Fundamentals of Gaseous Nanoelectrofluidics Using Semiconductor Devices
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Classical mass transport experiments on the nanoscale examine the flow of gases through nano-channels or nano-pores to determine parameters such as transmission probability, conductance, geometry and concentration. These parameters are critical for understanding the behaviour molecules in these confined domains. Nano-pore devices are made with precise control over pore geometry by drilling a silicon nitride membrane with a TEM [1]. Gas molecules are passed through a nano-pore and detected via mass spectroscopy which is effective, but inconvenient as it requires a mass spectrometer calibrated to the molecule of interest and lacks time resolution [2]. To improve these experiments, we introduce a cross-electronic flow via field emission across the nano-pore [3], that will interact with the gaseous flow allowing it to be measured (Figure 1). As such, the fundamentals of gaseous nanoeletrofluidics of a cross-electronic mass flow nano-pore device must be fully characterized; in particular, quantifying intrinsic fluctuation in a gas-current is critical to determining measurement uncertainty and ultimate instrumentation limits. [4-7]

We present preliminary results of control experiments for the characterization of gaseous nanoeletrofluidics using cross electronic measurements. Using devices fabricated from nano-patterned electrodes on a semiconducting silicon nitride membrane, we present a detailed analysis of mass transport of helium 4 (He4) through a nano-pore in the molecular (Knudsen) and continuous regimes for a range of pore sizes [8]. We further present evidence of Fowler-Nordheim field emission [3] across a 100nm gap. These results establish the first step of gaseous mass transport characterization and opens further research into high-frequency nano-electronic measurements.

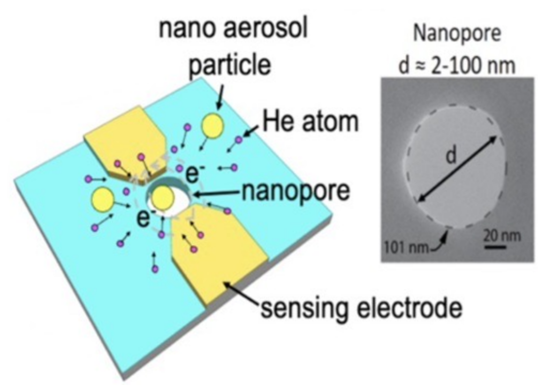

Fig. 1. An illustration of the nano-electronic detection schematic and a STM image of a nano-pore used for detection.

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