

Ceramic Coating to Knock Teflon out of the Pan

The Technical University of Denmark (DTU) and a Danish company are planning to replace problematic Teflon coatings with nano-thin ceramics.

Materials

By Berit Viuf redaktion@ing.dk

Researchers are developing a non-stick alternative to Teflon coatings for pots and pans that, unlike Teflon, can deliver a crisp fry up.

DTU and Danish Teflon coatings specialist Accoat A/S, have developed a ceramic material that can improve both the frying properties and the durability of tomorrow's pots and pans.

"We are in the process of developing a material that is looking very promising, and I am convinced that it will prove to be of great interest to the foodstuffs industry, even though it may be a bit more expensive to purchase" says Jens Hinke, Research Director of SP Group, which is Accoat A/S's parent company.

In order to design optimal coatings you have to have a thorough understanding of the frying process. Which is why the sweet smell of pancakes is currently wafting around DTU. In specially constructed experimental apparatus, PhD student Saranya Ashokkumar, under the supervision of Professor Jens Adler-Nissen of DTU's Foodstuffs Institute, is investigating how a pancake's proteins and carbohydrates react with the coating when heated.

One of the problems with Teflon, which both consumers and the foodstuffs industry use large amounts of, is the material's extreme water and fat repellent properties. When a surface is so water repellent, moisture collects in small droplets. This means that small pockets of water will collect under the food – making it harder to brown it. Instead of being fried it's actually, effectively boiled.

That's why researchers are looking to develop a surface that has more hydrophilic (water-friendly) properties, where the moisture released distributes itself more evenly.

The idea being that this will improve the material's frying properties. At the same time, the material must still have the necessary non-stick qualities.

Researchers are looking to produce a nano-thin layer of ceramic material whose molecules are so strongly bound to each other that foodstuffs which come into contact with them cannot react chemically with the surface. In this way it is hoped that fried food won't stick to the pan.

"It's all about thermodynamics and molecular bonds, or put a bit more simply: how atoms like to mix" as Jens Hinke puts it. The necessary calculations were performed by Professor Per Møller of DTU Mechanics.

It is also hoped that researchers will be able to create a material that is stronger than Teflon. Teflon is relatively soft and is easily damaged when scraped with a metal tool – a problem which all cooks are familiar with.

To top it all, researchers are also hoping to deliver a greater thermal effect: Teflon surfaces are poor heat conductors. When you transfer a piece of meat from the fridge to a Teflon pan, you cool the pan, and, because it's a poor conductor the Teflon coating makes it difficult to transfer heat quickly enough from the heat source to the food.

Using an ultra-thin ceramic coating will ensure that heat transfers more easily, and that fry ups taste better.

Pan Wear and Tear

At Danish foodstuffs company Tulip, Teflon-coated vats are used in the manufacturing process. Teflon's vulnerability is a significant weakness. In order to achieve an efficient temperature for frying, Teflon coatings are kept very thin, but the wear and tear involved in the use of conveyor belts means that lifetimes are short. It's normal for production to have to stop every three-four weeks whilst conveyor belts are replaced.

"The quality of the Teflon belt is always a bit of a compromise between heat-transferral and strength. The thicker the coating, the more durable it is and the more energy we have to use to warm it up" says Peter Winther, Tulip's Technical Manager.

There are limits to how much you can heat the hot plates. At temperatures of 270 °C Teflon starts to crack and evaporate. He can well imagine that new ceramic materials can provide an interesting alternative to Teflon, if it proves possible to develop materials that are sufficiently elastic for use with conveyor belts.

"If the new material can help us achieve less down time and save energy, then of course it would be very interesting for a company like ours. Just as long as total costs don't rise," says Peter Winther.

According to Jens Hinke, Accoat expect to have a prototype ready within the year, but he stresses that it is just a development project and additional time will pass before the product is ready for sale.

Teflon vs. Ceramics

Teflon (polytetrafluoroethylene or PTFE for short) is a polymer that incorporates a large number of carbon bonds. Chains of carbon atoms are surrounded by fluorine atoms which fill positions at the carbon atoms' poles. That's why the polymer chain doesn't react with other molecules, giving Teflon its unusual properties.

The ceramic surfaces under development must be similar Teflon in not reacting with the materials in foodstuffs. Ideally, they should be capable of absorbing moisture without reacting with it.

The article has been translated for Accoat by Daniels Bratcher. Please contact Nadja Susanne Lund nsj@accoat.dk if questions on the translation.