

Measuring Technique for Internal Structures of Ice Cream by Cryogenic Microtome Imaging System

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The objective of this work was to measure the size, morphology, and distribution of internal structures such as ice crystals and bubbles within ice cream samples prepared with two different types of milk solids by using a cryogenic microtome spectral imaging system (CMtSIS). The CMtSIS consists of a microtome unit, a heat exchanger, an automatic high-precision XY stage, an image acquisition unit (with visible, fluorescence, and spectroscopic settings), and a 3-dimensional image processor. The CMtSIS allows for consecutive acquisition of the cross-sectional images of a frozen sample processed through a multi-slicing operation with a minimum thickness of 0.25 μm . The temperature of the heat exchanger can be adjusted from room temperature to $-160\text{ }^{\circ}\text{C}$ by regulating the flow rate of liquid nitrogen. Samples were taken from a commercial standard ice cream and a low-fat ice cream, both of which are available on the market. Bubbles in the ice cream samples were identified as defocused spots in 2-dimensional CMtSIS images due to the differences in focal distance created by vacant spaces, and ice crystals and milk solids were identified using light flux differences reflected by the different interfaces of the ice cream.