Nanokits for School

because Nanotech is cool!

Experiments for School

Six do-it-yourself experiments

NANORA
Nano Regions Alliance

Imprint

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In the framework of NANORA, project financed by INTERREG IVB North West Europe.

Nanokits for school

Experiments for school – Six do-it-yourself experiments in nano-technology

How can we have facades that never get dirty, despite wind and weather?
Why is one sun cream transparent and the other not?
Why are there cars that you don't see scratches on?
Could computers and mobile phones exist at all without nanotechnology? Simple answer: NO!

Dear Students and Teachers,

Nanotechnology is regarded as one of the key technologies of the 21st century. It leads to exciting innovations and new products that revolutionise our world. Increasingly powerful smartphones and computers and cleaner renewable energies are just the tip of the iceberg.

Physics, chemistry, biology, materials sciences and medicine all merge together into nanotechnology. Be it new materials as the basis for many applications, new structures as the basis for computers and smartphones, or new medicines that fight diseases – the discoveries in nanotechnology open up entirely new possibilities and reveal phenomena we have never before known.

With our brochure "nanokits for school", we would like to introduce school students to a new, revolutionary technology. The six experiments presented in this brochure are suitable for children and adolescents from age ten to fifteen. They employ materials that are found in most school laboratories.

You can find even more experiments for school students at www.nanoschoolbox.com

Have fun!

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NANORA

Disclaimer

Given that the experiments have to be approached differently depending on the age of the students, you the teacher should supervise the experiments. You bear the responsibility for their supervision. Never leave the students unattended during the experiments. Please take the necessary safety measures. When working, the students should always wear personal protective equipment: coat, gloves and safety glasses.

Caution must also be taken when working with laser pointers. The light beam must never be shone into eyes and must never be pointed at reflective surfaces; otherwise – depending on the laser pointer – the mirrored beam can be dangerous.

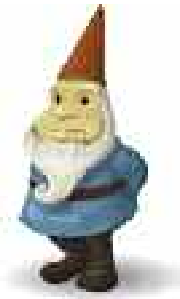
Whether the students perform the experiments on their own or with you as supervisor: It must be ensured that all instructions be followed and that only the experiments described in this brochure be performed. We assume no liability whatsoever either for success in reproducing results or for any damages or injury that may occur in the process.

Given their interdisciplinary nature, the experiments are equally suitable for chemistry, physics and biology classes. The workstation should be a solid table with a resilient, heat-resistant surface. The necessary resources are everyday goods and materials, chemicals and auxiliary materials typically found at schools.

We hope that you and your budding scientist enjoy exploring the nano world.

What is nanotechnology?

Over the past decades, nanotechnology has arisen from the disciplines of physics, chemistry, biology, medicine and materials science. Its purpose is to use technical means to make nanoscale processes or components useful for science and industrial application.



The word ‘nãnos’ comes from Greek and means ‘dwarf’.

Nanotechnology works with the very smallest particles. A nanoparticle is so tiny that you can’t see it. This might be very hard to imagine, and so perhaps a comparison will help: a metre is to a nanometre as the earth is to a football. Or: a human hair is 70,000 nanometres thick.

In mathematical terms, a nanometre is a billionth of a metre or a millionth of a millimetre, and the abbreviation for nanometre is nm.

In numbers, it looks like this:

1 nanometre = 1 nm = 10^{-9} m = 0,000.000.001 m.

One metre is to a nanometre as the earth is to a football.

What is nanotechnology?

Nanoparticles exist at a scale between individual atoms and a solid body. They also possess properties that reside somewhere between those of atoms and solid bodies. They are so small that they can no longer scatter visible light. That makes them invisible to the human eye, and means they can be worked transparently into varnishes, for example. Nanoparticles can be made from all kinds of materials.

Nanotechnology is in fact nothing new. We have long known of particles of such tiny dimensions. Nanoscale molecules have been used in colloidal chemistry for a very long time.

