We would like to sincerely thank the reviewers for their valuable feedback and constructive comments, which helped us improve the clarity, quality, and overall impact of our manuscript.

REVİEW 1:

Celebi et al. present a proof-of-concept for using the formvar replica technique to preserve the shape of ice crystals to analyze the surface roughness offline, e.g. using an optical profilometer. SEM imaging was also done. The comparison of roughness parameters derived from salt crystals and their replica showed agreement despite the skewness. By testing the technique with real ice crystals generated in the Manchester ice cloud chamber (MICC), it turned out that the mean roughness increased by increasing crystal length and levels off at around 50 µm, which can be considered as a reasonable result.
However, I don't fully understand what the aim of this study is. Is it planned as an add-on measurement technique for MICC to determine surface roughness of ice crystals which were formed in the chamber? How many ice crystals have to be analyzed to gain a representative statistic of the crystals and their roughness in the chamber? Is it possible to achieve this with the here presented method? Or what is the objective? I think it has to be shown that this method is robust to study a large number of ice crystals. I guess this is needed for any application. In principle, I see the potential of the here presented method as proof-of-concept. However, as there are some shortcomings using the actual formvar method and the fact that the objective is not defined, the value of the study needs to be presented more clearly.
After overcoming these problems, which are probably largely due to the formulation and description of the study, the manuscript can be published in AMT, as the formvar replica technique has potential and fits within the scope of the journal.

Specific comments:

Abstract: It would strengthen the paper if the abstract stated that this was a proof-of-concept study. In addition, giving information of the comparison between salt and salt replica as a test would eventually increase confidence in this method.
Response: We have revised the abstract to clearly point out that this is a proof-of-concept study. Additionally, we have included the information on the comparison of salt and salt replicas to enhance the proposed method. This revision can be found specifically in lines 8-10.

Introduction: The introduction is well written and gives a good overview about the necessity to study ice crystal surface roughness and the state-of-the-art of surface roughness determination with formvar. However, a short paragraph of the state-of-the-art of surface roughness using other methods is missing. I am sure there are more methods and publications on that topic, but the study of Magee et al. (2014) [1] applying ESEM, Ulanowski et al. (2014)[2] Voigtländer et al. (2018)[3] and Järvinen et al. (2018)[4] using SID-3 instrument could be mentioned.
Response: We agree that including a broader overview of surface roughness determination methods would strengthen the introduction. In response, we have added a paragraph (line 66-77) in the introduction section that mentions alternative methods for retrieval of surface roughness, including those used in the studies by Magee et al. (2014), Ulanowski et al. (2014), Voigtländer et al. (2018), and Järvinen et al. (2018), as you recommended.

Methodology part & Figure 1: The methodology part is very detailed. There are some repetitions. In my opinion Figure 1 is not important. I suggest to shorten the section and leave Fig. 1 out.

Response: We appreciate your suggestion to streamline the methodology section. In response, we have improved the methodology to and decided to exclude Figure 1 as recommended.

P9 l208-210: The authors gave the information that many features in the formvar are not a result of accreted ice crystals but artefacts from the formvar process. Do the artefacts affect the determination of surface roughness of ice crystals? Can always be distinguished between artefact and ice crystal? Do the artefacts influence the counting statistics of ice crystals when the fall on a spot with an artifact? Can the process been improved in order to reduce or avoid these artefacts?

Response: We acknowledge that artefacts can occur during the formvar process, especially when a smaller amount of formvar is used or the surface of the crystal is not wetted properly. However, by using a sufficient amount of formvar instead of brush technique, the chances of artefact formation gets lower. When artefacts do occur, they can generally be distinguished from ice crystals as they do not form complete shells and are mostly flat. Additionally, artefacts do not significantly affect the determination of surface roughness, as they are easily identifiable and do not interfere with the counting statistics of ice crystals. We believe that with proper control of the process, the occurrence of artefacts can be reduced, ensuring more accurate results. We have stated the high occurrence of artefacts when a small amount of formvar applied to glass slides (line 196-199).

P9 l210-215: I do not understand why it solves the problem that ice crystals do not sink when using a thicker formvar layer.

Response: When a thick layer of formvar is used rather than brush technique, the chance of ice crystals' surfaces getting wetted are higher when they fall to solution and when we give a shake to sample in order to increase it. We have included this explanation in line (200-202).

Fig. 5: What relevance do those ice crystals have that not fully sink into the formvar? Could it be that a certain type of ice crystals always not sink into formvar and would be missing in the analyzes leading to basis of this method?

