Supplementary Materials for Thermal regelation of single particles and particle clusters in ice

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14 December 2020

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Figure S1

Table S1

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1 Figure S1

The interface of freezing deionized water is a reference of 0°C in Figure 1. The same interfacial positions between freezing deionized water and freezing PS suspensions in the linear thermal gradient mean that they have identical temperatures. The interfacial temperature of freezing PS suspensions (0°C) implies that almost no solutes in the suspensions because if there were some impurities (i.e. soluble solutes) in the suspensions, they would depress the interfacial temperature of freezing PS suspensions (much lower than 0°C). Therefore, the white dotted lines imply there are few solutes in bulk suspensions. However, the surfactants on the surface of particles can not be excluded during the chemical synthesis because the surfactants are needed to separate individual particles.

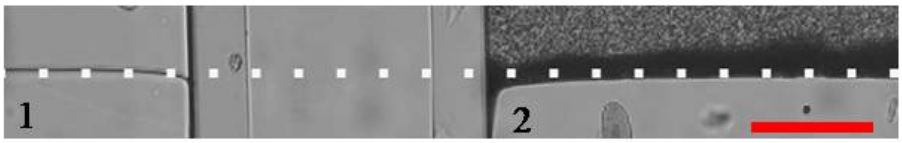

Figure 1: Interface positions of freezing deionized water (left sample 1) and freezing suspensions (right sample 2) under the identical thermal gradient. The lower part is cooling zone and the higher part is heating zone. The white dotted lines are their interface positions. The red scale bar is 150 μm.

2 Table S1

The length and width of particle clusters can be read from the observation of x-y plane. And the thickness of particle clusters can be calculated from the focus of the optical microscope (i.e. z plane). First, we focused on the upper surface of the glass cell, then on the upper plane and lower plane of the cluster and finally the lower surface of the glass cell. From these views, we measured the thicknesses of the clusters to be $\sim 10\ \mu m$, appreciably smaller

Table 1: Cluster size

Cluster name	Cluster size S ($x \times y \times z$ μm^3)	particle number n
1	$15.05 \times 8.6 \times 7$	1109
2	$17.2 \times 8.6 \times 10$	1807
3	$38.7 \times 8.6 \times 9$	3661
4	$30.1 \times 8.6 \times 12$	3796
red points in Fig.3a	$(8.7 \sim 17.4) \times (6.5 \sim 8.7) \times (7 \sim 9)$	$480 \sim 1700$

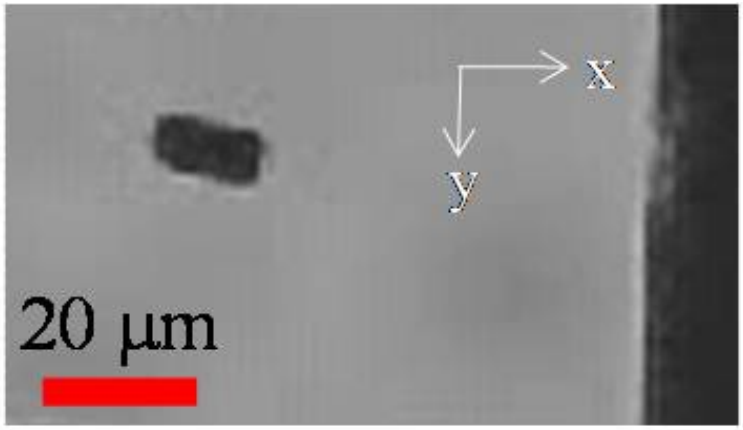

Figure 2: Movie of cluster migration

than the thickness of the glass cell 50 μm. We also determined that the particles were fully embedded in the ice. Using the calculation $n = \frac{3S \times \phi}{4\pi a^3}$, the numbers of particles in the cluster can be determined, where ϕ is the volume fraction of particles in the cluster (0.64) and a is the radius of particles.

3 Movie S1

Cluster migration in the ice under a uniform thermal gradient.