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Comment on amt-2022-153

Gabor Vali (Referee)

Referee comment on "The Microfluidic Ice Nuclei Counter Zürich (MINCZ): a platform for homogeneous and heterogeneous ice nucleation" by Florin N. Isenrich et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-153-RC1>, 2022

The instrument described in the paper is based on a good idea and it was built with care. The paper presents a thorough description in clear language appropriate for an AMT publication.

The main novelty of this instrument is to separate the droplet production microfluidic device from the testing section where the cooling of the sample and the observation of freezing events takes place. The advantage derived is a better control of the sample temperature, minimizing internal temperature gradients that are the limiting factor to accuracy in some other droplet freezing devices.

On the production section, the choice of materials is crucial. This is well described in the paper but would find it helpful to clarify two things: Why is a surfactant (line 216) needed for a water in oil suspension? How are air bubbles introduced (line 221) and why? In the end, are the water droplets in contact with the tubing and air, or also with some oil? How particle-free is the air? Is the surfactant likely to be covering the droplets in the test section?

The precision of droplet sizes is indicated in Tables 1 and 2 in terms of the estimated variation in droplet diameters. The $\pm 5 \mu\text{m}$ amounts to about 6.5%. This translates into a volume variation of about 20% which is not negligible in the evaluation of the results. This is a greater limitation to the overall performance of the instrument than is acknowledged in the paper. The authors' comment on this would be helpful.

The small droplet size and the immersion of the tubing in a liquid are the main features regarding temperature accuracy. However, mention is made of a stack of glass slips (line 163) being placed below the tube. How does this limit the flow of the cooling liquid around the tube and to what extent does it introduce further temperature gradients. Could this be clarified?

The spatial uniformity of temperature is demonstrated in Figs. B1 and B2. This display in terms of x and y coordinates` is somewhat unclear. Do both the x and y coordinates of all droplets in a sample are included? Probably yes. Also, is the x and y coordinate system given with respect to the internal dimension of the test chamber? A simple change to using the distance from the walls would be easier to understand.

The results and comparisons to other works are presented as the fraction frozen versus temperature. This is a straightforward manner of showing the results. However, it is specific to the volumes of the sample in the experiment. For even slightly polydisperse populations of drops the function loses generality and makes the calculation of the nucleation rate J for homogeneous freezing contain an error. It also influences the comparison of the three runs with microcline, as, according to Table 2, the drop volumes were about 20% larger for run 1 than for runs 2 and 3. The volume-dependence makes the FF(T) functions inadequate for comparisons with other experiments. It is not clear if any adjustments were made in Fig. 5 to overcome the problem.

In any case, this problem with the volume-dependence is not critical for this AMT paper. It would be more important for a science paper. To fully account for the volume variations in the samples is not a trivial matter. For the comparisons with literature results an appropriate caveat regarding the constant-volume assumption is probably sufficient. A more thorough step to bring results of different experiment on a comparable basis is conversion of the FF data into spectra (eq. 4 in Vali, G.: Revisiting the differential freezing nucleus spectra derived from drop-freezing experiments: methods of calculation, applications, and confidence limits, **Atmos. Meas. Tech.**, 12, 1219-1231, doi: 10.5194/amt-12-1219-2019, 2019.).

Regarding the image analysis process. As described it is a demanding process. Is there some future improvement possible so that the apparatus would really become as user-friendly as it aims to be (line 134)?