Response: The relevance of ice crystals that do not fully sink into the formvar is indeed significant because, in such cases, there is no shell formed on the top side, making it impossible to properly scan the crystal surface. Based on our observations, this issue typically arises from an inadequate level of formvar applied during the preparation process rather than crystal types. Ensuring a sufficient amount of formvar helps to create a complete coating, minimizing the occurrence of such artefacts and ensuring that all ice crystals are properly scanned.

P12 Fig.5: Please add a scale bar.

Response: We have added scale bars for both salt and ice crystal scannings.

P13 l283-286: I agree, but it would be good to have more information of the formation and history of the ice crystals which were examined (later it is discussed, but I missed the information already at this point in the text). Maybe the roughness is different due to different environmental conditions the ice crystals experienced [3, 4] before settled on the formvar. Further, the number of investigated ice crystals is not very high (caption of Fig. 9 'n=7 for each size bin'). It seems that this offline method -using formvar for ice crystal surface roughness detection- is very complex and time-consuming. How will it be possible to analyse a larger sample size? What are the advantages of this introduced method compared to online measurements of single airborne ice crystals such as e.g. SID-3?

Response: We acknowledge that providing more information on the formation and history of the ice crystals would enhance the understanding of the results. We have added this information in line 261-263 to clarify the environmental conditions the ice crystals experienced before settling on the formvar. As suggested, different environmental factors may influence surface roughness, as observed in studies such as [3, 4].

Regarding the sample size, we agree that the number of analysed ice crystals is limited. The offline method using formvar is complex and time-consuming which limits the sample size in our preliminary study. However, it might be possible to explore ways to be able to improve efficiency, such as optimizing the formvar process and such automation methods for handling a larger number of samples in future studies. In terms of advantages, this method provides high-resolution and detailed structural information on ice crystal surface roughness, which may be difficult to achieve with online measurements like SID-3. While SID-3 is effective for airborne ice crystal measurements, our offline approach offers the ability to study the crystals in a controlled environment and with more precision. Both methods have their strengths, and we believe our approach complements online methods by providing deeper insights into ice crystal morphology and roughness that can be used to refine future airborne measurements. This aspect is now explained in line 330-334.

P14 l316-317: 'However, if appropriate mitigation methods are implemented, the occurrence of these artefacts can be greatly reduced, resulting in the most accurate possible roughness measurements.' For such a statement a comprehensive analysis of already published methods is needed, which should be given in the introduction, see comment introduction of this review. And maybe it should be reformulated to 'one of the most accurate…'. I would expect SEM to have a higher spatial resolution.
Response: We have improved that paragraph by removing that phrase.

Technical corrections:

P2 l49: Insert a blank between '(1951)used'.
Response: Thank you for pointing out this formatting error. We have corrected the spacing issue between "(1951)" and "used" in line 51.

P5 l115: Insert a half blank '0.6wt%'.
Response: Thank you for your comment. We have inserted the space between "0.6" and "wt%" in line 126 as requested.

References: The AMT citation style has to be used.

Response: Thank you for your feedback. We have improved the reference section and reformatted according to the AMT requirements.

[1] N. B. Magee, A. Miller, M. Amaral, and A. Cumiskey, "Mesoscopic surface roughness of ice crystals pervasive across a wide range of ice crystal conditions," Atmos. Chem. Phys., 2014, doi: 10.5194/acp-14-12357-2014.

[2] Z. Ulanowski, P. H. Kaye, E. Hirst, R. S. Greenaway, R. J. Cotton, E. Hesse, and C. T. Collier, "Incidence of rough and irregular atmospheric ice particles from Small Ice Detector 3 measurements," Atmos. Chem. Phys., 2014, doi: 10.5194/acp-14-1649-2014.

[3] J. Voigtländer, C. Chou, H. Bieligk,T. Clauss, S. Hartmann, P. Herenz, D. Niedermeier, G. Ritter, F. Stratmann, and Z. Ulanowski, "Surface roughness during depositional growth and sublimation of ice crystals," Atmospheric Chemistry and Physics, 2018, doi: doi:10.5194/acp-18-13687-2018.

[4] E. Järvinen, H. Wernli, and M. Schnaiter, "Investigations of Mesoscopic Complexity of Small Ice Crystals in Midlatitude Cirrus," Geophysical Research Letters, 2018, doi: https://doi.org/10.1029/2018GL079079.