

Development of Measurement System for Three-Dimensional Structure of Ice Crystals in Frozen Materials

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Three-Dimensional Spectral Imaging System (3D-SIS) has been developed for measuring the 3-D structure and distribution of ice crystals formed in biological materials. The system has functions to reconstruct the 3-D image based on the image data of exposed cross-sections obtained by multi-slicing of a frozen sample with the minimum thickness of 1 μ m and to display the internal structure as well as an arbitrary cross-section of the sample choosing observation angles. The size and distribution of ice crystals can be determined from the 2-D quantitative information, such as the periphery and area of the crystals. The effects of freezing conditions on the morphology and distribution of the ice crystals were demonstrated quantitatively from the observations of raw beef stained by fluorescent indicator. For the samples frozen at -15°C , the network structure of ice crystals were approximately 100 μ m in cross-sectional size and observed mainly at intercellular space, while that prepared at -120°C showed the spherical crystals of 10~20 μ m in diameter within the cells. The 3-D image of the sample demonstrated that the growth of ice columns was restricted by the intrinsic structure of muscle fibers. The proposed method provided a new tool to investigate the effects of freezing conditions on the size, morphology and distribution of ice crystals.