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Motivation for X-ray imaging of food

The food quality in many food processes relies greatly on the structural changes that take place during heating or freezing of the food product. So far, it has only been possible to study these changes indirectly but recent new X-ray imaging modalities allow for direct visualization. We present preliminary results of structural changes by heating of bovine meat and freezing of berries inspected with X-ray phase-contrast and dark-field imaging.

Using X-ray imaging to study thermal-induced changes in food

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The method

A grating-based x-ray interferometer uses an interference pattern to increase sensitivity towards refraction effects and enable imaging of ultra small-angle X-ray scattering (USAXS).

The interferometer consists of a phase-grating, G1, which creates a periodic intensity modulation, and an absorption grating, G2, which is used to analyse changes in the interference pattern, by stepping one of the gratings through the pattern, recording an image at each step. [2]

Detecting frozen berries

Frost damages to fruit will cause the fruit to be discarded and is of concern to producers. However, frost damages can be quite difficult to detect in a non-destructive way.

Using dark-field imaging, micro structural changes in berries due to freezing can be detected which are absent in standard X-ray images. [3] Left: Blue berries Right: Black berries

In the dark-field images, CNR values in the range from 2.0 – 2.9 are found between raw and frozen/defrosted berries. For the transmission images the CNR values are 0.1 – 0.2.

Outlook

Phase-contrast and dark-field imaging show potential for direct visualization of thermal-induced structural changes in food products. Expanding on these preliminary findings, dark-field imaging may be of interest in industrial food inspection to discern whether fruit has sustained freezing damages while phase-contrast imaging could become a new standard tool for basic Food Science research.

References