Contribution ID: **4** Type: **Poster**

Seeing Through Food - New X-ray Imaging Modalities in Food Science

Applications of X-ray imaging within food science has previously been limited by the poor contrast in conventional X-ray absorption. However, this has changed with the advent of phase-contrast and dark-field imaging.

Due to the increased sensitivity towards small variations in electron density in soft matter materials, phase-contrast imaging have demonstrated improved signal-to-noise ratios (SNR) as well as contrast-to-noise ratios (CNR) for various food products such as meat [1]. Furthermore by recording the USAXS signal, dark-field imaging provides a sensitivity to ordered micro-structures which has been successfully applied in e.g. detecting foreign bodies in food products [2].

Here we present examples of applications of these novel modalities:

- X-ray phase-contrast imaging was applied to study heat-induced changes in electron density in protein structures in meat [3]. The phase-contrast modality provided an image contrast between protein, connective tissue, water and fat phases which allowed a quantification of parameters such as the cooking loss.
- X-ray dark-field imaging was used to distinguish between raw, frozen and defrosted fruits and berries [4]. When freezing and defrosting the food products, changes in the microstructures such as the pore space provide a contrast in the X-ray dark-field modality.

References

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[2] MS Nielsen, T Lauridsen, LB Christensen & R Feidenhans'l. Food Control, **30**, 531-535. (2013)
[3] R Miklos, MS Nielsen, H Einarsdottir, R Feidenhans'l & R Lametsch. Meat Science, **100**, 217-221, (2015)
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Summary

With the advent of X-ray phase-contrast and X-ray dark-field imaging, novel applications for X-ray imaging within food science have become available.

Phase-contrast imaging provides an increased sensitivity towards electron density differences in soft matter materials such that contrast between even small mass density differences is possible. In dark-field imaging the USAXS signal is recorded which provides a sensitivity to ordered micro-structures such as fiber or grain structures.

Here we present examples of applications of using X-ray phase-contrast imaging to study changes in electron density in protein structures in meat upon heating and applying X-ray dark-field imaging to distinguish between raw, frozen and defrosted food products.

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