

comparative or combination mass spectra. Acquiring both ES and APCI mass spectra of the same solution can provide a useful comparison to assess any solution chemistry reactions or suppression effects with either ES or APCI ionization. Both ES and APCI probes can have fixed or moveable positions during operation of the API source. Alternatively, different samples can be introduced through the ES and APCI probes individually or simultaneously. For example, a calibration solution can be introduced through an ES probe while an unknown sample is introduced through an APCI probe into the same API source. The ES and APCI probe can be operated simultaneously or sequentially in this manner when acquiring mass spectra to create an internal or an external standard. The combination of ES and APCI probes configured together in an API source minimizes probe transfer and setup time and expands the range of analytical techniques which can be run with a manual or automated means when acquiring data with an API MS instrument. Several combinations of sample introduction systems such as separations systems, pumps, manual injectors or auto injectors and/or sample solution reservoirs can be connected to the multiple combination ES and APCI probe API source. This integrated approach allows fully automated analysis with multiple ionization techniques, multiple separation systems and one MS detector to achieve the most versatile and cost effective analytical tool with increased sample throughput and little or no downtime due to instrumentation reconfiguration.

[0077] FIG. 14 is a diagram of an embodiment of the invention which includes individual or simultaneous ES and APCI ionization capability configured together in an API source interfaced to a mass analyzer. APCI inlet probe and ionization assembly 280 and an Electrospray probe assembly 281 are configured in API source assembly 282. APCI probe and ionization assembly 280 comprises dual inlet probes 283 and 284, spray region 286, optional separator ball 285, vaporizer 287 and corona discharge needle 288 with needle tip 289. APCI inlet probes 284 and 285 are configured to spray at an angle of ( $\theta_{283 \& 284}=0^\circ$ ) relative to vaporizer 287 centerline 291. APCI inlet probes 283 and 284 are configured with separate solution delivery lines 294 and 295 and separate nebulizer gas lines 294 and 295 respectively. Electrospray probe assembly 281 comprises three layer spray tip 296 with gas delivery line 297, sample solution delivery line 298 and layered liquid flow delivery line 299. The ES probe tip 296 is configured to spray at an angle of ( $\theta_{296}=70^\circ$ ) relative to centerline 300 of API source 282. The position of ES probe tip 296 is adjustable using adjuster knob 301. Alternatively, ES probe assembly 281 may be configured with two or more ES probe tips positioned to spray at an angle relative to API source centerline 300.

[0078] API source 282 is additionally configured with cylindrical lens 120, endplate 303 with attached nosepiece 304, capillary 305, counter current drying gas flow 306 and gas heater 307. ES probe tip 296 is positioned a distance ZES axially from nosepiece 304 and radially  $r_{ES}$  from API source centerline 300. Electrical potentials applied to cylindrical lens 302, endplate 303 with nosepiece 304, capillary entrance electrode 308, ES tip 296 and APCI corona needle 288 can be optimized to operate both the ES and APCI probes separately or simultaneously. Counter current drying gas flow 309, the nebulization gas flow from ES probe tip 296 and the nebulizer, makeup and vapor gas flow through

APCI vaporizer 291 can be balanced to optimize performance of simultaneous ES and APCI operation. Alternatively, the ES and APCI probes can be operated sequentially with fixed positions by turning on and off the solution and/or nebulizing gas flow for each probe sequentially. Mass spectra with ES ionization can be acquired with solution flow and voltages applied to the ES probe tip 296 turned on while solution flow to APCI inlet probe 283 and/or 284 and voltage applied to corona discharge needle 288 are turned off. Liquid flow and voltage applied to ES probe tip 296 can then be turned off with liquid flow to APCI inlet probes 283 and/or 284 and voltage applied to corona discharge needle 288 turned on prior to acquiring mass spectra with APCI ionization.

[0079] Different solutions or the same solutions can be delivered through the ES and APCI probes during acquisition of mass spectra. The electrical potentials applied to elements in the API source may be adjusted for ES and APCI operation to optimize performance for each solution composition and liquid flow rate. Also, voltages applied to elements or positions of elements in the API source may be changed and then reset to optimize ES or APCI operation. For example, if APCI assembly 280 operating and no sample is being delivered through ES probe 281, the voltage applied to ES probe tip 296 can be set so that tip 296 will appear electrically neutral to avoid interfering with the electric field in corona discharge region 290. Similarly, when ES probe 281 is operating and solution flow to APCI assembly 280 is turned off, voltage can be applied to corona discharge needle 289 such that it does not interfere with the Electrospray process or actually improves the Electrospray performance. For example, voltage applied to corona discharge needle 289 can aid in moving or focusing Electrospray produced ions toward capillary orifice 310. Alternatively, the position of APCI corona discharge needle 288 can be moved temporarily during ES probe operation to minimize interference with the Electrospray ionization process. APCI corona discharge needle 288 can then be moved back into position during operation of APCI probe assembly 280. Simultaneous ES and APCI operation can be configured to produce ions of opposite polarity. Ions produced in the APCI corona region 290 can be of one polarity, while spraying the ES needle at the corona needle can produce opposite polarity ES ions. Voltages applied to API source elements to achieve positive APCI generated ions and negative ES generated ions can be capillary entrance electrode 308 (-4,000V), endplate 303 and nosepiece 304 (-3,000V), cylindrical lens 302 (-2,000V), corona discharge needle 288 (-2,000V) and ES probe tip 296 (-5,000V). A portion of the resulting mixture of ions reacting at atmosphere of one polarity is enters vacuum through capillary orifice 310 and subsequently mass analyzed. Several combinations of sample inlet delivery systems, as have been described earlier, can be interfaced to the combination ES and APCI API source. Multiple ES and multiple APCI inlet probes can be included in an API source assembly. The ES and APCI probe assemblies can be configured to mount through the API source chamber walls, within the API chamber or through the API chamber back plate.

[0080] FIGS. 15A through 15D include mass spectra acquired from a combination API source configured similar to API source 282 diagrammed in FIG. 14 interfaced to a quadrupole mass spectrometer. Mass spectrum 320 shown in FIG. 15A was acquired with APCI ionization of a sample or