Modern microwaveable packages

Aluminium foil packages are safe in microwave ovens

Figure 1: Cooking chamber of microwave oven with microwave window in the right side wall and with glass turntable. Cover of microwave window is removed.

In the perception of most microwave oven users, all metal items including food packages with aluminium foil have to be banned from the oven. This perception is enhanced by manuals and general guidelines, which strictly advise not to introduce metal into the microwave oven. Aluminium foil packages are not even mentioned in most manuals. Interestingly, the same manuals promote the use of household foil to cover exposed parts like the legs of a chicken during microwave heating [1].

Contradiction

Neglecting packages with aluminium foil for microwaveable foods is however not justified by microwave physics and is in contradiction to numerous experimental studies in the past [2, 3, 4, 5]. The studies dating from the 1970ies through the 1990ies agree that use of aluminium foil trays in the microwave oven is perfectly viable and can lead to good heating results. A recent experiment carried out at the Fraunhofer Institute for Process Engineering enforces the earlier results [6].

Modern microwave ovens are equipped with a glass or ceramic turntable onto which food containers or dishes are placed **(Figure 1).** The turntable promotes more uniform heating by continuously turning the food container through the microwave interference pattern inside the oven chamber. The microwave energy enters into the chamber through a microwave window, mostly at the right side wall of the oven, and is reflected and scattered by the oven walls until it is absorbed in the food. A small part of the energy may be reflected through the window back to the magnetron, the device producing the electromagnetic microwave field. If, however, no absorbing material is present in the oven chamber, large amounts of power can be reflected back and can lead to thermal wear of the magnetron. The presence of food containers with aluminium foil does not alter the situation significantly. The contribution of such containers to the back reflection is small and does not affect the operating life of the magnetron [4].

A further concern in connection with food packages containing aluminium foil in microwave ovens is the formation of sparks between container and metal walls of the oven chamber. These sparks are safely avoided if only a few millimetres wide air-gap is maintained between the food package metal surface and the oven wall. The glass turntable supports a safe distance of package material to both, oven chamber walls and floor, and makes occurrence of sparks extremely unlikely.

The Fraunhofer Institute for Process Engineering and Packaging recently carried out a study in order to re-assess microwave heating of food in different packaging solutions containing aluminium foil in a number of modern microwave ovens for the home kitchen. The tested packs included aluminium foil trays in different sizes, plastic containers with foil or laminated foil lid, and dishes covered with household foil. **Figure 2** shows two of the used foil trays. Performance comparison was made with similar plastic trays. Four different ovens with microwave-power ratings from 700 W to 1000 W were used. The heated foods were egg batter, frozen lasagne, and minced meat. Microwave heated foods were investigated for minimum and maximum temperatures, temperature patterns, and visual appearance of food.

Results of the microwave heating experiments with packages containing aluminium foil can be resumed as follows:

– Microwave heating of food packages containing aluminium foil is safe.
– Good heating quality can be achieved in the microwave oven.
– Rapid heating can be attained.

Safe microwaving with aluminium foil

More than 200 packages with aluminium foil were heated in microwave ovens without a single case of hazardous condition or damage of oven. Electric sparks with aluminium foil trays were only observed in severe abuse situations, where empty trays touched each other or touched the oven wall during microwave exposition. The abuse situations had to be provoked and it is unlikely to create them by careless operation. Thus this situations will hardly occur during normal operation of the microwave ovens. Even though sparks can look spectacular, they are not dangerous nor do they damage the oven. Mostly they result in small marks or burnt

Photos: FhG

Figure 2: Two aluminium foil containers used in the microwave heating experiments. Left: single compartment container. Right: dual compartment container.

