



HAL
open science

3D imaging analysis method to measure ice crystal size

Mathieu Sadot, Sylvie Chevallier, Sébastien Curet, Olivier Rouaud, Alain E
Le-Bail, Michel Havet

► **To cite this version:**

Mathieu Sadot, Sylvie Chevallier, Sébastien Curet, Olivier Rouaud, Alain E Le-Bail, et al.. 3D imaging analysis method to measure ice crystal size. 31st EFFoST International Conference, Nov 2017, Sitges, Spain. hal-01833524

HAL Id: hal-01833524

<https://hal.science/hal-01833524>

Submitted on 9 Jul 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Important notes:

Do **NOT** write outside the grey boxes. Any text or images outside the boxes **will** be deleted.

Do **NOT** alter the structure of this form. Simply enter your information into the boxes. The form will be automatically processed – if you alter its structure your submission will not be processed correctly.

Do not include keywords – you can add them when you submit the abstract online.

Title:

3D imaging analysis method to measure ice crystal size.

Authors & affiliations:

Mathieu SADOT¹, Sylvie CHEVALLIER¹, Sebastien CURET¹, Olivier ROUAUD¹, Alain LE-BAIL¹, Michel HAVET¹

¹ONIRIS, Université de Nantes, GEPEA, CNRS,
Rue de la Géraudière - CS 82225 - 44322 NANTES CEDEX 3

Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Freezing is widely used in the food industry to preserve product quality thanks to the low storage temperature. It is well known that a faster freezing enhances frozen food quality while forming smaller ice crystals. Indeed large ice crystals damage cells membranes. However fast freezing processes are energy demanding. It is therefore a challenge to reduce process cost without increasing ice crystals size or to reduce ice crystal size without a dramatically increase of cost.

Some experimental studies have shown that it is possible to obtain smaller ice crystals by using electromagnetic waves assisted freezing [1,2]. The freezing process could thus be carried out with less intensive conditions. To evaluate the impact of this innovative process on frozen product quality, a method had to be developed.

Methylcellulose was chosen as a model gel. A 9 g sample of 2.6 cm height was frozen with gaseous nitrogen at -40°C on its top surface. Other surfaces were insulated to consider unidirectional freezing. The non-porous gel was then freeze-dried to sublimate ice crystal so that crystals phantoms size can then be measured by X-ray tomography [3]. The ice crystal distribution was measured along height by dividing the sample in 8 sub-volumes from VOI1 to VOI8 (Figure 1).

The results obtained showed a logarithmic correlation between crystal diameters and depth (Figure 2). The distribution of crystal size was Gaussian. To evaluate temperature without invasive measurement a predictive model [4] was used to perform numerical simulation from the gaseous nitrogen temperature. It permitted to find correlations between ice crystal sizes, characteristic freezing times and freezing rate.

The coherence of the results allows to validate this analysis method for methylcellulose. In the context of the European project FREEZEWAVE (*FP7-ERA-Net_SUSFOOD*), the impact of low energy microwave pulses during freezing on ice crystal size will then be investigated.

- [1] M. Anese, L. Manzocco, A. Panozzo, P. Beraldo, M. Foschia, M.C. Nicoli, Effect of radiofrequency assisted freezing on meat microstructure and quality, *Food Res. Int.* 46 (2012) 50–54. <http://www.sciencedirect.com/science/article/pii/S0963996911006491>.
- [2] E. Xanthakis, A. Le-Bail, H. Ramaswamy, Development of an innovative microwave assisted food freezing process, *Innov. Food Sci. Emerg. Technol.* 26 (2014) 176–181. <http://dx.doi.org/10.1016/j.ifset.2014.04.003>.
- [3] R. Mousavi, T. Miri, P.W. Cox, P.J. Fryer, Imaging food freezing using X-ray microtomography, *Int. J. Food Sci. Technol.* 42 (2007) 714–727. doi:10.1111/j.1365-2621.2007.01514.x.
- [4] M. Sadot, S. Curet, O. Rouaud, A. Le-Bail, M. Havet, Numerical Modelling of an Innovative Microwave Assisted Freezing Process, *Int. J. Refrig.* (2017). doi:10.1016/j.ijrefrig.2017.04.017.

Important notes:

Do **NOT** write outside the grey boxes. Any text or images outside the boxes **will** be deleted.

Do **NOT** alter the structure of this form. Simply enter your information into the boxes. The form will be automatically processed – if you alter its structure your submission will not be processed correctly.

Do not include keywords – you can add them when you submit the abstract online.