Nanoparticles have always been created in nature, e.g. by volcanic activity, in oceans (erosion), in sand storms, as pollen, or from wildfire and bushfires. The particles from natural fires can be less than 1,000 nm in size. Particles occurring in oceans reach up to 10,000 nm.

Other particle sources are industrial processes, energy generation (in particular electric power and district heating plants), traffic, construction and households (heating). The burning of fossil fuels releases tiny particles of a scale of 500 nanometres (nm).

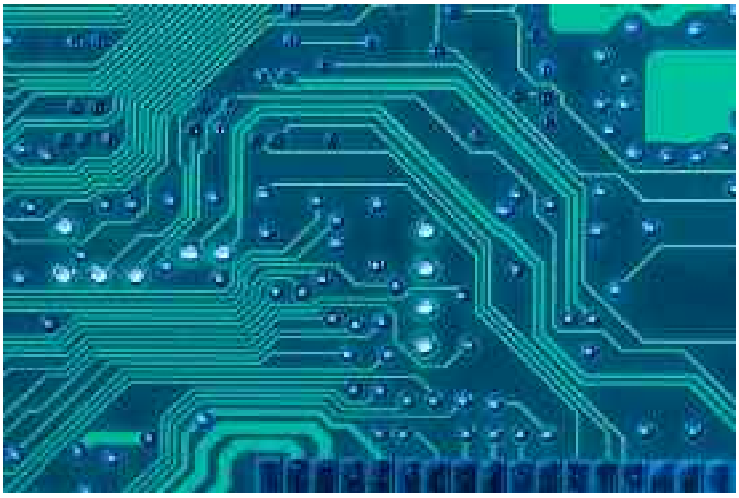
Nanoparticles have always been created in nature, e.g. as pollen.

Nanotechnology achieves specific functionalities by shrinking systems down to characteristic structural dimensions of below 100 nm. The term nanotechnology is thus a collective term for many different technologies. All nano research areas concentrate on the same scale from individual atoms to a structural size of 100 nm. It is most meaningful to use the term nanoscale to refer to the range of 1 to 100 nm, since many entirely new, size-related functionalities arise at this scale. Below this scale are individual atoms or molecules, and above it is the realm of microtechnology.

What is nanotechnology?

Nanotechnology plays a central role in storage media. The global volume of data is expected to increase tenfold by 2020 – from a current 4.4 trillion gigabytes to 44 trillion gigabytes. These are almost unimaginable numbers.

In the 1980s, data density became so high that hard disks reached their limits, and hard disk manufacturers and datacentres were faced with major challenges. Modern hard disks have only grown to such high storage capacities thanks to nanotechnology.



Modern hard disks have only grown to such high storage capacities thanks to nanotechnology.

In 1988, a discovery by German physicist Peter Grünberg and French physicist Albert Fert revolutionised hard disks. Based on nanotechnology, they developed a coating that uses the so-called “GMR effect”, or giant magnetoresistance. Such a coating is used in the new generation of hard disks and boosts the disks’ performance to help them cope with the ever-growing flood of data. For this groundbreaking invention, Grünberg and Fert received the 2007 Nobel Prize in physics.

Within ten years, all previous hard disks had disappeared completely from the market. It is very unusual for a new system to completely replace a former one in such a short time.

Those who would like to know more will find a lot of interesting information by searching for the “GMR effect”.

There are countless other examples that show what nanotechnology can do. Be it saving energy, developing medicines, building circuits and transistors, or cleaning and filtering water and air – thanks to nanotechnology, we can improve our products, manufacturing processes and methods.

The following experiments represent a tiny fraction of what is possible, and so provide a small yet stimulating insight into the wide field of this highly exciting technology.