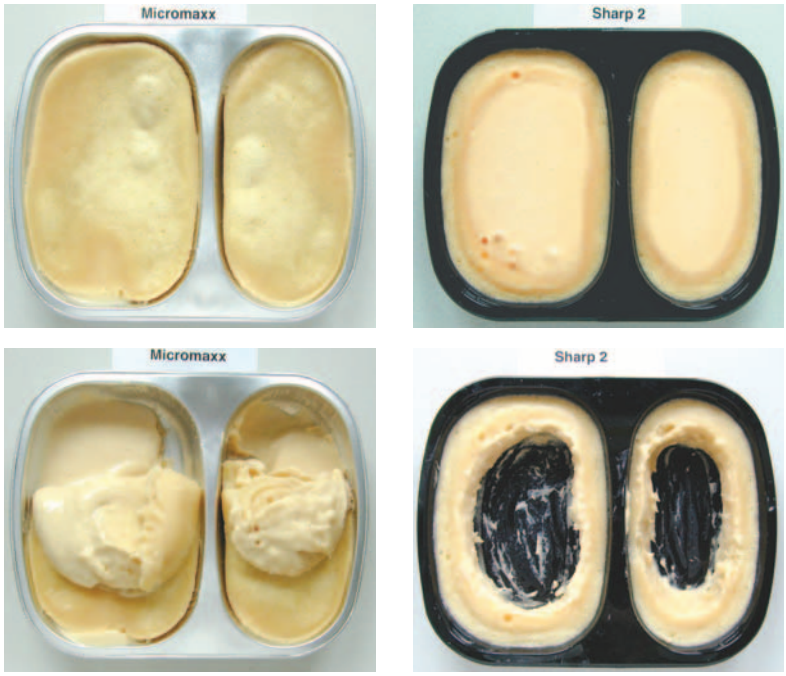

Figure 3: Heating patterns visualised with egg batter in dual compartment foil (left) and plastic trays (right). Below left: liquid batter at bottom of foil tray. Below right: liquid batter at centre region of plastic tray was scraped away.

spots in the oven walls that are without consequence on the oven's operation.

Good heating by microwaving

The heating quality of food in packages with aluminium foil was similar to heating in plastic trays though heating patterns were quite different. Temperature patterns can be visualised in a simple way by heating liquid egg batter for a short time and then separate solidified batter from still liquid material. This is shown in **figure 3**. In the case of foil trays, microwave power enters the food load generally from the surface of the tray filling, where the batter starts to solidify. Direct access of the microwave field to batter at edges, corners, and bottom is shielded by the foil. Therefore it heats at a slower rate and stays liquid for a longer time. Minimum temperatures were measured at tray or compartment edges and corners in particular at the bottom, maximum temperatures were always at the surface near the tray or compartment centre.

Microwave heating patterns in plastic trays were nearly complementary. Solidification of batter started at edges and corners of filling. Most of the centre area including the surface heated slower and stayed liquid with the chosen heating times. The liquid batter fraction has been scraped away in **figure 3** bottom/right for better visualisation of the heating pattern. Maximum temperatures were measured at corners and edges while minimum temperatures were measured at surface near the centre of the tray or compartment.

With some foods like frozen lasagne and minced meat, temperature patterns seemed to be more uniform in aluminium foil trays than in plastic trays. In some cases, the visual appearance of heated food was better in aluminium foil trays by surface browning and crust forming, while in plastic trays the food surface remained wet and soft. This is exemplified in **figure 4,** which shows a comparison between lasagne heated in foil and in plastic tray. In practically all heating trials, it was possible to achieve satisfying results with aluminium foil trays as well as with plastic trays with a simple heating scheme. The oven power was set to maximum and chosen heating times resulted from a schematic calculation. Further improvement of heating in aluminium foil trays seems possible, if the heating regime is optimised and adapted to the specific food and to tray geometry.

Rapid heating

Microwave heating in packages containing aluminium foil is in many situations nearly as quick as in plastic packages. In order to achieve the same heating effect heating times for foil trays had to be longer as compared to the heating time for plastic trays. Depending on food composition and tray geometry the heating time was extended by 20% to 70%.