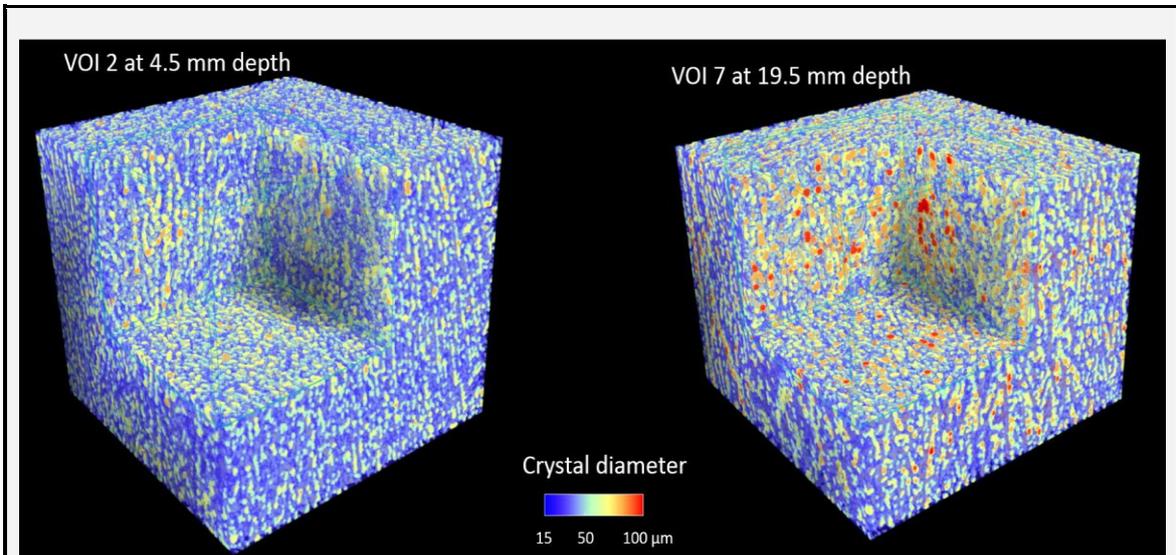


Figure 1. Ice crystal size in two different sub-volumes.

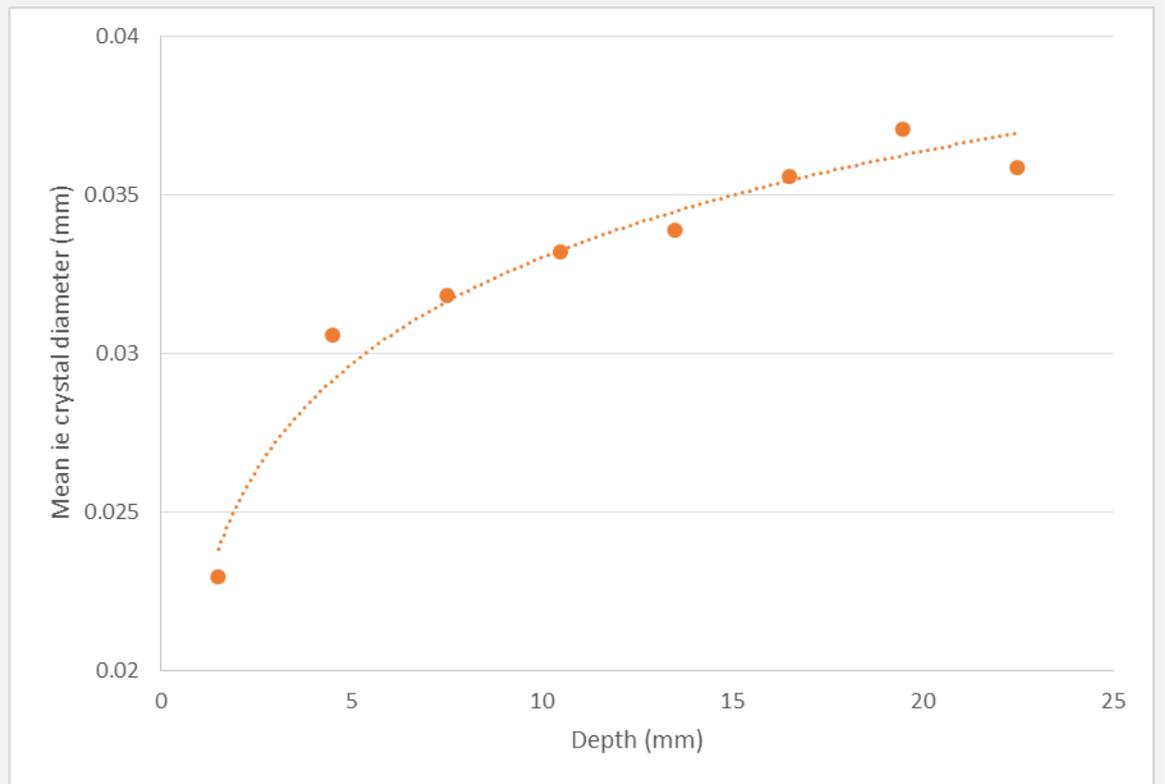


Figure 2. Mean ice crystal diameter as a function of sample depth.