MICROWAVE TECHNOLOGIES ASSOCIATION

HIGHLIGHTS

Winter 2019, Issue 103 Newsletter for the MICROWAVE TECHNOLOGIES ASSOCIATION

From our Chairman:

It is said that a picture says a thousand words…
Amongst the usual routine of running the MTA's office, it's been another busy PR related year here at the MTA with the Microwave cooking show at the IMPI Conference in Las Vegas last June, that was just one of 14 microwave cooking shows put on during the year.

An opportunity to 'quiz' the likes of Rick Stein and Yotam Ottolenghi, together with other members of the Radio 4 'Food programme'. At least we were able to make them aware of the existence of the MTA!

To giving live interviews on BBC Radios Berkshire and Surrey in November with Debbie McGee – all about making Christmas cooking easier – with better use of your microwave oven.

Long may we continue to educate everyone about our passion!
I wish you all a happy and safe holiday season.
Best wishes
Jennipher Marshall-Jenkinson

Special Feature – Solid-State Microwaves

Although the topic of solid-state microwaves was briefly discussed in issue 101, a more in-depth article was considered important due to the implications of this new method of generating microwave energy.

The discovery of microwave's ability to heat food in the 1940s sparked a revolution. Aside from the domestic heating of ready meals, the industry has found many ways to apply this technology, with commercial processes that include raw meat cooking and ready meal sterilisation. It continues to develop methods to this day with new technologies such as continuous flow microwave processing. However, around 70 years on, while they may be almost ubiquitous, it is evident that traditional magnetron microwaves still have some issues.

What are the issues with traditional microwaves?

Traditional magnetron microwave ovens remain one of the few technologies that have experienced little change since they were first invented. The convenience of this technology for heating food is unparalleled. Although, with a 'fixed' frequency and (usually) only one energy source (magnetron), traditional microwaves can cause non-uniform heating of foods, creating hot and cold spots in a product which can impact food product quality (Figure 1).

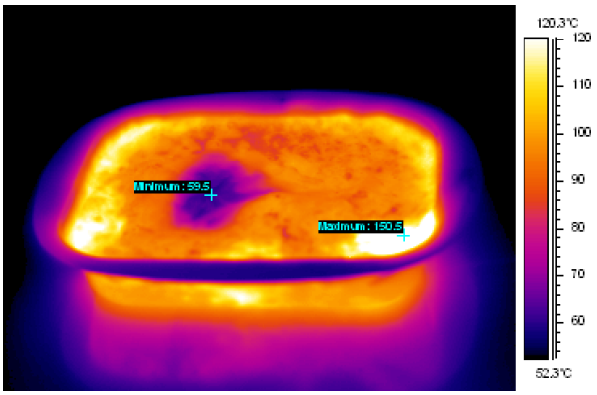

Figure 1: The lack of uniformity in heating this ready meal is apparent with a cold spot (surface temperature in this case) of approximately 60°C and a corner temperature of over 150°C.

But just how limiting can a 'fixed' frequency be when heating food? A fixed frequency means a fixed wavelength (frequency and wavelength are related). Simply put, when a single source of microwave energy of a fixed wavelength enters the oven cavity, it can be reflected off the walls forming a 'fixed' pattern of microwave energy inside the cavity with some areas of higher energy and some areas of lower energy. The result? Hot and cold spots in foods. If there are multiple sources of microwave energy and/or if the frequency (and thus wavelength) are changing, then the microwave (field) pattern inside the cavity can vary, meaning more even heating. With these points in mind, it is easy to see how specific areas of a food could be 'neglected' during heating with a traditional magnetron microwave and thus remain colder than other parts. Or conversely, how some areas could be over-heated from excess exposure to the microwave energy. Figure 2 shows how these variances in heating uniformity can differ even between microwaves of similar power output.

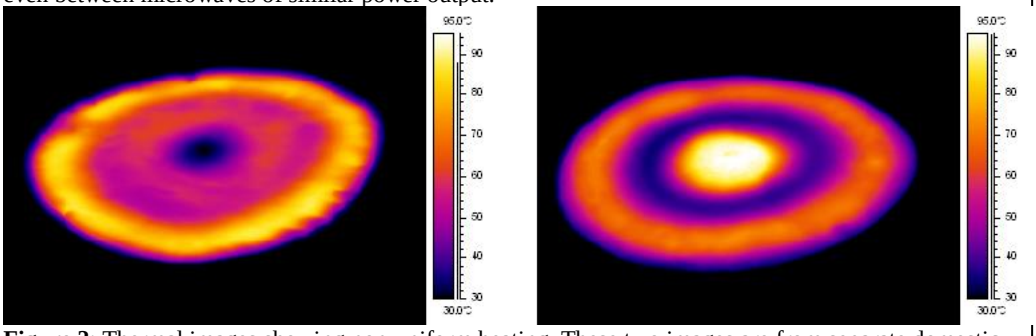

Figure 2: Thermal images showing non-uniform heating. These two images are from separate domestic microwaves with a similar rating (wattage). When heating the same product, they were found to have different heating patterns; the right image showing a hot spot in the centre and the left showing a cold spot in the same place, but with more heating around the edge of the product.

