Innovative and low energy microwave assisted freezing process for high quality foods

http://freezewave.eu

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THE FREEZEWAVE PROJECT:

FREEZEWAVE is an ERANET project funded under the SUSFOOD umbrella by European National Agencies & European Commission.

FREEZEWAVE started on 1st May 2015 and will be closed in December 2018

http://susfood-db-era.net/drupal/

THE FREEZEWAVE CONSORTIUM:

FREEZEWAVE partners are

- ONIRIS-UMR GEPEA – CNRS 6144 (France)
- SAIREM – SME (France)
- RISE-Research Institutes of Sweden (Sweden)
- TTZ Bremerhaven(Germany)

THE FREEZEWAVE OBJECTIVES:

FREEZEWAVE aims at understanding the effect of electromagnetic perturbation (Microwave/2.45 GHz) on crystallization in the case of food freezing. Each partner is equipped with a batch prototype MW assisted freezer to optimize the technology for lipids, emulsions, fruit & vegetables (ONIRIS), meat (RISE) and fish (TTZ). In the end of the project, an innovative microwave assisted freezing process will be developed to obtain high quality frozen food with optimized energy demands.

RECENT FREEZEWAVE RESULTS:

➔ *EQUIPMENTS*

FREEZEWAVE partners are equipped with freezers connected to a low energy solid state emitter manufactured by SAIREM. Powers from 1 watt until 150 watts can be delivered to the food in a continuous way or with specific pulse sequences.

➔ *MODELLING*

A modelling approach is carried out by ONIRIS in collaboration with RISE. M SADOT, PhD student in ONIRIS works on the optimization of the process considering a single mode wave guide. The figure below presents the experimental installation. M SADOT works on gels used as model food systems.

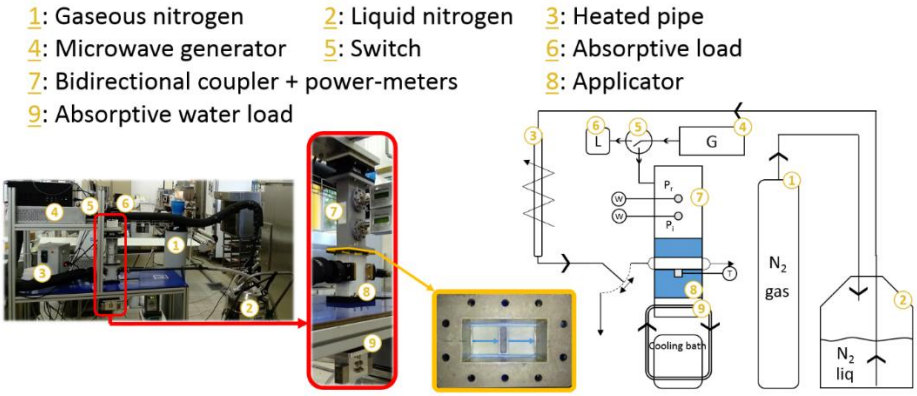

Figure 1 : Experimental equipment used by M SADOT at ONIRIS for the modelling activity

The interest in this study is to understand and predict the interactions between microwaves and food during freezing. Due to the big differences of the dielectric properties between frozen and non-frozen state, the reflection at the product surface, the microwave penetration depth and the generated heat generated by microwave heating within the product change a lot during the freezing process. It's even more complex because of the heterogeneity of the phase change along the product depth. The solving of the Maxwell's equations coupled to the resolution of an original enthalpy formulation of the heat equation permits to model properly the thermal behaviour of the microwave assisted freezing process. RISE interacts with ONIRIS on the modeling aspects. Specific original mathematical and physical models are used for the prediction of the dielectric properties of food during freezing. These data are of ultimate importance for the global models developed at ONIRIS. Recent results were presented at the 16th International Conference on Microwave and High Frequency Heating AMPERE 2017, Delft, The Netherlands, (http://www.ampere2017.nl/program/show_slot/32).

M. Sadot received the prestigious "BIOT & FOURIER Award" in 2016 during the annual congress of the "French Society of Heat Transfer" (SFT), confirming the very original work and innovative approaches developed within FREEZEWAVE thanks to the collaboration between ONIRIS and RISE.

➔ ***RESULTS ON FOOD SYSTEMS***

ONIRIS works on apple, potato and sauce as model systems. Piyush Kumar JHA is preparing a PhD at ONIRIS on these food systems. Results obtained on apple using CRYO-SEM are shown below, evidencing the benefit of micro wave assisted freezing (image on the right). Further work is now starting on sauces and emulsion systems.

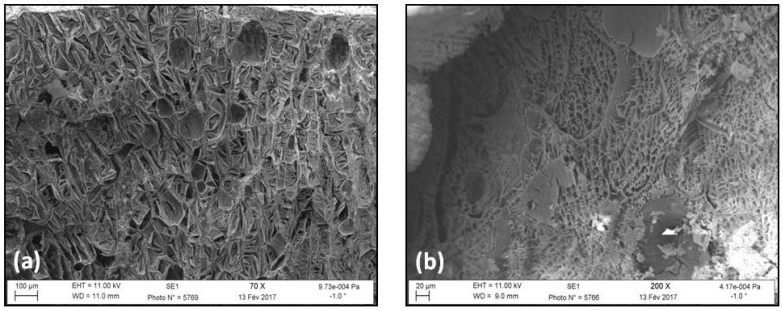

Figure 2 : Cryo-Scanning Electron Microscopy images of frozen apple tissue; (a) conventional freezing, (b) microwave assisted freezing (5 watts, constant power). These images show the inside of frozen cells. Ghosts of the Ice crystals correspond to the small cavities, which are much smaller for microwave assisted freezing than for conventional freezing.

