pressure. These would include, but not limited to, an interface formed by drilling a plurality of passageways into a block of material, an interface formed by casting a block of material with passageways formed in a casting process or molding process, and an interface formed by providing an array of capillaries as described in the description of the preferred embodiment herein.

[0009] While the present invention should be broadly construed to include any application wherein the multi-capillary inlet is desired juxtaposed between an ion source and the interior of an instrument maintained at near atmospheric pressure, it finds particular advantages when deployed to improve the ion transmission between an ESI source and the first vacuum stage of a mass spectrometer, and finds its greatest advantages when deployed in conjunction with an electrodynamic (RF) ion funnel deployed within the interior of the mass spectrometer. When deployed in this fashion, the multi-capillary inlet described herein has been demonstrated to provide more uniform droplet evaporation conditions than are provided by a single capillary having the same gas conductance. The present invention is further advantageously deployed with an ion funnel equipped with a jet disturber, as described in co-pending U.S. patent application Ser. No. ______, filed ______, "Improved Ionization Source Utilizing a Jet Disturber in Combination with an Ion Funnel and Method of Operation" the entire contents of which are incorporated herein by this reference.

[0010] The subject matter of the present invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. However, both the organization and method of operation, together with further advantages and objects thereof, may best be understood by reference to the following description taken in connection with accompanying drawings wherein like reference characters refer to like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is a schematic diagram of a preferred embodiment of the present invention.

[0012] **FIG. 2** is a schematic diagram of the quadrupole instrument used to demonstrate the preferred embodiment of the present invention.

[0013] **FIG. 3** is a graph of the ion currents measured through the ion funnel using the 0.51 mm I.D. seven capillary inlet design (closed circles), the ion current through a inter-quadrupole lens (IQ1, located between Q0 and Q1) (open circles), and the ion current after the analyzing quadrupole (reversed triangles) as functions of ion funnel RF amplitude. The inlet ion current was 5.4±0.2 nA.

[0014] **FIG. 4** is a spectrum for the 4.0 μM DDTMA solution obtained using a 0.51 mm I.D. seven capillary inlet with the ion funnel interface described in the experiments conducted to demonstrate a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0015] To demonstrate a preferred embodiment of the present invention a multi-capillary inlet interface was designed for operation with an electrodynamic (RF) ion funnel. The experiments were conducted using an API 3000 triple quadrupole mass spectrometer system (SCIEX, Concord, ON).

[0016] A heated multi-capillary inlet was designed and fabricated by silver soldering seven 76 mm long stainless steel tubes (Small Parts Inc., Miami Lakes, Fla.) into a hole of a cylindrical stainless steel heating block. Two different capillary diameters were evaluated (0.51 mm I.D., 0.71 mm O.D. or 0.43 mm I.D., 0.64 mm O.D.). A schematic of the seven capillary inlet is shown in **FIG. 1**. The same diameter was used for all seven tubes 1 resulting in inlets whose theoretical conductance differs by factor of 7 compared to a single capillary of the same dimension. To maintain constant temperature on the inner surfaces of the capillaries, the interstitial space was filled with silver solder. A single 0.51 mm I.D., 76 mm capillary inlet of similar design was also constructed and used as a reference inlet. The stainless steel block 2 was heated by a 60 W cartridge heater (Ogden, Arlington Heights, Ill.) and the temperature monitored by a thermocouple. For these experiments, a controller maintained the temperature of the block at ~200° C., however, as will be recognized by those having skill in the art, the heating block may be advantageously maintained at temperatures between about 100° and 350°.

[0017] An ion funnel conceptually similar to the RF ring electrode ion beam guide, but further incorporating an additional DC potential gradient and electrodes of varying diameter (decreasing "down" the funnel) was also utilized in these experiments. The funnel interface had two major parts; (a) a front section of the funnel that consists of fifty-five 25.4 mm I.D. rings and (b) a rear section with forty-five ring electrodes with diameters linearly decreasing from 25.4 to 2.3 mm. The front section reduces the gas dynamic effects upon ion confinement, allows improved conductance for pumping, reducing the gas-load to downstream of the ion funnel and providing an extended ion residence time to enhance desolvation of charged clusters or droplets. RF voltages of equal but opposite phases were applied between adjacent rings and gradually decreasing DC potentials were applied along the lens stack. The oscillating RF fields near the ring electrodes served to push ions to the weaker electric field region, the central axis region of the ring electrodes. Concurrently, a low DC electric field pushed the ions towards the electrodes having progressively smaller apertures (i.e. the bottom of the ion funnel) while buffer gas collisions thermalize the ion kinetic energy (i.e. collisionally damped the motion of the ions).

[0018] As shown in the schematic of **FIG. 2**, in the operation of the multi-capillary inlet, the first vacuum stage was pumped by two roots blowers providing nominal pumping speeds of 168 L/sec (Model EH500A system, EDWARDS, Crawley, West Sussex, England) and 84 L/sec (Model WSU251 system, Leybold, Koln, Germany). The pressure in the first vacuum stage was monitored by a Model CMLA-11-001 capacitance manometer (Varian, Lexington, Mass.). In some experiments, the pressure of the first vacuum stage was adjusted by partly closing butterfly valves installed between the ion funnel chamber and the roots pumps. The ion funnel was generally operated at a pressure similar to that of the first vacuum stage of the standard API 3000 ESI interface (i.e. about 1 Torr). The multi-capillary inlet, however, actually resulted in a greater-down stream pressure. Even though conductance of the last ring electrode