1st Experiment: the lotus effect

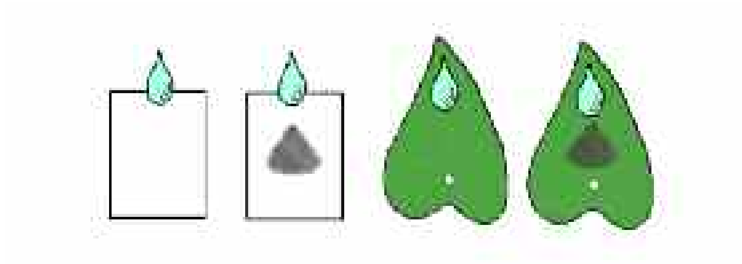
This experiment shall show that different materials have different surfaces and therefore they exhibit different behavior. We can see, which surfaces are water-repellent (hydrophobic) or water-absorbing (hydrophilic). This even works without lotus leaf...

Materials

- Various types of paper, e.g. printer paper, a piece of newspaper, filter paper, etc.
- Plant leaves, two of each type, e.g. nasturtium leaves, kohlrabi, red cabbage or a gum tree, lettuce, dandelion, blades of grass, etc.
- Measuring cup
- Pipette or teaspoon
- Water
- Some 'dirt', e.g. finely ground garden soil or fine dust

Method

1. Always place two of the same leaves or pieces of paper next to each other. Put a bit of dirt on one and leave the other clean..
2. Use the pipette or the teaspoon to trickle a few drops of water onto the leaves or paper.
3. Carefully pick up the leaves or paper one at a time in turn and move them gently to let the water run back and forth.
4. Repeat with all the pairs of leaves and paper that you have collected.



THE LOTUS EFFECT

Method

The droplets of water roll across some leaves and paper like a marble. On the nasturtium leaf or the cabbage leaf, for example, you will see wonderfully round droplets which you can roll back and forth. Where there is dirt, the drop of water absorbs it and leaves the leaf clean.

On some, like the dandelion, the droplets of water spread out. The coffee filter paper even completely absorbs the water.

Explanation

The leaves and paper where you can see balls of water are water-repellent (hydrophobic). The more strongly a leaf repels water, the better the ball that is formed by the water will be, meaning that the droplet can pick up the dirt more successfully.

The leaves and paper where the droplets spread out or even soak in are water-absorbent (hydrophilic).

When you look closely, what at first seems to be a smooth surface is in fact not smooth. If you examine the nasturtium leaf under a microscope you will see lots and lots of bumps.

The surface is actually very rough, rather like a hilly landscape. These bumps are in turn made up of lots of water-repellent wax crystals. The water molecules in the droplet are also pulled towards each other (cohesion).

The combination of these two forces creates the remarkable droplet shape on the nasturtium leaf.

The dandelion does not have a waxy surface, and so the droplets spread out over the leaf.

If you rub your fingers over the leaves and then trickle more water on the areas that you have rubbed, you will see that it doesn't form round droplets this time. The rubbing has flattened the bumps on the surface, which significantly reduces or even entirely stops the bead effect. This means that the effect is entirely lost in the areas which you have rubbed.

THE LOTUS EFFECT

Application

Imagine if you spilled ketchup but it didn't leave any spots! Or if you didn't have to wash the family car anymore! Wouldn't that be great? Researchers weren't the ones who came up with such a great idea – it was nature!

Structures that nature has developed in the course of evolution repeatedly serve as a model for new technological developments. Science has copied this phenomenon (known as the lotus effect) from nature and used it in a variety of areas. The lotus effect doesn't just work with different leaves; it also works with various other materials like glass and some fabrics. The lotus effect is already used for varnish, windowpanes, glasses lenses, and roof tiles. There are even some self-cleaning fabrics such as awnings, tents, or outdoor clothing which use the benefits of the lotus effect.

Water beads off in droplets when the surface is water-repellent (hydrophobic).

Nice to know

A botanist from Bonn discovered the lotus effect more than 50 years ago. Professor Wilhelm Barthlott created the brand name 'Lotus Effect®' to describe this phenomenon which has occurred in nature for a very long time. This earned him the German Environment Prize in 1999. The 'lotus effect' is also sometimes called the 'nano effect'.

