High-Aspect-Ratio CNT Micronozzles for Electrospray Ionization

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Initial attempts to fabricate silicon micronozzles utilized deep reactive ion etching (DRIE), but the best results only produced nozzles approximately 200 µm tall. The walls provide additional iron catalyst to minimize the proximity effect.

Project Goal

Fabricate micronozzles on-chip for use in a compact mass spectrometer for applications in astrobiology such as in-situ analysis of organic molecules.

Electrospray Ionization (ESI)

ESI is a technique for ionizing molecules used in mass spectroscopy. It is particularly useful for analyzing large, organic molecules because it does not cause them to fragment as readily as other methods.

Nozzle Fabrication

The CNT-M method will use the same initial steps as the DRIE process to pattern and create holes through the silicon substrate. The nozzle fabrication step is much different, however, and requires the deposition of aluminum oxide (30 nm) as a diffusion barrier followed by a thin film of iron (4-10 nm) which serves as a catalyst for CNT growth. The grown CNT nozzle is then coated and filled with another material to create a solid structure. This step was not done in this preliminary study due to the fact that the CNT forest provides the shape of the final structure.

Preliminary Work

Preliminary work has been done on the use of the CNT-M process for the fabrication of high aspect ratio micronozzles. It has been demonstrated that design geometry must be optimized to allow a relatively large amount of iron catalyst around important features. This optimization allows the minimization of the proximity effect of iron catalyst in CNT growth, and allows for the creation of devices with higher aspect ratios. In the future, these CNT nozzles will be filled with other materials to create working nozzles for electrospray ionization.

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