WHY YOU GENERALLY SHOULDN'T PUT METALS IN THE MICROWAVE

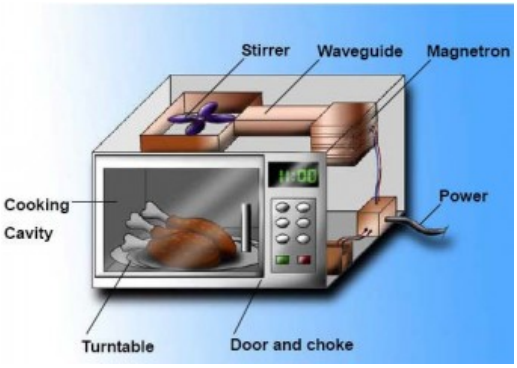
DAVEN AUGUST 31, 2010 7

Today I found out why you generally shouldn't put metals in a microwave.

First, it should be noted that it is not unsafe to put all metals in the microwave. Indeed, you often put metals in the microwave anytime you put a hot pocket in the little pouch and place it in the microwave. The pouch has a thin layer of aluminum lining the inside that is designed to absorb the microwaves and heat up a bit so as to brown the outside of the hot pocket.

On top of that, the inside walls of your microwave oven are made of metal. This forms something called a Faraday Cage which traps the microwaves inside the box, so that they cook the food and not things around the microwave oven, like you. If you look closely, you'll also see that the window you look at the food through has metal mesh lining it. The holes in this mesh are smaller than the wavelengths of the electromagnetic radiation your microwave is producing. This makes it so the waves can't pass through the holes. Visible light, however, is comprised of much smaller wavelengths, so that form of radiated energy passed through the holes just fine, allowing you to see inside your microwave while it's running without getting cooked yourself.

So if the inside of your microwave is lined with metal and certain food products, such as hot pockets and pot-pies, have containers that contain metal, why does your microwave manual say not to put metal in the microwave?



First, let's talk a little about how a microwave oven actually works. At its core, a microwave oven is a pretty simple device. It's basically just a magnetron hooked up to a high voltage source. This magnetron directs microwaves into a metal box. These generated microwaves then bounce around inside the microwave until they are absorbed via dielectric loss in various molecules resulting in the molecules heating up (more on how this works in the *Bonus Factoids* section). Matter that work well here are things such as water, ceramics, certain polymers, etc. These all end up converting microwave energy into heat quite effectively.

Metals, on the other hand, are great conductors of electricity, being packed with electrons that can move freely. Depending on the shape/type/thickness/distribution/etc. of metal, you may observe some heating of the metal itself in the microwave or none at all. You may also observe some arcing of electricity or none at all. In any event, when these microwaves hit the metal, free electrons on the surface of the metal end up

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moving from side to side very rapidly. This, in turn, prevents the electric wave from entering the metal; thus, the waves end up being reflected instead. However, there is also the potential that this ends up creating a sufficient charge density that the electrical potential in the metal object exceeds the dielectric breakdown of air. When this happens, it will result in arcing inside your microwave, from that metal to another electrical conductor with lower potential (often the wall of the microwave). In extreme cases, these electrical sparks can end up damaging the wall by burning small holes in the metal wall. It can also end up burning out the magnetron in your microwave oven or, in modern microwaves, can provide a surge that ends up damaging sensitive microelectronics, possibly killing your microwave or making it unsafe to use, in the case of a hole in the inner metal wall in your microwave.

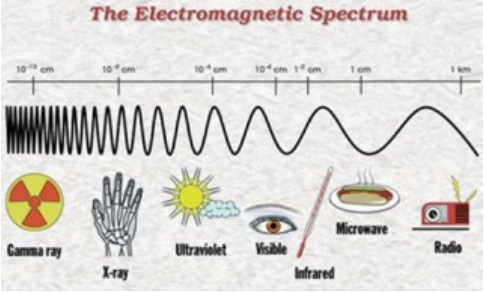
Another way it can kill the magnetron of your microwave is when enough of the generated microwaves don't get absorbed, such as if the food is wrapped in aluminum foil or mostly enclosed in a metal container. This can create a lot of energy not getting absorbed, with nowhere to go but eventually back to the magnetron, which can eventually damage the magnetron. Once again, killing your microwave oven.