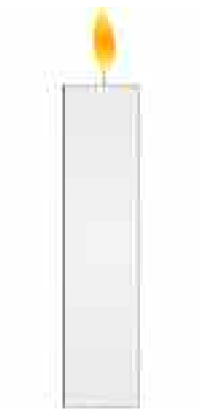
The lotus effect is not a random phenomenon – it has arisen as an advantage for the plant's survival.

2nd experiment: Creating a hydrophobic surface

Plants are naturally exposed to all kinds of pollutants. Most are of inorganic nature (various dusts or soot), but some are also of biological origin (e.g. fungal spores, honeydew or algae). The inorganic substances on their own have several harmful effects on the living tissue of the plant: they can become very hot under sunlight, have a strong acidic action, or potentially block the stoma through which the plants respire. Then there are the organic particles, such as fungal spores, bacteria or algae, which add to the burden on the plant. They can cause diseases in the plant or actively cause more damage to the surface of the leaves.

The lotus effect offers the plant an elegant way to ward off these problems. It prevents the substances from taking hold on the surface in the first place. Spores simply wash off in the rain; and if it doesn't rain for a long time, then the unwanted visitors don't get the water they need to germinate.

In this experiment, we will develop a surface that recreates the lotus effect.



Materials

- Crucible tongs (or tweezers)
- Glass plate or slide
- Candle
- Lighter
- Pipette

Method

1. Set the candle up so that it stands steadily and securely, then light it.
2. Now use the crucible tongs or tweezers to hold the glass plate or slide with one side directly in the flame, and carefully move it back and forth until a uniform layer of soot forms on it.
3. Rest the piece of glass on absorbent paper to cool.

HYDROPHOBIC SURFACE

4. Once the glass has cooled, hold the plate at a slight angle and use the pipette to carefully drip little droplets of water onto the soot-covered side of the glass.

Observation

The water droplets do not rest on the glass, but roll straight over the surface instead. The soot particles that deposit on the glass surface form a compact, hydrophobic layer. The soot on the glass plate therefore causes the water droplets to bead off. The water droplets have streaks of soot on their surface, meaning the droplets pull off soot particles that are not firmly stuck to the glass.

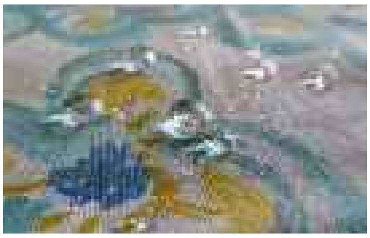
Explanation

When you hold the slide over the candle flame, partially burnt wax forms a nanoscale structure on the glass surface. Water droplets roll off this very thin layer because it is hydrophobic.

A water droplet will stick differently to different materials. The less it sticks, the more it resembles a perfect sphere, and the more easily it glides over it. This is the case with pollutants or a layer of soot. If it sticks well, then the spherical shape of the droplet flattens or is completely disrupted. This is what happens on a clean glass surface

Application

Microscale and nanoscale coatings can make surfaces insensitive to pollutants. On a glass lens with a non-stick coating, for example, water droplets bead off with practically no residue. Such hydrophobic (water-repellent) coatings are used in many other areas as well (e.g. sealing ceramics or waterproofing textiles). The coat is only a few nanometres thick and cannot be seen with the naked eye.



3RD EXPERIMENT:
SURFACE ENLARGEMENT

Materials

- 8 sugar cubes
- 1 pen
- 1 sheet A4 graph paper
- Scissors

Method

1. Use the 8 sugar cubes to build a big cube. Look closely at the surface of your big cube. Count all of the sides of the sugar cubes which are on the outside of the big cube – and don't forget the ones on the bottom underneath.