TTZ works on fish (Cod species as model system). First results concern mainly microstructure. Care has been taken to freeze the fish in a well-defined timing with respect to slaughtering. Indeed, freezing in pre rigor conditions yield in intracellular ice. First images showing trends of microstructure improvement by using FREEZEWAVE technology are shown below; in the case of microwave assisted freezing, a combination of intra and extra cellular ice crystals has been observed.

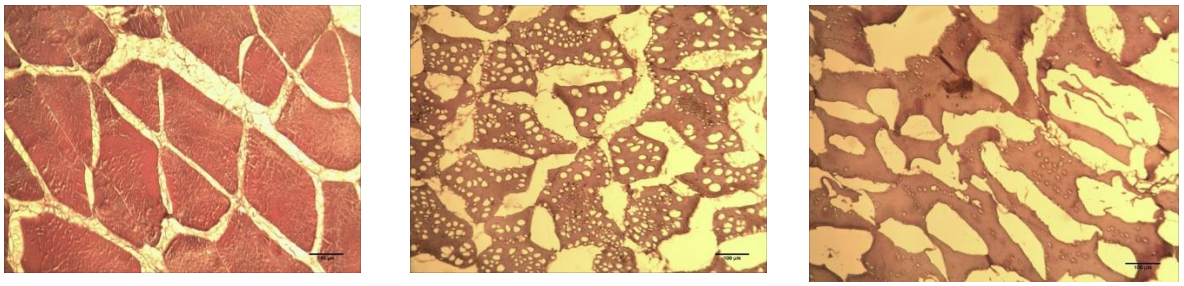

Figure 3 : Micro structure of COD-FISH tissue fresh (left), frozen with conventional (center) and microwave assisted freezing (right). Optimization of the process is closely linked to the freshness of the fish. Intracellular freezing is expected to occur in pre rigor state, which may induce freeze damage. In the case of freezing assisted with micro wave, a combination of intra and extracellular ice is observed.

RISE (Sweden) works on chicken and pork loin filet as meat model systems as well as on dielectric properties measurements during freezing and thawing of all the involved food systems. First results concern mainly microstructure indicating also trends of microstructure improvement by using FREEZEWAVE technology are shown below.

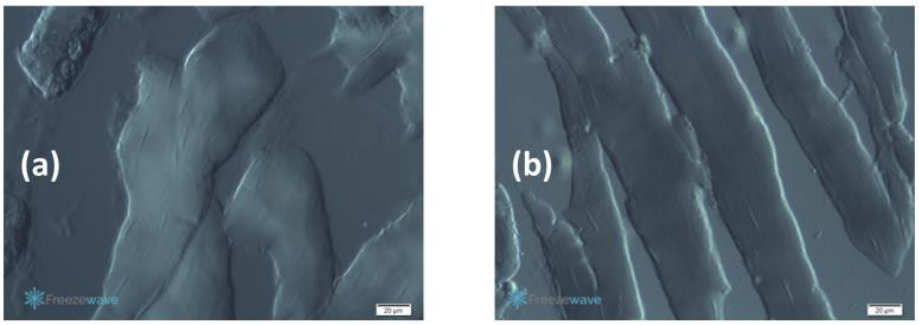

Figure 4 : Microstructure images of chicken breast tissues after (a) conventional freezing and (b) microwave assisted freezing (8 watts constant MW power)

SENSORY TESTS

Sensory tests will be carried out during the first semester of 2018 at TTZ research center to assess the interest of the FREEZEWAVE Technology. Tests will be carried out on Potato, Sauce, Fish and Meat

Figure 5 : IMAGE – TTZ (Bremerhaven – Germany) will take care of the sensory tests that will be carried out to compare different food frozen with different technics. Ranking tests and triangular tests are envisaged and will be applied to Potato, Sauce, Fish and Meat.

FORTHCOMING COMMUNICATION AND DISSEMINATION

You can meet FREEZEWAVE in the following congresses:

- EFFoST 2017 – Sitges (Barcelona)-SPAIN 13-16 November 2017 http://www.effostconference.com/
- ICCC Conference – Beijing – CHINA 6-8 April 2018 http://iccc2018.medmeeting.org/en
- FINAL PROJECT CONGRESS: 5th Nov 2018 in NANTES – FRANCE as a pre-congress of EFFoST 2018 held in Nantes – FRANCE 6-8 Nov 2018

CONCLUSION

FREEZEWAVE project is now progressing quickly. First results confirm the initial results obtained in preliminary published studies (Xanthakis et al., 2011). More information on freezing under electric and magnetic field from FREEZEWAVE consortium are available below. We hope to meet you in Beijing next April 2018 and in Nantes on 5th Nov 2018 for FREEZEWAVE final conference and dissemination.

MIDNIGHT FREEZEWAVE Sunset in SALTHOLMEN Island – SWEDEN during the last meeting (RISE)

Freezewave

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