236 on the ejection side of the silicon substrate exposing the underlying silicon substrate **220**.

[**0116**] **FIG. 15H** is a cross-sectional view of a silicon substrate **200** showing removal of silicon substrate **220** to form an annular space **240** around the nozzles **242**.

[**0117**] **FIG. 15I** is a cross-sectional view of the DRIE etch of silicon **220** to form the recessed annular region **240** and the nozzles **242**.

[**0118**] **FIG. 15J** is a cross-sectional view of a silicon substrate **200** showing removal of silicon dioxide layers **210**, **212**, **233** and **238**.

[**0119**] **FIG. 16A** is a cross-sectional view of a silicon substrate **200** showing thermal oxidation of the exposed silicon substrate **200** to form a layer of silicon dioxide **244** on all exposed silicon surfaces.

[**0120**] **FIG. 16B** is a cross-sectional view of a silicon substrate **200** showing low pressure vapor deposition of silicon nitride **246** conformally coating all exposed silicon surfaces.

[**0121**] **FIG. 16C** is a cross-sectional view of a silicon substrate **200** showing deposition of layers of conductive metal **247**, **248**.

[**0122**] **FIG. 17A** is a cross-sectional view of a silicon substrate **200** showing the reservoir **232** and through-wafer channels **242** filled with a polymerizable solution **252**. The polymerizable solution **252** is contained within the device with coverplates **248**.

[**0123**] **FIG. 17B** is a cross-sectional view of a silicon substrate **200** showing the reservoir **232** and through-wafer channels **242** filled with polymer monolith **254**.

[**0124**] **FIG. 18** is a cross-sectional view of a two nozzle polymer monolith/electrospray device of the present invention **250** showing metal deposition of electrode **256** on silicon substrate **200**.

[**0125**] **FIGS. 19A and 19B** show a perspective view of scanning electron micrograph images of a multi-nozzle device fabricated in accordance with the present invention.

[**0126**] **FIG. 20A** shows two stacked separation blocks each having a plurality of separation channels filled with a porous polymeric material.

[**0127**] **FIG. 20B** shows a separation block having a separation channel filled with a porous polymeric material stacked on an electrospray device.

DETAILED DESCRIPTION OF THE INVENTION

[**0128**] Control of the electric field at the tip of a nozzle is an important component for successful generation of an electrospray for microfluidic microchip-based systems. This invention provides sufficient control and definition of the electric field in and around a nozzle microfabricated from a monolithic silicon substrate for the formation of multiple electrospray plumes from closely positioned nozzles. The present nozzle system is fabricated using Micro-ElectroMechanical System ("MEMS") fabrication technologies designed to micromachine 3-dimensional features from a silicon substrate. MEMS technology, in particular, deep reactive ion etching ("DRIE"), enables etching of the small vertical features required for the formation of micrometer dimension surfaces in the form of a nozzle for successful nanoelectrospray of fluids. Insulating layers of silicon dioxide and silicon nitride are also used for independent application of an electric field surrounding the nozzle, preferably by application of a potential voltage to a fluid flowing through the silicon device and a potential voltage applied to the silicon substrate. This independent application of a potential voltage to a fluid exiting the nozzle tip and the silicon substrate creates a high electric field, on the order of 10^8 V/m, at the tip of the nozzle. This high electric field at the nozzle tip causes the formation of a Taylor cone, fluidic jet and highly-charged fluidic droplets characteristic of the electrospray of fluids. These two voltages, the fluid voltage and the substrate voltage, control the formation of a stable electrospray from this microchip-based electrospray device.

[**0129**] The electrical properties of silicon and silicon-based materials are well characterized. The use of silicon dioxide and silicon nitride layers grown or deposited on the surfaces of a silicon substrate are well known to provide electrical insulating properties. Incorporating silicon dioxide and silicon nitride layers in a monolithic silicon electrospray device with a defined nozzle provides for the enhancement of an electric field in and around features etched from a monolithic silicon substrate. This is accomplished by independent application of a voltage to the fluid exiting the nozzle and the region surrounding the nozzle. Silicon dioxide layers may be grown thermally in an oven to a desired thickness. Silicon nitride can be deposited using low pressure chemical vapor deposition ("LPCVD"). Metals may be further vapor deposited on these surfaces to provide for application of a potential voltage on the surface of the device. Both silicon dioxide and silicon nitride function as electrical insulators allowing the application of a potential voltage to the substrate that is different than that applied to the surface of the device. An important feature of a silicon nitride layer is that it provides a moisture barrier between the silicon substrate, silicon dioxide and any fluid sample that comes in contact with the device. Silicon nitride prevents water and ions from diffusing through the silicon dioxide layer to the silicon substrate which may cause an electrical breakdown between the fluid and the silicon substrate. Additional layers of silicon dioxide, metals and other materials may further be deposited on the silicon nitride layer to provide chemical functionality to silio-based devices.

[**0130**] Arrays of multiple electrospray nozzles of any nozzle number and format may be fabricated according to the present invention. **FIG. 1A** illustrates a two by two array of groups of four electrospray nozzles for one common fluid stream. **FIG. 1A** shows a perspective view of the ejection or nozzle side a four-nozzle electrospray device array **250** of the present invention. Each recessed annular region **240** has four nozzles **242** that generate one or more electrosprays for the same fluid stream introduced to a reservoir containing a polymer monolith on the injection side of the device. Each device has a group of four electrospray nozzles in fluid communication with one common reservoir containing a single fluid sample source. Thus, this system can generate multiple sprays for each fluid stream up to four different fluid streams. An electrode **256** is placed on the silicon substrate **200** for application of a potential voltage to the substrate.