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Studies on the Freezing of Water

(III) Crystallography of disc crystal and dendrites developed from disc crystals

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Examinations are carried out for the determination of the crystal system of a disc crystal by the use of polarization microscope and by the etching method. The latter method was recently deviced by HIGUCHI. It is proved that the disc crystal belongs to the hexagonal system. The direction of optic axis is perpendicular to the disc plane. All the hexagonal etch pits produced on a base plane show the regular orientation throughout the crystal in each case of a disc crystal, a notched crystal and a stellar crystal. In the case of stellar crystals, the direction of a side of the hexagonal pit is parallel to the direction of main branch. It is concluded that the circular shape of the disc crystal is due to the radial symmetry of thermal condition in water around it.

§ 1. Introduction

In the former paper[1] it was reported briefly that the disc crystal was uniaxial and probably optically positive. With respect to the disc crystal, however, no direct evidence was obtained which shows the hexagonal symmetry of crystal. Recently HIGUCHI[2] succeeded to make etch figures on the surface of component crystals of polycrystalline ice, so that the optic axis and three a-axes of each of component grains, are determined. The direction of a-axis was obtained by the vapor figure method by NAKAYA.[3] The vapor figure means the hexagonal void in single crystals of ice.

This paper gives full details of the results obtained by the polarization microscope and also additional data obtained by HIGUCHI's method.

§ 2. Examination by a Polarization Microscope

Observations of growing disc crystals suspended in slightly

supercooled water are carried out under the polarization microscope. All growing disc crystals observed show uniaxial nature and the direction of optic axis is perpendicular to the disc plane. Some disc crystals were taken out from the water and placed on a glass plate. The observations on these crystals gave the same result and they looked to be optically positive. The latter fact is obtained by the observation of thin rectangular specimens cut from a disc crystal. These experiments are done in a cold chamber at $-15°C$.

Examinations of notched crystals and stellar crystals show that their optical properties are the same as those of disc crystals.

§ 3. Etch Figures Produced on Basal Planes.

Etch figures are produced on the base plane of a disc crystal placed on a glass plate, by coating the whole surface 2 per cent solution of polyvinyl formal dissolved in ethylene dichloride and keeping them in the cold chamber at about $-25°C$. Etch figures are circular pits in the early stage and gradually they grow into sharp hexagons. Photo. 1 shows etch figures produced in the region near to the periphery of a disc crystal, which is 2 mm in diameter. There are many similar hexagons on the whole surface of the base plane, and the orientation is the same for all hexagons.

Etch figures are produced on the base plane of a notched crystal and also of a stellar crystal. In Photo. 2 etch figures in the region near to the edge of the notched crystal are shown. In each of two cases above mentioned, all the hexagonal etch figures are orientated in the same way. In the case of stellar crystals, it was verified that the direction of a side of pit hexagon coincides with the direction of the main branch. No observable difference in orientation can be seen even in the joint parts of six branches or of notches. Therefore, it is confirmed that notched crystals and stellar crystals are also single crystals.

§ 4. Discussions

Results obtained by the two method show that the disc crystal and the dendrites developed from the disc are not different from ordinary ice crystals belonging to the hexagonal system. This results is in accord with the results observed by IMAI[4] on disc

crystals and by WEINBERG[5] on stellar crystals.

A disc crystal often grows into a very beautiful circular form. When there are neighbouring crystals growing in its vicinity, however, it grows into a deformed shape far from a perfect circle, although it shows a circular nature. The circular development of these crystals is explained by the uniform heat transfer of the latent heat, which flows in all radial directions from the growing disc crystal.

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References

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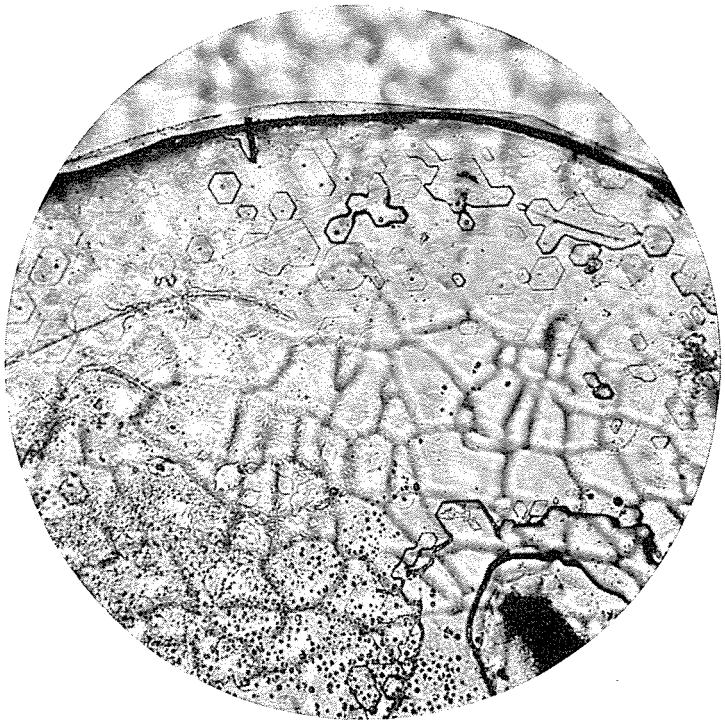

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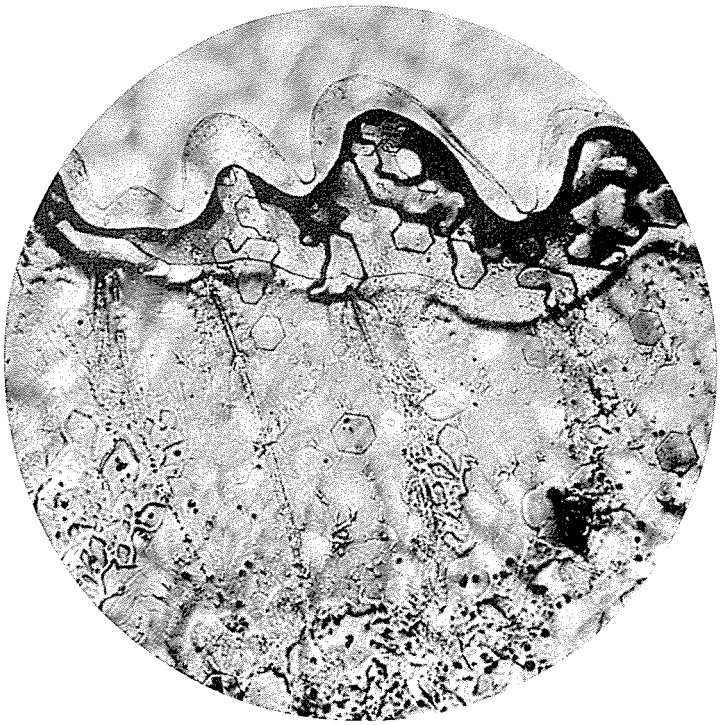
1. Etch figures on a base plane of a disc crystal.



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2. Etch figures on a base plane of a notched crystal.