# Exposure of Plastic Cling-Wrap Packaging to Microwave Energy

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## Summary and Conclusions

This writer is a polymer chemist with many years of industrial experience. He has followed the debate regarding the "release of toxic chemicals from plastic packaging when exposed to microwave irradiation" with interest, and concludes that:

- Cling-wrap plastic films are usually made from polyethylene or plasticized polyvinyl chloride (PVC), whilst rigid containers are usually made from polystyrene, polyester, or polypropylene.
- All plastic packaging designed for use in direct food contact must qualify against very stringent extraction testing in order to meet FDA approval.
- There is nothing which would deter him from using plastic 'cling-wrap', which is identified as "microwavable".
- There is no toxic hazard arising from cling-wrap film which becomes hot
  when used as a 'splatter shield' cover - when heating food, such as baked beans, in an open ceramic dish using a microwave oven.
- He would not hesitate to microwave-heat food which is wrapped in the plastic package 'as purchased' from the Supermarket (frozen dinners). Although he would make small holes in it to allow any steam generated from the hot food to escape !
- Plastics do not absorb microwave energy (radiowaves), hence do not get hot upon exposure to microwave energy.
- A plastic film will pick up heat if it is in direct contact with microwave-heated food, so he would try to prevent the plastic cling-wrap film from contacting the food - because he wants it to stay cool enough to be removed by hand.
- The reports that ".... rigid plastic containers melt in the microwave" is an incorrect interpretation of the change in shape of a microwave-exposed food or beverage container. In fact the observed dimensional change are the result of the plastic undergoing a phenomenon known as 'stress relief' when exposed to the moderate temperatures developed in a microwave oven.
- He will continue to cook his 13 kg Christmas turkey using a nylon bags - to contain the fat splatter - in a conventional oven set at 200 degrees centigrade - much higher than the temperatures experienced by microwaved food.. The nylon plastic is designed to survive this extreme temperature for a much longer time than required to cook the bird.

## Background

The focus of this note is to explore the safety aspects of food and drink containers which are exposed to microwave energy in order to heat their contents. Stories of how dangerous, toxic, chemicals can 'leach out' into microwaved food have circulated on the internet for years. Such stories are without foundation.

Microwave energy is delivered to the food in the form of high frequency (2.5 gigahertz) radiowaves (1). Radiowaves have the interesting property that they are absorbed by water, fats, and sugars and converted directly into heat as they cause the chemical bonds holding these molecules together to vibrate rapidly.

Most plastics (see below for the exception of plasticized PVC), glass, and ceramics do not absorb microwaves - hence do not get hot. It is well known that metals reflect microwaves, which is why metal pans do not work well in a microwave oven, and why plastic film containing metal particles is used for the packaging of 'microwavable popcorn'.

Manufacturers of cling-wrap films and food trays are well aware of the rigorous FDA extraction testing requirements regarding 'extractables' from these articles when used in direct food contact, and proudly display the term 'microwavable' or 'microwave safe'on their products. One should always look at the cling-wrap package for these terms to be sure that the film has been designed for this application.

## Discussion

The basis for the conclusions listed above follows, using a series of questions to clarify issues around the microwaving process.

## General Questions:

### 1. What are Microwaves?

Microwave energy is delivered to the food in the form of high frequency (2.5 gigahertz) radiowaves. There is a wide range of different types of radiation, called the electromagnetic spectrum - ranging from low energy radiowaves, through infra-red, visible light, ultra-violet light, to high energy x-rays, gamma rays and cosmic rays.

### 2. How Do Microwaves Heat-up Food?

The chemical bonds which make up the chemical structure of water, fats, and sugars absorb the low energy of the radiowaves - causing them to oscillate and generate heat. Most food contains a combination of water, fat and sugars - and will respond to microwave energy by getting hot fairly quickly.

An acceptable level of heat generation is in the region of 60 degrees celcius.

**3. Do Plastics Absorb Microwaves (Radiowaves)?**

No. The chemical bonds which make up most plastics (carbon-hydrogen bonds) do not respond to microwaves (radiowaves). If you want to heat up plastics you need to use higher energy radiation such as infra-red or ultra-violet rays.

**4. Why Does Cling-Wrap Film Become Limp and Get Hot?**

The film will respond to direct contact with the hot food by becoming hot. It will become less stiff (see below) as the temperature increases, but this does not indicate that it has become 'unstable' to the point where it is breaking down chemically . There should be a one-inch or greater space etween the shrink-wrap plastic film and the food during microwave heating (2). The film should be placed loosely over the food so that steam (generated by microwave heating of water in the food) can escape.