On a more mundane level, something like a spoon or a metal plate or the like, positioned correctly, will simply make your food potentially not cook normally. On that note, it is once again, actually acceptable to put metal in a microwave under the proper conditions. Some microwaves even have metal grates inside for setting food on, such as is often the case with certain convection ovens. There are also certain types of metal pots and pans that are microwave safe. These all, however, are carefully designed to not cause any problems in your microwave oven. In general, putting metal in the microwave is unsafe, not because you are at risk of bodily harm or the like (though in extreme cases a fire might be started in your microwave), but, more to the point, primarily because it has the potential of damaging your microwave in the ways listed above.

Bonus Factoids:

Metal powder at room temperature actually does a good job of absorbing microwave radiation. When it does so, it heats up. It's not wholly understood what is going on here; but it is known that if the metal particle size is less than 100 micrometers, the particle will absorb microwaves, instead of reflecting them. This is generally how the microwave pouches, such as come with hot pockets or pot pies, work; though, they sometimes use a form of ceramic instead, with the same effect of generating heat to brown the outside of the food. These pouches and containers meant for browning are known as susceptors.

It's also generally a bad idea to run a microwave with nothing in it. This creates microwaves in the oven that have nothing to absorb them. This standing wave is reflected back and forth within the microwave, between the tube and the cooking chamber, and will eventually burn out the magnetron. This same effect can occur when cooking dehydrated food or, as noted previously, food wrapped in some sort of metal where there is very little to absorb the emitted microwaves.



The type of radiation emitted by microwave ovens is non-ionizing. This means that it doesn't contribute to your chance of getting cancer like x-rays, ultraviolet light, etc do. Outside of potential burn risks, experiments done with rodents have yet to show any major adverse effect to prolonged exposure to microwaves at the 2.45 GHz range seen in most microwave ovens, even with continual low level exposure.

Bluetooth and IEEE's 802.11 (like your wireless internet router probably uses) both typically emit microwaves in the 2.4 GHz band, very close to the frequency found in most microwave ovens. Radar and GPS also operate using radiation in the microwave spectrum.

Electromagnetic waves were predicted by James Clerk Maxwell in 1864. It wasn't until 1888 though that Heinrich Hertz was able to build a device that was capable of producing and detecting microwaves. His device used a horse trough; Leyden jars; a zinc gutter (worked as an antenna); and a wrought iron point spark.

The first known documented use of the term "microwave" was in 1931 in a Telegraph & Telephone Journal: "When trials with wavelengths as low as 18 cm were made known, there was undisguised surprise that the problem of the micro-wave had been solved so soon."

Microwave ovens work by having an internal magnetron emit electromagnetic waves around the frequency of 2.45 GHz (vibrates at about 2.45 billion times per second). These waves are absorbed by water molecules, fat molecules, sugars molecules, and certain other substances, which then heat up by a process known as "dielectric heating". Basically, molecules such as water molecules are electric dipoles. This means that they have a positive charge and a negative charge on opposite ends. Thus, they will rotate themselves rapidly when trying to align themselves with the alternating electric field from the microwaves. As these molecules rub against each other, they heat up and, as they do so, they themselves also become part of the cooking process, heating up molecules around them that may not be absorbing much, or any, of the microwaves.

Microwaves are not nearly as efficient at heating frozen food due to the fact that the molecules are not free to rotate or move.

Microwave ovens do not "cook from the inside out", as many people say. Microwaves actually heat from the outside in, very similar to other heating methods. The misconception arises from the fact that some foods that you microwave have a very dry outer cover (such as a crust), which the microwaves penetrate with little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very little absorption. Thus, the liquid inside will appear to heat up first. This is why, with frozen objects, the center might remain frozen and the outer layer somewhat cool, while the layer just under the crust may be super hot. If it was truly cooking from the inside out, as people say, you'd never end up with that frozen center while the rest was super hot.

The particular band of microwaves produced by typical microwave ovens (2.45 GHz) was chosen primarily due to the fact that it is a frequency set aside for non-communication uses. Within the available frequencies that are not set aside for communication, 2.45 GHz was chosen because 433.92 MHz would require expensive equipment to generate sufficient power to heat food; 5.8 GHz and 24.125 GHz would require a much higher cost on electricity used to run the oven; and 915MHz was rejected as it wasn't a band available world-wide, as 2.45 GHz was. 915 MHz, though, is occasionally used in industrial microwave ovens.

Even though most microwave ovens let you choose between power levels, there generally isn't any change in the frequency level of the microwaves being generated. Rather, it simply changes the duty cycle of the magnetron. In other words, it turns on and off at a different rate.

