

Accurately mixing oil and water

Mayonnaise, milk, hair conditioner and medicinal ointment: all examples in which oil and water are mixed. But oil and water do not mix well. At Wageningen University, a chip has been developed that can create this type of emulsions very accurately. 'The chip can be used to mix any substance that we add to it.'

[Read this highlight](#)





To overview



Previous



Next

EN

Select other language

The EDGE (Edge-based Droplet GEneration) chip created by professor Karin Schroën and PhD student Sami Sahin is technically a thick sieve, they explain. 'The chip is made up of several layers of microchannels. For a modest production volume, we can produce twenty cubic metres of product per hour for oil percentages of up to thirty percent,' says the PhD student. 'And we have demonstrated that it is possible to make oil droplets that are all exactly ten micrometres in size.' With the EDGE chip, you can even calibrate the size of the droplets.

“

The size of the oil droplets determines how creamy a food product tastes. By using this chip, the same creamy taste can be achieved with less fat.

”

Creamy taste with less fat

The dimensions of the oil droplets are important for a wide range of applications. For example, the size of the oil droplets determines how creamy a food product tastes. As with the current mixing methods the oil droplets produced are not only the large, creamy tasting droplets, but also less desirable small droplets, manufacturers often add slightly more oil than necessary to ensure the desired taste. Using the chip from Wageningen University, all oil droplets are exactly the same size. This way, the same creamy taste can be achieved with less fat.

No overdosing in the case of medicines

The chip can also yield advantages for the production of medicines. For example, you can selectively reach certain organs in the body by using emulsions of oil droplets with specific dimensions. In addition, droplets with the same dimensions always contain exactly the same quantity of active substance. This means you can use the chip to prevent overdosing.

From sixty football fields to office size

'When Sami Sahin started his PhD research, we had a chip that did the same but would have required a surface area of sixty football fields to produce sufficient amounts. Thanks to Sami's smart new design, we have reduced that to ten square metres. And because you the chips can be stacked, the complete production facility can now easily fit inside my office,' says professor Schroën.

NanoNextNL EDGE chip



Identical droplets

The chip is made of glass in which microchannels have been etched, explain the researchers. 'We allow a layer of oil to run over a plateau. As there is a pressure difference before and after the plateau, the oil spontaneously forms droplets. The surface forces, viscosity and friction with the walls ensure that these droplets are always exactly the same size.' By adjusting the shape of the channels and the pressure difference, you can calibrate the droplet size.

Fabrication

Fabricating Sahin's design was far from easy, says Schroën. 'Eventually, we found Cytocentrics, a development company that designs and produces microsystems, willing to seek the boundaries of its technology for us.' 'Realising Sami's design was a fantastic challenge,' says Cytocentrics product engineer Arne Heessels. 'To ensure that all of the oil droplets are exactly the same size, the channels may not differ from each other in the slightest. We therefore had to etch the holes with exceptional accuracy. We eventually decided to treat the top and bottom of the chip separately. But we had to ensure that the holes in the bottom plate would line up exactly with those in the top plate. That was an exceptionally tough technical challenge. We were therefore extremely pleased when a video showed that the chips made the exact droplets and mixtures that Sami and Karin had intended.'

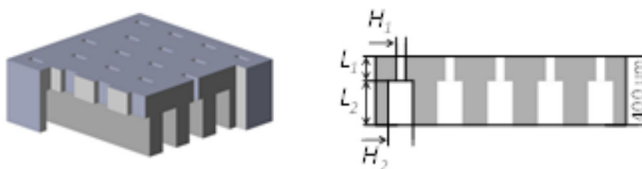
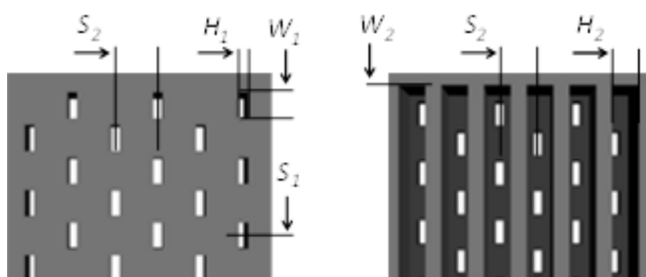
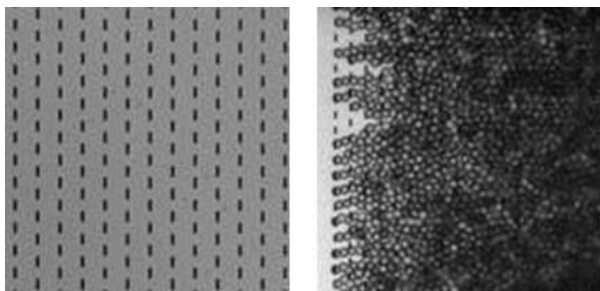


Fig. left: Schematic 3D representation of multi-EDGE device. Oil is pushed from the bottom side and the droplets emerge at the top side. Fig. right: schematic section view.



Schematic top view (fig. left) and schematic bottom view (fig. right).



Optical micrographs of the top side, before and during emulsification. Droplets are carried away from left to right by the cross flowing continuous phase; please note that the cross-flow is not needed for droplet formation.

Developing and producing a prototype

Sahin received his doctorate at the end of May 2016. Now he wants to develop a prototype with the help of an STW Demonstrator Grant so that the possibilities of the chip can be demonstrated to industry, tells Schroën. 'We want to increase the yield by a factor of ten and gain an even better understanding of the process.' 'In addition, we need to demonstrate that the chip can run 24/7,' says Sahin. 'We have a lot of knowledge about the settings you can tweak to create various sizes and quantities of oil droplets, and now we want to share this knowledge with interested manufacturers. This way, we can advise them about the formulas that they must use to realise a final product with the desired properties. This could be the texture of a cream, the final taste experience of a dressing, or the concentrations of active substances in a medicine,' he says.

Cytocentrics can produce this first prototype and possibly make a small run of these as well. 'However, once the switch is made to larger volumes, we would like to transfer the technology to a party that can handle bulk production,' says Heessels.

Demonstrating the advantages

'The profit margins in the food industry are very small. We must therefore offer a big advantage compared to the current methods. For example, our mixing method uses 90% less energy than the current standard equipment used to produce emulsions (homogenisers), and with our chip we can even improve the properties of the product. By demonstrating how our chip works, we hope that a company will take over its further development, so that the chip will actually be used within the food industry,' concludes Schroën.

Read more

- [Publication Nature 'Microfluidice EDGE emulsification'](#)
- [Video promotion Sami Sahin](#)

Back to top

