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Editorial

Ice Crystals

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Abstract: The special issue on “Ice Crystals” includes seven contributed papers, which give the wide varieties of topics related to ice crystals. They focus on the interface structure of ice, the physical properties of hydrate crystals and the freezing properties of water controlled by antifreeze proteins. The present issue can be considered as a status report reviewing the research that has been made recently on ice crystals. These papers provide research information about the recent development of ice crystal research to readers.

Keywords: ice crystal

Ice crystals are the most ubiquitous material in the cryosphere environment of the Earth, in the planetary system, and also in our daily lives. In recent years, ice crystals have increased in importance as one of the key materials for finding solutions to settle various environmental concerns at a global scale. Furthermore, ice crystals are also expected as one of the unique materials which are extremely useful to various applications, for example, the food sciences, medical sciences, and other various fields. Dealing with these interesting subjects, research on ice crystals has been more actively pursued in recent years.

Since research on ice crystals is included in many different fields, communications and discussions among researchers are not sufficient, nor are they smooth. Publications related to ice crystals are also distributed in various journals, such as those dealing with physics, chemistry, biology, geoscience, planetary science, crystal growth, and others. Consequently, this special issue will provide a platform for discussion among the researchers working in different fields.

This special issue may include various subjects related to the structures, phase transitions, surface and interfaces, defects, crystal growth, clathrate hydrate, chemical properties, biological aspects, glaciological aspects, planetary aspects, and others for ice crystals, studied by theoretical, experimental, numerical and observational methods. This special issue presents seven papers, covering phase transition, surface and interface, clathrate, and biological aspects. Here we will briefly summarize the contents of papers appeared in this issue.

Two contributions related to the structures and physical properties of ice crystals confined in nanoscale porous materials. Zeng and Li [1] discussed the formation of the quasi-liquid layer (QLL) at the interface between the confined ice and the pore walls. Freezing of the water confined in thin pores can be destructive to the porous frame, but the effect of QLL remains still far from being fully understood. They clarified that the existence of QLL at the interface narrows the gaps between the predicted and measured freezing deformations. On the other hand, Wan et al. [2] discussed the decomposition of methane hydrate confined inside the nanoscale pores of silica gel.

Computer simulation studies for ice crystals are important in order to understand the structure and the dynamic properties of ice. This special issue includes three interesting papers related to the computer simulation. Huda et al. [3] discussed the origin of negative thermal expansivity of ice crystal, which has been experimentally observed at low temperature conditions. They first showed that the original monatomic water model using the quasi-harmonic approximation could not this property of ice, but a simple prescription, namely re-adjusting a so-called tetrahedrality parameter, proposed to recover the negative thermal expansion. This is an interesting result to understand on of the mysterious ice crystal properties. Liu et al. [4] discussed the formation mechanism of THF hydrate based on the ab initio calculations and ab initio molecular dynamics simulations. They found that weak hydrogen bonds exist between THF and water molecules. This finding suggests that the THF can promote water molecules from the planar pentagonal or hexagonal ring. On the other hand, Mochizuki and Matsumoto [5] presents an interesting paper related to the activities of antifreeze proteins. It is well-known that antifreeze proteins protect organisms living in subzero environments from freezing injury, which render them potential applications for cryopreservation of living cells, organs, and tissues. They clarified that the water molecules confined between a pair of insect hyperactive antifreeze proteins is discontinuously expelled as the two proteins approach each other at a certain distance.

Another article related to the antifreeze protein was presented by Perez et al. [6] They assessed the function of antifreeze proteins in the solution of cryoprotective agents such as glycerol and propylene glycol, we have the applied site-directed spin labeling technique to a Type I antifreeze protein. They finally illustrate that antifreeze proteins can also play an active role in cryoprotective agent solutions for cryopreservation applications.

The last paper published in this special issue was an interesting and unique one. Mo et al. [7] discussed the ice crystal coarsening in ice cream during the cooling process. Ice cream is a complex multi-phase structure and its perceived quality is closely related to the small size of ice crystals in the product. Consequently, quantitative understanding of the coarsening process of ice particles is important to optimize the manufacturing process of ice cream. They discuss the relation between the coarsening process and the sugar concentration in ice cream.

In conclusion, this special issue presents advances in recent studies about ice crystals and provides helpful information for future studies related to ice crystals.

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