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Atmospheric Measurement Techniques Discussions

Interactive comment on "Size Resolved Online Chemical Analysis of Nano Aerosol Particles: A Thermal Desorption Differential Mobility Analyzer Coupled to a Chemical Ionization Time Of Flight Mass Spectrometer" *by* Andrea C. Wagner et al.

Anonymous Referee #1

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This manuscript (amt-2018-116) describes the development of a thermal desorption differential mobility analyzer (TD-DMA) coupled to a chemical ionization time-of-flight (CI-TOF) mass analyzer for the analysis of ambient nanoparticles down to ∼10 nm diameter. Nanoparticles are charged with an X-ray source, size selected in a custom DMA, and collected onto a metal filament. After sufficient particle mass has been collected, the filament is resistively heated to desorb the collected material, which is subsequently analyzed by CI-TOF. This approach provides a size resolution of 1.19, a transmission efficiency of 50% at 15 nm, and a detection limit of about 10 pg aerosol

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mass.

The manuscript represents a new approach to analyze the composition of ambient nanoparticles, which is significant because very few approaches currently exist. The manuscript is within the scope of Atmospheric Measurement Techniques and will be suitable for publication if the below comments are carefully addressed. These comments generally revolve around provide more details about the instrumental approach and its effectiveness as well as better placing this instrumental approach in the context of existing nanoparticle chemical analysis approaches.

Comments:

1. The first major comment relates to insufficient experimental details and justification. For example, on page 5, lines 28-31, the authors that there is a trade off between size resolution and collected mass that underlies their choice of aerosol flow and sheath flow rates. However, they provide no additional detail as to how they arrived at that choice: how much have the authors sacrificed in size resolution to increase collected mass? A second example relates to aerosol charging. As the authors acknowledge on page 15, lines 16-19, multiply charged aerosol could compromise their measurement as a doubly charged particle with the same mobility as a singly charged one has about 8 times more mass to it. Only a small number of multiply charged particles are required to significantly bias the composition measurement. The authors discount this possibility by simply stating “multiple charging does not play a significant role” (page 15, line 19). In their revision, the authors need to provide significant more justification for this statement as its accuracy determines whether this approach is actually sampling particles at the size they claim.

2. The second major comment relates to placing this new approach in the context of other existing approaches. The authors have attempted to do this to some extent in Table 1. However, in their revision they must provide additional comparison to existing measurements. For example, perhaps the most commonly used approach similar to

this instrument is the thermal desorption chemical ionization mass spectrometer (TD-CIMS), which also charges the aerosol, size selects using DMAs, collects it onto a filament, which is then resistively heated to desorb molecules that are then ionized and detected. As far as this reviewer can ascertain, the main differences in these two approaches are 1) this approach uses a bipolar charger whereas TDCIMS uses a unipolar charger, 2) the DMAs used in each approach may be configured differently, and 3) TD-CIMS uses water clusters whereas TD-DMA uses nitrate clusters for ionization. The impact of this work would be significantly enhanced if the authors discussed the similarities and differences between their instrument and others (like TDCIMS), providing details about how charging efficiencies, multiple charging, detection limits, time resolution, and ionization efficiency differ based on the instrumental configuration. At a minimum, in their revision the authors should include, perhaps in an additional table, key parameters describing instrument performance (e.g. detection efficiency/sensitivity, aerosol mass collection rates, etc.) for their instrument as well as available literature data for the other approaches.

3. The authors highlight as a key benefit of their instrument that they can perform gas phase measurements as well as particle phase measurements. However, virtually no further details are provided, and the instrument does not appear to have been used to investigate partitioning in the example study in the manuscript. In their revision, the authors should provide some additional details about the benefits of being able to do both measurements with their instrument, as that is a unique aspect of their instrument. Related to this point, on page 4, line 30, the authors do not indicate whether this gas sampling line has a filter to remove any aerosol that might bias the measurement. The authors should clarify this point in their revision.

4. Some of the language used in the manuscript is imprecise. One example of this is in the discussion of the sampling setup on page 6, lines 1-15. In this section, what does “electrical energy” (page 6, line 5) mean? Does it refer to heat, or voltage? The authors also describe different “parts” of the DMA (page 6, lines 7-9), but don’t make

use of their labels in the figure, resulting in this section being difficult to follow. In their revision, the authors should carefully read through their manuscript and improve the precision in language.

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