segments **315** and/or endcaps **317** may be substantially similar to like-named components described above.

[0043] The apparatus **300** may also include an ionization source **305**, a first lens **320**, a second lens **330**, a sample inlet **340**, a buffer gas inlet **350**, a pump system **360**, and/or a detector **370**.

[0044] Depending on the type of sample and the method of introducing the sample into the apparatus **300**, the ionization source **305** may be operable for electron impact ionization, photoionization, thermal ionization, chemical ionization, desorption ionization, spray ionization, and/or other processes. In the example depicted in FIG. **3**, pass-through electrodes **307** extend from the ionization source **305** to outside the apparatus **300**. The lenses **320**, **330** may be electrically conductive plates with central apertures, or other means for applying an rf and/or dc bias to the incoming and outgoing ion streams. For example, one or both of the lenses **320**, **330** may be substantially similar in composition and/or manufacture to the endcaps **317** of the ion trap **310**. Moreover, one of both of the lenses **320**, **330** may include an array or series of lenses or lens elements, such as the lens **330** which is depicted in FIG. **3** as comprising three different lens elements **335**.

[0045] The sample inlet **340**, buffer gas inlet **350**, and pump system **360** may be conventional or future-developed means for routing the appropriate gases to and from the ion trap **310** and/or other portion of the apparatus **300**. Exemplary buffer gases include, without limitation, helium and/or mixtures thereof.

[0046] The detector **370** may be or include a single-point ion collector, such as a Faraday cup or electronic multiplier, in which ions arrive at the collector individually. The detector **370** may alternatively be or include a multipoint collector, such as an array or microchannel plate collector, in which all of the ions arrive at the collector simultaneously. However, additional or alternative means may be employed as detector **370** within the scope of the present disclosure.

[0047] Referring to FIG. **4**, illustrated is a graph depicting the relationship between ion detection and mass for a coaxial ring ion trap according to one or more aspects of the present disclosure, as well as for several cylindrical ring ion traps of the prior art. For example, for ions having an amu (atomic mass unit) of about 100, a detection time ranging between 555 μs and 580 μs is experienced with conventional cylindrical ring ion traps, whereas a detection time ranging between about 535 μs and about 545 μs may be experienced with a coaxial ring ion trap according to one or more aspects of the present disclosure. Similarly, for ions having an amu (atomic mass unit) of about 110, a detection time ranging between 760 μs and 780 μs is experienced with conventional cylindrical ring ion traps, whereas a detection time of about 750 μs may be experienced with a coaxial ring ion trap according to one or more aspects of the present disclosure.

[0048] Referring to FIG. **5**, illustrated is a schematic view of an apparatus **500** according to one or more aspects of the present disclosure. The apparatus **500** may represent another example of an implementation of the apparatus **100** and/or **200** described above. For example, the apparatus **500** may be or include a coaxial ring ion trap that may be substantially similar in composition and/or manufacture to the apparatus **100** shown in FIG. **1** and/or the apparatus **200** shown in FIG. **2**D, or may otherwise have one or more aspects in common with the apparatus **100** of FIG. **1** and/or the apparatus **200** of FIG. **2**D.

[0049] The apparatus **500** includes an injection endcap **510**, an extraction endcap **520**, and five coaxially aligned, cylindrical ring segments **530***a-c*. The endcaps **510**, **520** are biased by signal Ve, the ring segments **530***a* are biased by signal Va, the ring segments **530***b* are biased by signal Vb, and the ring segment **530***c* is biased by signal Vc. Turning briefly to FIG. **6**, illustrated is a chart graphically depicting an example of the relative magnitudes of each of these signals. In the illustrated example, Vb may be greater in magnitude than Vc, Va may be greater in magnitude than Vb, and Ve may be greater in magnitude than Va. Moreover, the collective bias profile generated by the signals Va, Vb, Vc, and Ve may be linear, exponential, parabolic, or hyperbolic, among other examples, such as in the example depicted in FIG. **6** in which Vb is about 30% greater in magnitude than Vc, Va is about 50% greater in magnitude than Vb, and Ve is about 70% greater in magnitude than Va.

[0050] Returning to FIG. **5**, the signals Va, Vb, Vc, and Ve may each be (or include as a component) an rf or dc signal. For such rf signals or signal components, the frequency may range between about 100 kHz and about 2 GHz, although other frequencies are also within the scope of the present disclosure. Such frequencies may, for example, be a harmonic fraction of the resonant frequency of the apparatus **500**.

[0051] The signals Va, Vb, Vc, and Ve may be configured such that ions are trapped in a central portion **540** of the apparatus **500** and extracted as an ordered ion stream **550**, such as according to ion m/z ratio. However, other configurations are also within the scope of the present application.

[0052] Thus, it should be clear to those skilled in the art that the present application introduces an apparatus that is or includes an ion trap, wherein the ion trap comprises an injection endcap, an extraction endcap, a plurality of ring electrode segments collectively positioned in substantially coaxial alignment between the injection and extraction endcaps, and a plurality of insulators each interposing neighboring ones of the plurality of ring electrode segments.

[0053] The present application also introduces a method of manufacturing a coaxially segmented ring ion trap, comprising forming a first ring electrode segment over a substrate, forming a first insulator over the first ring electrode segment, and forming a second ring electrode segment over the first insulator. A second insulator is formed over the second ring electrode segment, and a third ring electrode segment is formed over the second insulator. A third insulator is formed over the third ring electrode segment, and a fourth ring electrode segment is formed over the third insulator.

[0054] The present application also introduces a mass spectrometer system having an ion trap, an ionization source, a sample gas inlet, and an ion detector. The ion trap includes an injection endcap, an extraction endcap, a plurality of ring electrode segments collectively positioned in substantially coaxial alignment between the injection and extraction endcaps, and a plurality of insulators each interposing neighboring ones of the plurality of ring electrode segments.

[0055] Positioning a plurality of coaxially aligned ring electrodes between the injection and extraction endcaps according to one or more aspects of the present disclosure may provide the ability to control the dc offset of each ring segment, which may improve ion packet focusing and defocusing within the ion trap. This may lead to the ability