A convection oven is basically just a conventional microwave that also has a way to brown food like a traditional oven. In order to provide this browning effect, the convection oven may use traditional oven heating elements or might use something such as a high powered halogen bulb.

The ability to use microwaves as a heating device for food was originally discovered by an engineer by the name of Percy Spencer. Spencer was working on building magnetrons for radar sets. One day, he was standing in front of an active radar set when he noticed the candy bar he had in his pocket melted. Upon noticing this, Spencer made the monumental mistake of telling other people instead of keeping it to himself and working on it on his own. He and some other experimenters began trying to heat other food objects, presumably to get out of actually working while they were at work. The first one he heated intentionally was popcorn. The second was an egg, which ended up exploding in the face of one of his co-workers. Spencer then created what we might call the first true microwave oven by attaching a high density electromagnetic field generator which would then shoot into a metal box, so that the electromagnetic waves would have no way to escape and the oven would be much more efficient and safe. He then placed various food items in the box and monitored their temperature to observe the effect.

The company Spencer was working for, Raytheon, then filed a patent on October 8, 1945 for a microwave cooking oven, eventually named the Radarange. This first microwave oven was about 6 feet tall and weighed around 750 pounds. The price tag on these units was about $5000 a piece. It wasn't until 1967 that the first microwave oven that was both relatively affordable ($495) and reasonably sized (counter-top model) was available.

In 1971 only about 1% of American homes had a microwave. By 1986, that number had risen to about 25%. In 2009, the estimate was that about 90% of American households have a microwave.

It wasn't until microwave ovens became extremely popular in the 1970s that they were commonly known as "microwave ovens". Before that, they were typically known as "electronic ovens".

Forks are particularly susceptible to sparking in a microwave due to the fact that their tines are relatively close together and will produce high voltage at the tips. This voltage will exceed the dielectric breakdown of air, which is about 3 megavolts per meter. The air then forms a kind of conductive plasma, which is the spark you see. This, in turn, makes the fork an even more effective antenna for the microwaves, worsening the problem.

Microwaves convert Vitamin B12 to an inactive form, which means about 30-40% of the Vitamin B12 in microwaved foods is not usable by mammals.

On the other hand, spinach loses about 77% of its folate when cooked in a normal stove, but retains nearly all of it when cooked in a microwave. In the same way, steamed vegetables, as a rule, tend to retain more of their nutrients in a microwave than when cooked in a traditional oven.

At one time, most long distance telephone calls were transmitted via a large network of microwave radio relay links, such as AT&T's "Long Lines". In the 1950s, about 5400 telephone calls could be run through a single microwave channel via multiplexing. The distance between hops was typically around 40-50 miles. The additional cost of transmitting this way was a large part of why long distance was so expensive historically. With the advent and installation of fiber optic lines and advanced satellite systems, this made the old ground based microwave relay links obsolete for transmitting long distance calls. (Although, satellite systems are essentially just a space-based version of this same thing).

Sources:

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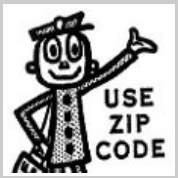

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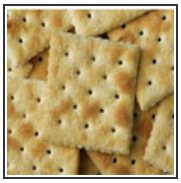

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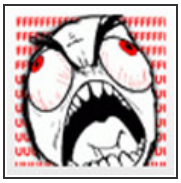

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The Padrino September 1, 2010 at 6:29 pm -

I always liked to put empty beer cans in the microwave during a stay at the hotel lmao

bob September 3, 2010 at 3:56 am -

to long… most people ending up here are just looking for cool/funny stuffs, make it short…

Jared Bond January 21, 2011 at 2:02 pm -

Nooo, don't dumb it down! Smart people are reading, despite the dumb ads on this site!
Nice to include the nutritional info. I suspected that microwaves destroy the vitamin content somewhat. Though I'm not deathly afraid of them as some people are. It would hypothetically be nice to avoid them, but for me I couldn't do without one.

Grapes March 9, 2011 at 4:32 pm -

"to long… most people ending up here are just looking for cool/funny stuffs, make it short…" - bob
Really? Your comment is worthless and annoying, shutup and move on!

Tommy T August 6, 2011 at 2:14 pm -

If you put an egg in the shell in the mircowave, the strength of the eggshell will contain the growing pressure of the cooking egg- until the critical point is reached and the egg explodes violently, blowing open the door in most cases! Great trick at parties- NOT in your own house… 😀

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