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How Microwave Cooking Works

by Marshall Brain

Introduction to How Microwave Ovens Works

Photo courtesy Panasonic and Matsushita Electric Corporation of America

The microwave oven is one of the great inventions of the 20th century -- millions of homes in America have one. Just think about how many times you use a microwave every day:

You're running late for work, so there's no time to fix breakfast at home. On your way to the office, you stop to gas up your car. Inside the quickie-mart, you grab a frozen breakfast burrito and pop it in the microwave on the counter. Later that day, you have to work through lunch. By 3:00 p.m., you're starving, so you grab a snack-pack of microwaveable popcorn from the vending machine and pop that in the break-room microwave. That night, after a really long day at work, you're simply too tired to grill out, so you dish up last night's lasagna and heat it up in the microwave...

As you can see, microwave ovens are popular because they cook food in an amazingly short amount of time. They are also extremely efficient in their use of electricity because a microwave oven heats *only* the food -- and nothing else. In this article, we'll discuss the mystery behind the magic of "meals in a minute" with microwave cooking.

Microwaves

A microwave oven uses **microwaves** to heat food. Microwaves are radio waves. In the case of microwave ovens, the commonly used radio wave frequency is roughly 2,500 megahertz (2.5 gigahertz). Radio waves in this frequency range have an interesting property: they are absorbed by water, fats and sugars. When they are absorbed they are converted directly into atomic motion -- heat. Microwaves in this frequency range have another interesting property: they are not absorbed by most plastics, glass or ceramics. Metal reflects microwaves, which is why metal pans do not work well in a microwave oven.

Photo courtesy Panasonic and Matsushita Electric Corporation of America

Microwave Cooking

You often hear that microwave ovens cook food "From the inside out." What does that mean? Here's an

explanation to help make sense of microwave cooking.

Let's say you want to bake a cake in a conventional oven. Normally you would bake a cake at 350 degrees F or so, but let's say you accidentally set the oven at 600 degrees instead of 350. What is going to happen is that the outside of the cake will burn before the inside even gets warm. In a conventional oven, the heat has to migrate (by conduction) from the outside of the food toward the middle (See How a Thermos Works for a good explanation of conduction and other heat transfer processes). You also have dry, hot air on the outside of the food evaporating moisture. So the outside can be crispy and brown (for example, bread forms a crust) while the inside is moist.

Photo courtesy Panasonic and Matsushita Electric Corporation of America

In microwave cooking, the radio waves penetrate the food and excite water and fat molecules pretty much evenly throughout the food. No heat has to migrate toward the interior by conduction. There is heat everywhere all at once because the molecules are all excited together. There are limits, of course. Radio waves penetrate unevenly in thick pieces of food (they don't make it all the way to the middle), and there are also "hot spots" caused by wave interference, but you get the idea. The whole heating process is different because you are "exciting atoms" rather than "conducting heat."

In a microwave oven, the air in the oven is at room temperture, so there is no way to form a crust. That is why microwavable pastries sometimes come with a little sleeve made out of foil and cardboard. You put the food in the sleeve and then microwave it. The sleeve reacts to microwave energy by becoming very hot. This exterior heat lets the crust become crispy as it would in a conventional oven.

For more information on microwave cooking and related topics, check out the links on the next page.

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