The consumed electric energy was higher by the same proportion. A large influence of oven design on heating performance with aluminium foil trays was also observed. Generally, the heating efficiency was lower for small foil trays and higher for large foil trays. Dependence of heating efficiency from food properties was not quite as clear. Efficiency was at the low end for heating tests with tap water and at the high end for egg batter. Frozen lasagne and minced meat were in between. In plastic containers with foil lid, the effect of the lid on heating efficiency was very small. The heating time extension

Figure 4: Frozen lasagne after microwave heating to serving temperature in foil tray (above) and in plastic tray (below). Lasagne in foil tray has a crust.

required to achieve the same heating effect as without lid was estimated to about 10%.

Conclusion

Microwave heating of food in packaging solutions containing aluminium foil is perfectly viable. The operation is safe, if some simple rules are followed. Heating results are similarly satisfying with packages containing aluminium foil as with plastic packages. However, heating patterns are quite different and require careful product development. Packages with aluminium foil are therefore a viable option for microwaveable foods and should not be neglected, if new food products are developed. In specific applications like combination heating, they may offer a real advantage. ■

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References

1 Pfeiffer T.: Literature Study on Microwaveability of Aluminium Foil Packages. Report, Fraunhofer-Institut für Verfahrenstechnik und Verpackung IVV, Freising, 2005.

2 Decareau R.V.: The Effect of Aluminium Packaging Materials on Microwave Oven Performance. Final Report, 1978.

3 Foil container bureau: Foil containers in microwave ovens. Notes on tests conducted by Campden Food and Drink Research Association, 1990.

4 Wirth O.E.: Aluminium foil containers for microwave ovens: exploding the myths with hard facts. Journal of Packaging Technology 2 (2), 1988, pp 52-54, 76; Verpackungsrundschau 11, 1991.

5 Ahvenainen, R., Heiniö, R.-L.: Factors Affecting the Suitability of Aluminium-foil Trays for Microwave Oven Heating: Comparison with Plastic Trays. Packaging Technology and Science 5, 1992, pp 255-264.

6 Pfeiffer T.: Experimental Study on Microwaveability of Aluminium Foil Packages. Report, Fraunhofer-Institut für Verfahrenstechnik und Verpackung IVV, Freising, 2006.

Microwaveable containers from Spain

EDV Packaging drinks Gallina Blanca's caldos/twelve months shelf-life

Photo: EDV Packaging

It is a good time for pre-cooked meals and healthy snack markets, so Gallina Blanca has joined the trend of packaging with on-the-go caldos packed in rigid barrier plastic containers. Throughout the last decade, ready-to-eat caldos and soups have been sold in one litre family tetra-brick packages, but Gallina Blanca chose EDV Packaging to develop the individual microwaveable container that was launched in the Spanish market in December 2005. The supplier coextrudes and thermoforms the base material at its production plant in Barcelona and has designed a modern container with a PP/EVOH/PP white structure. The combination of barriers is said to guarantee a good thermal stability through a robust sterilisation process. The product is stored at ambient temperature and offers twelve months shelf-life, according to the company.

The microwaveable package has a diameter of 89,5 mm, a height of 101 mm and a brimfull capacity of 320 cc. Moreover, the package offers properties such as long preservation of packed product and barriers to oxygen and moisture. The cup has been designed with the inclusion of ribs in the side panels for two purposes. Not only to resist deformation in processing, but also to offer some insulation properties to the customer during consumption when the product is hot.

The cup has been hermetically sealed using a peelable plastic lidding, thus offering a 100% plastic barrier solution. It has been decorated with a high quality shrink sleeve, rotogravure printed, and an injected rigid overcap – supplied by Procap Llagostera – which assists in stacking. Altogether, the pack has a significant on-shelf presence and is eyecatching and attractive to consumers who are looking for a quality product and convenience, the manufacturers believe. ■