**5. Why Do Plastic Films or Rigid Containers Appear to Melt When Exposed To Microwave Energy?**

People assume that the distortion of the plastic film, bottle, or tray (containing food or beverage) which they observe when it is exposed to microwave radiation implies that the plastic is melting. This is a common misunderstanding - the appearance of melting is simply heat distortion of the plastic article - a phenomenon known as 'stress relaxation'.

An example of this is when a PET bottle is partially filled with water and exposed to microwave energy. It will distort in a rather spectacular fashion!

**Why does this happen -:**

During its manufacture, the film, bottle or tray is the molten plastic is forced through a shaping device - a film or sheet die, a bottle blowing operation, or a 'thermoforming' process in which an extruded sheet is forced into the shape of a tray. These processes create regions within the plastic shape that are severely stressed (like a coiled spring). These stressed parts are dimensionally stable until they experience heat, through contact with the hot food or beverage - which allows this stress to relax (the spring uncoils), and the part undergoes distortion - changes shape.

**6. Which Plastics Are Used For Cling-Wrap Films?**

There are two common plastics used for shrink-wrap film manufacture - polyethylene and plasticized poly vinyl chloride (PVC).

Polyethylene is a very thermally stable plastic, and is ideal for any end-use application where the ambient temperature is below 100 degrees centigrade. At room temperature the PE film is quite flexible but, as the temperature increases towards its melting point (~100 degrees C), the film softens and eventually melts. A desirable temperature for microwaved food is ~60 degreesC, so the PE cling film is well below its melting point and, at no time - even above its melting point - does the plastic exude any toxic components.

Polyvinylchloride (PVC) is the rigid material used for the manufacture of guttering and downspouts. PVC shrink-wrap film is flexible because the rigid PVC hs been 'plasticized' by blending it with a liquid which is very compatible with PVC. This 'plasticizer' acts like an internal lubricant by allowing the polymer chains to slide past each other - making the film very flexible.

It is possible for a minor portion of this liquid plasticizer to migrate out of the hot PVC shrink-wrap film during microwave heating - and come in contact with food which is in contact with the film. Because these small molecules also 'like' fatty foods, there is increased potential for their migration from the flexible PVC cling-wrap if it is in contact with a microwave-heated fatty food.

**7. Are the Plasticizers Used To 'Flexibilize' PVC Toxic?**

There are literally hundreds of plasticizers - usually small molecules, which are very compatible with PVC. One plasticizer, diethyl hexyl adipate (DEHA), has received a lot of negative publicity on the basis of (non-proven) potential toxicity. Because of this it was voluntarily withdrawn as a plasticizer for PVC in New Zealand. A similar unsubstantiated rumour regarding phthalate ester plasticizers led New Zealand cling-wrap manufacturers to eliminate this family of plasticizers from their products.

All plasticizers used for flexible PVC food contact cling film must meet the stringent human toxicity safety limits defined by the FDA based on animal testing. The cling-wrap film must also meet these same regulations using extraction testing protocol established by the FDA. Actual testing of cling-wrap film samples shows that levels of plasticizers extracted from cling wrap films based on plasticized PVC are well below these stringent safety limits established for the plasticizers.

**8. Do Plastic Food Containers Release Dioxins When Heated in a Microwave?**

No. This was an email hoax. Plastics used for food contact/ microwaving do not contain the 'building blocks' which would be required to make dioxins. In fact, even with the appropriate ingredients the synthesis of dioxins requires temperatures above 300 degrees centigrade - well beyond the capability of microwaving (3).


REFERENCES

(1). Marshall Brain, http://home.howstuffworks.com/microwave1.htm

(2). Edward Machuga Ph.D, FDA Centre for Food Safety, http:www.fda.gov/fdac/features/2002/602_plastic.html.

(3). http://www.plasticsinfo.org/s_plasticsinfo/sec_level2_faq.asp

(4) Jean Weese, Extension Food Scientist, 334-844, 3296

**Other Resources and google links;**
Microwave Heating Guide
Plastics Division of the American Chemistry Council
Microwaving Plastics
American Cancer Society
Plastics and the Microwave
FDA Consumer, US Food and Drug Administration,
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