

Review of “Ice nucleation activity of silicates and aluminosilicates in pure water and aqueous solutions. Part 3 – Aluminosilicates” by Kumar et al.

General Comment:

This is the third manuscript of a series of studies that aimed to understand the ice nucleating abilities of mineral dust particles with an especial focus on feldspars. Part 3 reports the ice nucleating abilities of different aluminosilicate particles in the immersion freezing mode in pure water and aqueous solutions. The authors investigated the effect of surface ion exchange, NH_3 or NH_4^+ adsorption, and surface degradation on the ice nucleating abilities of kaolinite, sanidine, andesine, muscovite, biotite and gibbsite. The ice nucleating abilities were enhanced in some cases and reduced in others. The increase/decrease of the ice nucleating abilities was found to depend on the type of mineral and also on the exposure time of the surfaces to water and solutes.

This is a very interesting topic of high relevance for the atmospheric chemistry and physics communities. The experiments from the current study were carefully designed and performed. The current results brings our understanding one step forward and it helps the ice nucleation community to better understand why mineral dust particles are good ice nucleating particles. Although the reviewer did not find any major point in terms of the scientific content and the drawn conclusions, the structure, length, and readability of the manuscript needs to be significantly improved before it can be accepted for its publication in ACP.

“Major” comments:

1. The manuscript is unnecessary long and different information is repeated several times along the text. This makes the manuscript difficult to read and confusing in some parts.
2. The structure of the manuscript is not the best with too many subsections and mixing information from sections 3 and 4.
3. The usage of qualitative terms (e.g., strong decrease, remarkable enhancement, strong enhancement) is pronounced and not appropriate.

Minor comments:

1. Abstract: I suggest to reduce its length and to focus on the main results only. Leave out unnecessary or theoretical information for the Introduction section.

2. Introduction: It is missing why the authors focused on immersion freezing and what is the importance of mixed-phase clouds. Also, why are mineral dust particles important on a global or regional scale, and why this specific aerosol type is important in comparison to biological or organic particles?
3. There are too many statements/paragraphs without a proper citation(s).

Specific comments:

Line 38: Add a reference after “properties”.

Line 41: Add a reference after “crystalline ice”.

Line 46: Add a reference after “deposition nucleation”.

Lines 52-53: Either clarify that this studies refer to immersion freezing only or add studies for other ice nucleation modes using feldspar.

Line 56: Add the Kanji et al. ACPD (2018) study.

Line 58: Add a reference after “humidity”.

Line 62: Add a reference after “function of a_w ”.

Line 64: Add a reference after “solute”.

Line 73: Add “previous” after “our” and before “freezing”.

Line 84: Why immersion freezing? Why is this heterogeneous freezing mode important?

Lines 90-101: This paragraph deserves more than a single reference.

Line 103: Add a reference after “time”.

Line 107: Add a reference after “crust”.

Line 111: Add a reference after “edges”.

Line 129: Add a reference after “dusts”.

Line 167: Add a reference after “1000 particles”.

Lines 192: Given that the authors separated the Results from the Discussion of the Results in different sections, there are several parts which are repeated. It would be ideal to reduce this where possible. I suggest combining the Results and Discussion sections to avoid redundancy along the manuscript and to reduce its length.

Line 201: Add a reference after “ice”.

Line 219, 228: What is strong? I suggest to report this in a more statistical fashion.

Lines 223-224, 241: “Remarkable enhancement”. Please be more specific.

Line 241: “Strong enhancement”. Please be more specific.

Line 293: “because of the high bonding energy involved”. On the other of?

Line 330: “a thick amorphous surface”. How thick?

Lines 383-384: Given that there are many studies on this topic, I suggest to include review papers only where most of previous studies are included (e.g., Hoose and Mohler (2012), Murray et al. (2012), and Kanji et al. (2017)).

Line 385: Is this sample only used by ETH research groups?

Line 385: For consistency also mentioned relevant studies using the KGa-1b sample.

Lines 390-391: Why this should not be the case if both studies used the same sample and the same instrument?

Lines 391-395: I do not get the point or contribution of this paragraph.

Lines 410-444: This is a nice review of recent studies and discoveries on this topic, but this is unnecessary long and I believe that it does not contribute too much to the manuscript. I suggest to summarize this and to focus on the papers that are strictly necessary to explain the present results.

Line 368: This belongs to section 3 instead to section 4.

Line 486: Line 201: Add a reference after “activity”.

Lines 510-549: Unnecessary long. Please be more concise and specific.

Lines 550-634: This is a super long summary and it repeats many things already mentioned in the Abstract and Section 4. If the authors would like to keep this section focus on the main results/discoveries/conclusions only.

Figures 2 and 3: Open symbols are too small.