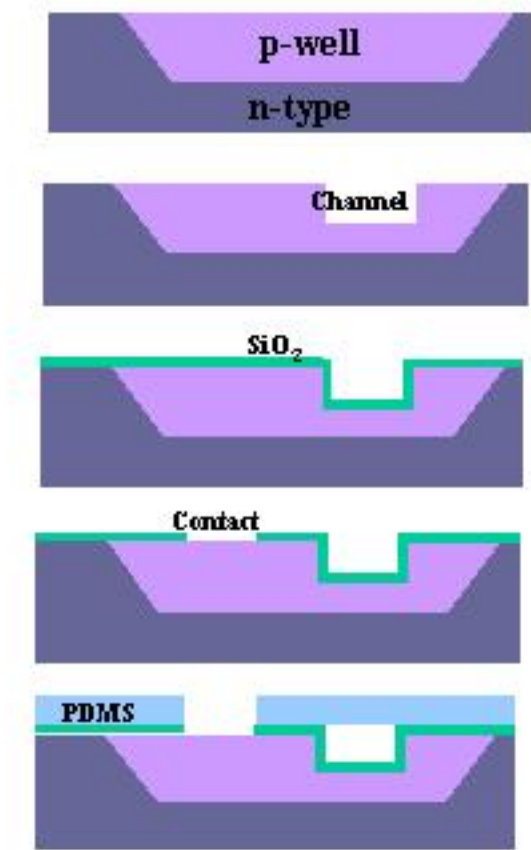


### MOSFET analogy

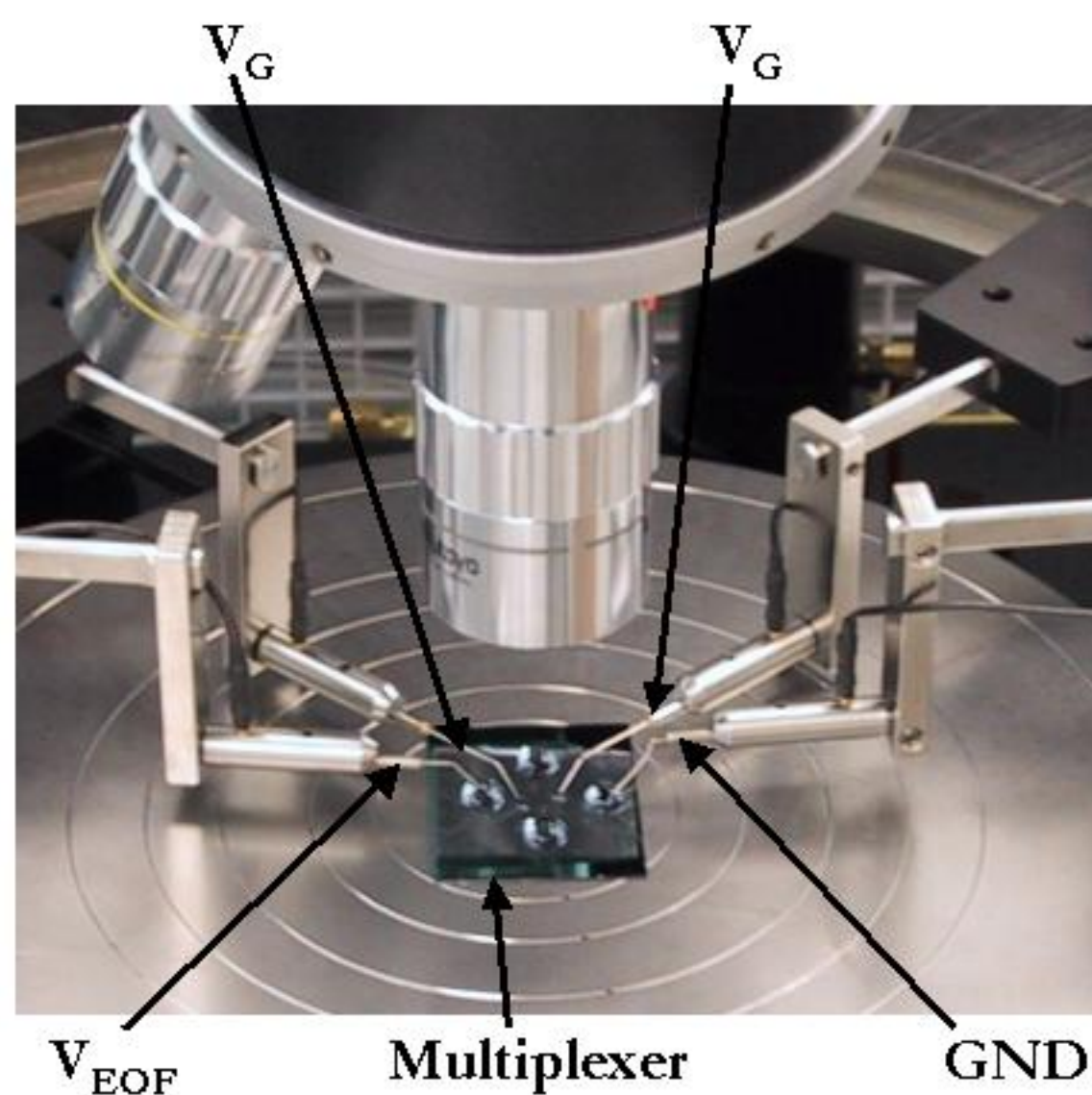


$$I_{DS} = (1/2)\mu_n C_{ox} (W/L) (V_{GS} - V_T)^2 \quad I_{DS} = (\epsilon/\eta) \zeta_0 (V_{DS}/L) (1 + V_{GS} C_{wall}/C_D)$$

