4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

# Alternative Material Nanomembrane Electro-osmotic Pump Fabrication and Applications

Greg Madejski* and James McGrath

*Department of Biomedical Engineering, University of Rochester, Rochester, NY, 14616, United States*

Accepted for publication on 15th February 2015

The extraordinary permeability and manufacturability of ultrathin silicon-based membranes are enabling devices with improved performance and smaller sizes in important areas as molecular filtration and sensing, cell culture, electroosmotic pumping, and hemodialysis. However, silicon materials are not necessarily optimal at such small thicknesses. There is room for improvement in applications where silicon produces a large background signal, interferes with surface chemistry, or has poor electrical performance. Recent work at the University of Rochester has developed porous nanocrystalline silicon (pnc-Si) as an extremely effective, low-voltage, electro-osmotic pump due to the thinness (15 nm) and pore characteristics (20 nm average pore diameter, 5 % porosity) of the material. Extending this work, it is possible to make even more effective pumps by optimizing the material characteristics of the nanomembrane for the intended pumping use. Using silicon-based nanomembranes as a template, we have exchanged the silicon for alternative materials (gold, platinum, magnesium fluoride) with a combination of evaporation and reactive ion etch. The new membranes share similar physical characteristics to the original silicon templates, approaching the desirable thinness (50 nm thin) and pore characteristics at active areas over one square millimeter, but also allow additional modifications and procedures not possible with silicon. Pumping rates are increased proportionately by the deposited material's zeta potential, adding to the utility of the nanomembranes as low voltage pumps and streaming potential flow sensors within lab-on-a-chip (LOC) systems.

**Keywords**: pnc-Si; nanomembrane; zeta potential; nanofluidic transistor; electroosmotic pump