Turntables/stirrers can help to reduce this non-uniformity, but they are not a panacea - some parts of the product can still be over-processed when ensuring that the whole product has received a targeted temperature for a specified hold time (thermal process). The non-uniform temperature distribution raises the issue of food safety with the possibility of microorganisms within the cold spots not being destroyed. This is unless thorough instruction testing has been performed. For example, using several microwave ovens with different heating patterns (as shown in the above images) to test cooking instructions.

An unexpected solution to these problems may well come from a relatively recent development, the advent of smart phones - and subsequently the invention of the solid-state microwave generator.

What are solid-state microwaves?

The rapid developments in the telecommunications sector to accommodate smart phone wireless communications has led to the advance of solid-state semiconductor devices. These devices can generate and amplify radio frequency (RF) signals that the phones use for data transmissions.

However, the solid-state semiconductors can produce variable frequencies, including the microwave frequencies (2.4-2.5GHz) that we're interested in. This opens the potential for these devices to also be used for food heating applications.

How could solid-state microwaves overcome the issue of non-uniformity?

Solid-state RF technology has the potential to enable slight changes in the frequency, measure the energy in the cavity for feedback and shift the frequency and phase in 'real-time'. When heating food this could minimise standing waves and potential hot spots which will improve product quality by heating it more uniformly. It could also reduce the chance of over-processing and the risk of under-processing.

Uniformity may also be improved with multiple energy sources. As mentioned, traditional magnetron microwaves usually only have one energy source, however the multiple microwave generators of solid-state microwaves allow simultaneous heat penetration from several energy sources. From this you can see how exposing a food product to microwaves from multiple sources simultaneously could distribute the microwaves (and subsequent heat) more evenly.

The future of solid-state microwaves

Due to cost implications, solid-state microwaves currently only hold potential in combination ovens. But as the technology develops and the price comes down, it's possible that these microwaves will challenge or even replace traditional magnetron microwaves. The applications of these solid-state microwaves will then depend solely on our creativity.

So, what's in it for the food and drink industry?

If this technology can prove itself with more uniform heating than what we see in conventional magnetron microwave ovens, the industry may find itself with a new and revolutionary heating method in its tool box.

More uniform heating will reduce the possibility of over-processing in specific areas of the product which will likely improve overall product quality. Under-processing will also be far more unlikely and will therefore increase the safety of such foods.

Researching the new technology

As part of Campden BRI's research into emerging technologies, they are exploring the potential benefits of solid-state microwaves as part of a feasibility study. With the processing kit installed, they are conducting initial trials on ready rolled pastry and mashed potato to evaluate the heating performance of a solid-state microwave cooker and contrasting with a traditional magnetron microwave powered device. The investigation will determine whether the solid-state microwave can reduce hot and cold spots in a product as it applies the mechanisms discussed above. The trials will also investigate whether traditional magnetron microwave issues, such as power output dependence on mains supply voltage and power drop off with magnetron warming can be reduced using solid-state generated microwave energy.

The research is part of Campden BRI's member-funded 'New Technologies for Food and Drink Manufacturing' project which has been running in various forms since 1990. Although this work is confidential to members of Campden BRI, a summary of the results will be made available (and published here!) in due course.

For further details contact **Danny Bayliss**, New Technology Research Team Leader at Campden BRI.
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Forthcoming Events

E. coli STEC and Salmonella – still on the loose and wreaking havoc
Seminar: Thursday 27th February, Campden BRI, Chipping Campden, Gloucestershire, GL55 6LD, UK
See: https://www.campdenbri.co.uk/stec-salmonella-seminar.php

The UK show for food processing, packaging and logistics 'Foodex' - will be held March 30th to April 1st at the NEC, Birmingham, B40 1NT.
Further details see: https://www.foodex.co.uk/

The 54th Annual Microwave Power Symposium (IMPI 54)
Jun 15th - Jun 17th, The DeSoto Hotel, Savannah, Georgia, USA
Deadline for Abstract Submission: January 15th , Acceptance Notices: February 14th , Final Papers Due: March 13th
Additional details can be found at www.impi.org

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