### Fabrication



## Testing Methodology



Testing on Probe Station

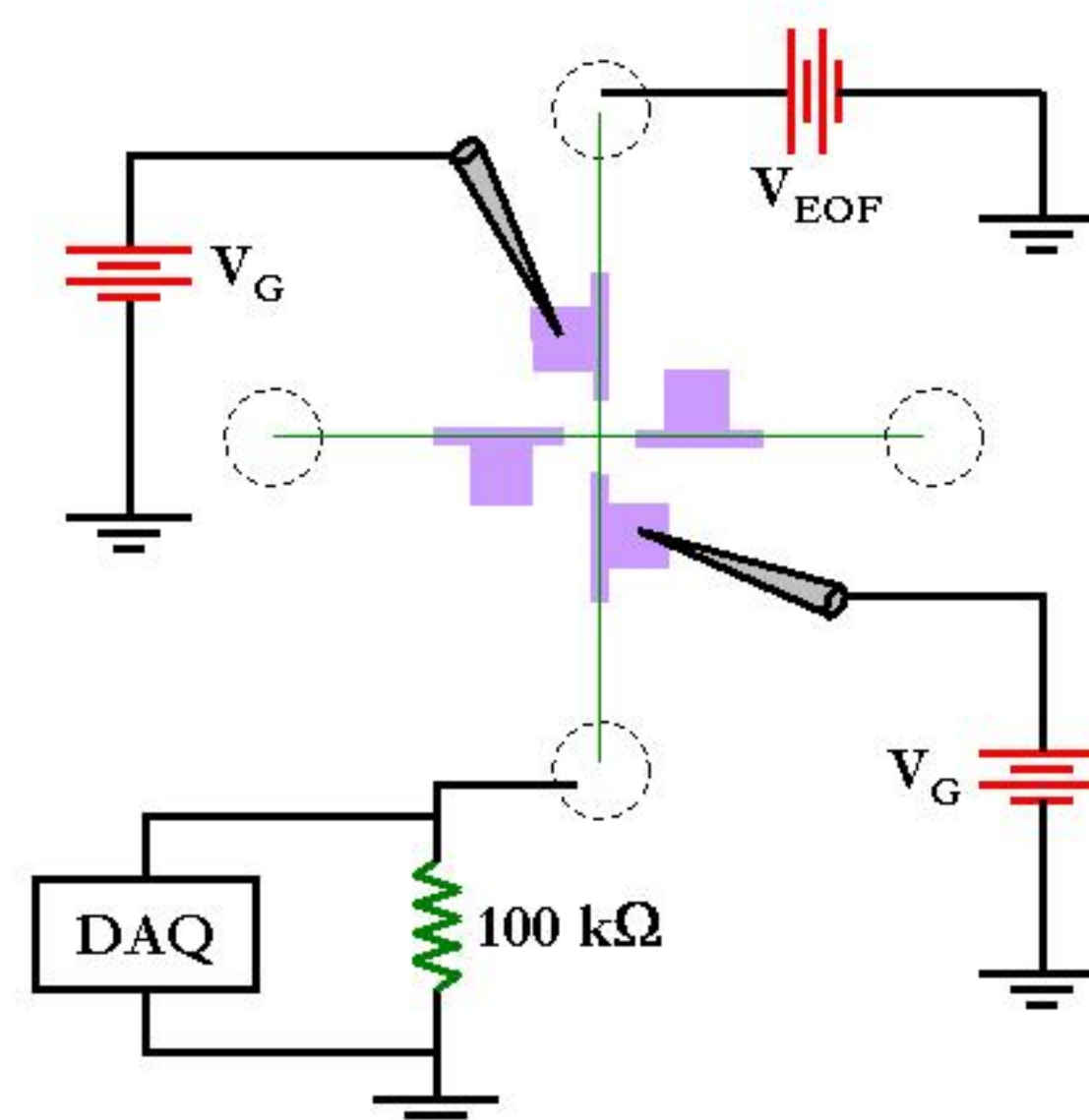


Diagram of Testing Circuit

## Flow Control Characterization

- Least-square fitting
  - $\epsilon$ -ACA pH 3:  $-15.5 \times 10^{-3} \text{ cm}^2/(\text{V}^2 \text{ s})$
  - $\epsilon$ -ACA pH 4:  $-7.2 \times 10^{-3} \text{ cm}^2/(\text{V}^2 \text{ s})$
  - PBS pH 5:  $-4.4 \times 10^{-3} \text{ cm}^2/(\text{V}^2 \text{ s})$

Compare with theory:

