Flatscreen television

DESIGNING THE MINIATURE

Wageningen scientists were experts at bionanotechnology when it was still called colloid chemistry. Even before that era, however, people were playing with these particles that measure a mere one-millionth of a centimetre. Paint consists of minuscule (yet multimolecular) particles, as does coffee. So humans have actually been nanotechnologists for centuries, and it is only relatively recently that it has been considered as a discipline in its own right.

The Laboratory of Physical Chemistry and Colloid Science at Wageningen University achieved global renown among fellow physicists at the start of the 1980s when two of its scientists formulated the Scheutjens-Fleer theory. 'This theory describes the behaviour of long, wiry molecules that float around in billions of different shapes in solutions,' explains Professor Martien Cohen Stuart. 'It explains in detail how molecules respond once they have attached themselves to a surface.'

The theory turned out to have more applications than was originally anticipated. Manufacturers of television and computer screens use it for example. Lined with fluorescent particles that light up, the quality of these screens depends on how precisely and orderly the makers can arrange the particles on the surface. To ensure that they do not clot, the particles are attracted to the surface of the screen while also repelling each other.

Unsurprisingly perhaps, one of the creators of the Scheutjens-Fleer theory, Professor Gerard Fleer, has since become a scientific consultant to Philips. The department has also been providing consultancy services to the leading photography brand Kodak.

A possible development is creating cell-like structures filled with medicine, which can travel through our body in search of cancer cells

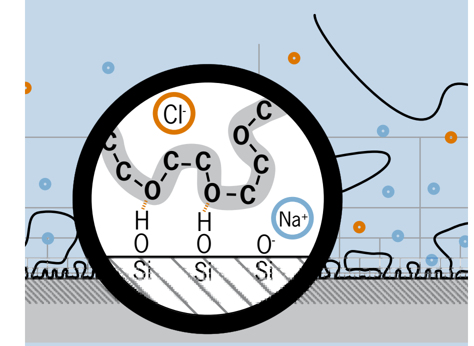
Meanwhile, the laboratory's research has continued to evolve since the 1980s. One spearhead is the behaviour of molecules that form new structures on their own accord, also called self assembly. The group studies, for example, how greasy phospholipids in a liquid form the same membranes that are found in human cells. This research may contribute to the development of cell-like structures filled with medicine, which can then travel through our body in search of cancer cells.

Scientists are also looking into the possibilities of moulding molecules at the nano level elsewhere within Wageningen University. In the laboratory of Professor Remko Boom of the Process Engineering group, for example, vegetable protein particles are being created that can meticulously imitate the structure of meat. 'We don't know what it tastes like yet,' admits Boom. 'But the point is that we can make artificial meat without animals. The food industry has failed to develop a genuine meat replacement that satisfies consumers. The fine fibre structure that gives meat its particular texture and juiciness has yet to be discovered in any product.'

Boom and his team now know how to mould molecules on such a small scale, however. Although the work is still at the laboratory stage, it is a promising start and the research suggests that designing molecules in this way will also impact

The SF-theory

Professor Gerard Fleer explains that the theory of Scheutjens-Fleer was initially the brainchild of his postgraduate student Jan Scheutjens: 'It was the first theory to provide an accurate description of the behaviour of chain molecules on interfaces,' he says. A solid bounded by a fluid is an interface, but so is the boundary between air and water. Scheutjens and Fleer were initially working on creating better purification processes for sewage water. When bacteria carry out this task they are removed from the sewage with a flocculation agent: material consisting of long, wiry molecules to which bacteria attach themselves. Once this occurs, the bacteria cluster, settle and can be removed. 'The first version of the theory described exactly how this occurs,' Fleer recalls. 'In later years our theory was '*expanded*' and applied to more complex systems of chain molecules.'



the food industry in other areas. For instance, scientists from Boom's group have successfully wrapped a variety of compounds in smart molecules, which release their content at a given time.

Nano equals healthy

'We can encapsulate the tiniest drops of artificial odours and tastes so that they are not damaged during the production process,' Boom says. 'In addition, we can make sure that they are released in the mouth at the right moment. We can do the same for healthy nutritional components.'

Boom and his colleagues are considering applications in areas such as probiotics, the healthy bacteria in the intestines which appear to reduce the chance of illness. 'It is not easy to get bacteria to the right part of the body and ensure that, for instance, the organisms survive the gastric juices. This is one of the reasons why the food industry is so interested in the encapsulating technology emanating from Wageningen UR.'

