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Interactive comment on "Aqueous particle generation with a 3D printed nebulizer" *by* Michael Rösch and Daniel J. Cziczo

Anonymous Referee #3

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Rösch and Cziczo present characterization of a 3D printed nebulizer for aerosol generation. The instrument is tested by nebulizng PSL spheres and ammonium sulfate and measuring the particle size distribution using an optical particle spectrometer between 300 nm and 10 micron. Heatmaps of particle size distribution between 160s and 3x10ˆ4 s are presented, which are intended to show the stability of the atomizer.

Overall, this is an interesting contribution. The paper is short and easy to digest. The paper might be publishable in AMT if the authors are more forthcoming about the details of the instrument. However, to make this work publishable either more experiments are needed that demonstrate that the technique is an improvement over existing technologies (or at least not a regression), or detailed open access publication of the plans is needed to increase accessibility of the technique. Either require major revisions to

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the manuscript.

Specific comments

Particle generation by nebulization is a very well established, commercially available, and widely used technique. The experiments amount to a couple of days worth of work in an aerosol laboratory outfitted with basic equipment. A new way to manufacture such an item in itself is in my opinion insufficient to warrant publication. To this referee, the criteria for publication are either a significant improvement over existing technology or an increase in accessibility of the technique.

Is the technique improved over existing technology? The authors do not show data for D < 300 nm, the authors do not quantify the total number concentration of drops or typical droplet size produced, the authors do not quantify the composition of particles produced, the range of solvents that can be used (I guess some organic solvents might be problematic), the degree to which mixed particles (e.g. ammonium sulfate + organic compounds and preserving the ratio in the atomized particles) can be generated from aqueous stock solutions, or the minimum aerosol diameter that can be generated, which is determined by cleanliness of the solvent and drop size, the maximum time the instrument can run unattended, the degree of drying that is needed, and the range of pressure and flow rates at which the atomizer produces particles. All of these are critical to evaluate if such a device is suitable for application in laboratory research, including for instrument calibration. Thus, the answer to the question is no.

Experiments including an SMPS to measure the full size distribution should be included. Experiments should systematically characterize the output for a much wider range of inputs (solvent, composition, solute weight percent) and analyze the results to infer drop number size and concentration. Ideally composition measurements of mixed particles are included to test for artifacts such as dissolution of the plastic and faithful representation of stock solution (e.g. adsorption of organics while the liquid passes through the atomizer).

Does the work increase accessibility of the technology? The paper states that the authors were able to build this device, which is nice. However, there is no benefit to the community if it is not widely shared on how to do that. The authors state that STL files are "available upon request". This is insufficient. In my experience, share requests are often conveniently ignored or come with strings attached by the sharer. They present an unnecessary barrier. Thus, the answer to the question is no.

If the authors want this instrument to be a low cost, self-manufacture replacement, the authors should provide the STL files as a supplement or make them available in an archived repository. The paper should include an itemized list what people need to purchase, including part numbers and cost estimates. A photo of the instrument would be a good addition to the paper. The printing could be performed by a 3D printing service and ordered with a couple of clicks. Quotes can be generated from online vendors within minutes (e.g. sculpteo) by uploading the STL file. Assembly instruction should be provided. Comments about alternative print materials should be made and the precision that is needed for printing (is 100 micron the limit?). All of the designed parts should be made available using open licenses, e.g. the CERN open hardware license (https://www.ohwr.org/cernohl). Such a device would be very welcome and provide a platform where anyone could build, try, and characterize the output for themselves. In this case, the likely performance limitations and/or deficits in characterization raised earlier are less critical.

Irrespective the route the authors wish to pursue, the authors need to comment on the technical limitations above in the revised paper. The authors should also compare cost and performance to other techniques. For example, the TSI atomizer is ~$3k and very stable, and very well characterized. Small medical nebulizers (pressure and ultrasonic) can be obtained for < $30 and are more than sufficient to generate good aerosol for shorter duration (5-15 min). It might be useful to juxtapose data from these side-by-side and discuss use cases for the printed design.

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