New 3-D Plastic Nanospray Chip for Mass Spectrometry

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A three-dimensional, injection-molded microfluidic nanospray array device to or mass spectrometry analyses of proteins and small molecules has been developed. The polymers usable for injection molding includes polypropylene, polybutylteraphthalate and carbon-filled polypropylene for an electrically conducting device. The breakthrough design and molding technologies that allow this nanospray microfluidic chip to be built in true 3-D result in a device that has uniformly high performance, virtually unlimited potential to grow in versatility and integration with other analytical techniques, and yet very affordable. Each nanospray chip consists of 4 20μm-i.d, 50 μm-o.d. nozzles at the tip of 1.5 mm tall cones. This extremely large aspect ratio is not achievable by conventional semiconductor microfabrication technology. Sample for spraying is supplied to each nozzle by a microfluidic channel the end of which is a collar that forms a liquid-tight fitting when a polyimide-coated silica capillary is inserted into the collar without any extra fitting. This plastic chip with an inert polypropylene surface works simply and conveniently when compared to conventional electrospray or the nanospray tips made of individually tapered glass or quartz tubes or capillaries. Moreover, this chip is clog-resistant and can handle a wide range of flow rates, from 50 nL/min. to over 800nL/min. The spray conditions afforded by the design of the nozzle and the microfluidic channel appear to be close to optimal because the ideal cone-jet spray is observed uniformly from nozzle to nozzle and from chip to chip. Sample sizes as small as 2 μl may be sufficient for obtaining high signal-to noise spectra. New capabilities are being added onto the chip, e.g. LC-nanospray chip-MS and automated nanospray chip with built-in sample storage reservoirs compatible in format with conventional robotic sample dispensing equipment. The design and fabrication of the nanospray nozzle, as well as mass spectrometry results obtained with the direct-infusion nanospray chip on a variety of proteins, peptides, small molecules will be presented. Preliminary mass spectrometry results with the LC-nanospray chip and automated nanospray chip will be presented.