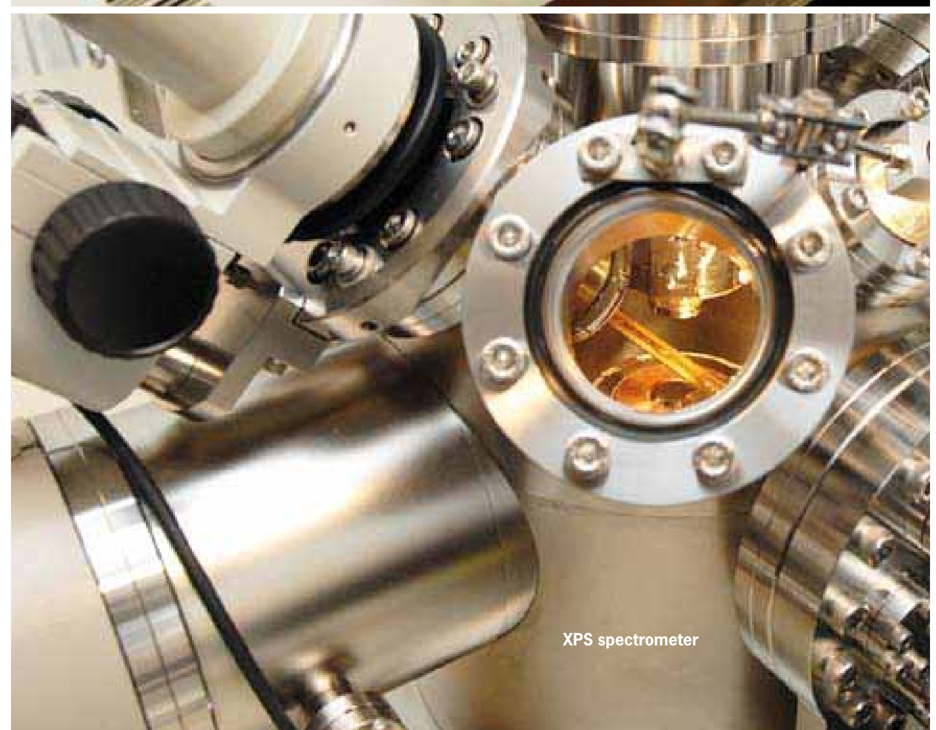
While the nano-encapsulating technology is still under development, other nano-applications have already been used in foodstuffs. Food companies are manipulating molecules on a nano-scale to make sure that chocolate does not melt in the hand, or that bodies absorb the extra calcium in enriched dairy products.

General acceptance

The Market and Consumer Behaviour group investigates how people feel about the use of nanotechnology in the food industry. According to the researchers, studies by independent organisations into the safety of nano-applications will lead to an increase in consumer trust. This will also occur when scientists admit that they do not know everything about the risks of nanotechnology and continue to try and find the answers to any questions that may arise. Only then will consumers know that doubts about nanotechnology are being taken seriously.

'It is equally important that scientists and companies convince consumers of the added value of nano-applications,' says Lynn Frewer of the research group. 'Nanotechnology only has a chance when consumers feel not only that the new technology will benefit them but that it is also safe.'

Frozen plasma



XPS spectrometer

'One possible application of our research involves the regeneration of tissues in or outside the body'

Strangely, however, there has been little toxicological research into nano-applications. Toxicologists are mainly interested in whether bio-active substances can reach certain places in the human body by means of nanotechnology. A European research project into the possible risks of nanotechnological food applications performed by the Toxicology research group of Professor Ivonne Rietjens should provide more clarity on this subject. Trendwatchers believe that this type of research is essential if nanotechnology is to be accepted by consumers.

Blood plasma

Wageningen scientists are also working on medical applications of nanotechnology, for instance in the laboratory of Frits de Wolf at the Agrotechnology and Food Sciences Group. Working on an assignment for the Japanese company Fuji, De Wolf and his team have developed a simple but intelligent protein molecule for synthetic blood plasma.

'This blood plasma can be given to seriously injured people on the battlefield or in a hospital A&E department who have lost a lot of blood,' he says. 'In such situations the first priority is to administer fluids. Unfortunately, saline solutions only have a brief effect as the kidneys quickly discharge the fluid. Add our polymer and the speed at which the fluid leaves the body is reduced as the molecule retains the water.'

An immune response is not initiated as the molecule is recognised as being a part of the body. Enzymes can break down the molecule, which is one of many designer proteins De Wolf has made by adding new genes to the genome of yeast cells. 'What we are really creating are long strings of pieces from natural proteins or chains of proteins that we designed ourselves. We can also determine what shape the proteins will have – threads, spheres, or sheets'.

De Wolf's group uses the designer proteins in medical applications. 'One possibility involves the regeneration of tissues in or outside the body,' he continues. 'Perhaps we can make new skin cells grow on these proteins. Inside the body they could be used by doctors to speed up the healing of broken bones or damaged nerve tracks.'

De Wolf is keen to emphasise that there is still a long way to go: 'Although the interest is increasing, this technology is still in its infancy. We have much more work to do.'