   You should find a total of 24 sugar cube sides making up the big cube.
2. Take the graph paper, colour in 24 boxes in a row and cut out the shape.

3. Next, lay all 8 sugar cubes out separately, as a snake, circle, or however you like. If you compare this shape with the large cube you made before, you will see that the total number of sugar cube sides showing in this arrangement is much bigger.

   This is called surface enlargement.

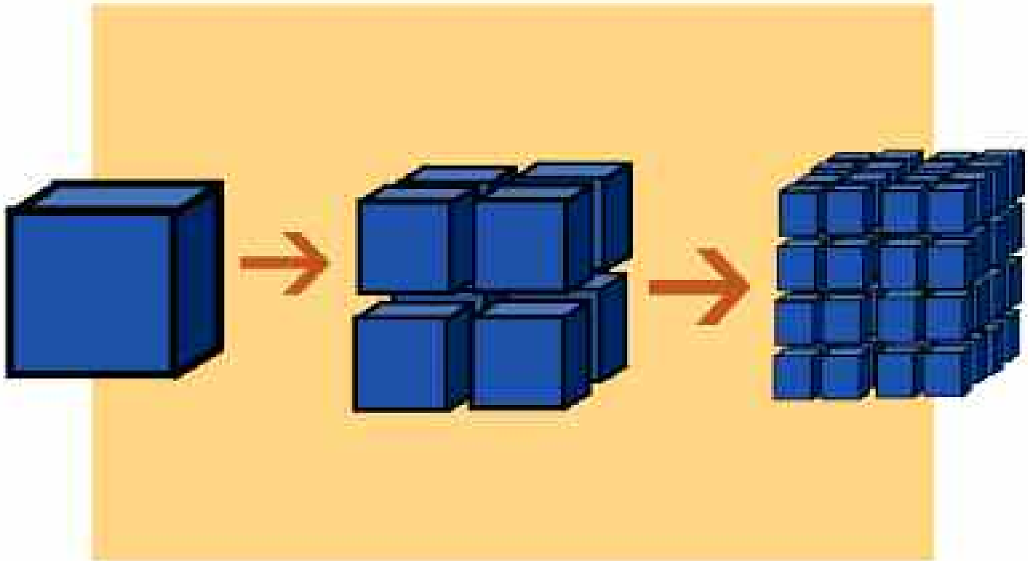
   To see this more clearly, count up all of the sides of the small sugar cubes which you can see on the outside. You should count a total of 48 sides.

   Now, colour in 48 boxes in a row on your graph paper and cut out the shape.

SURFACE ENLARGEMENT

Observation

If we look at a big cube and then split it up into lots of small cubes, we can see that the total surface area of the small cubes is much bigger than the surface area of the single big cube.



Explanation

If you cut the cubes into even smaller pieces, the surface will get even bigger. If you cut them up enough you will get a material that is nearly entirely made of the surface. This dimension, which is rather difficult to imagine, is known as nanoscale.

We can't see it – it is invisible to us. You need a very special microscope called a scanning tunnelling microscope to see nanoscale particles. You can also use an atomic force microscope. Both microscopes are expensive, extremely sensitive, and found only in large research institutions. A 'normal' atomic force microscope costs about as much as a Mercedes.

SURFACE ENLARGEMENT

If a material is in small particles, the material may behave completely differently to the same substance in larger particles. The increased surface area means that other substances which would perhaps not otherwise have reacted with the original substance have more surface area to 'dock'.

It's a bit like a party: the more people there, the more conversations you can have, the more fun it can be, and the more exciting stories you can hear.

The behaviour of a substance depends on the size of the particles of which it is made. Large surface areas also mean better bonds between nanoparticles. We can say that the larger the total surface area is, the more properties a substance displays.

This is something which we will look at in more detail in the third experiment by examining the solubility of a substance.

Application

Science can produce materials on the nanoscale and thus manipulate substances so that they have entirely new properties. For example, we can make steel harder without it becoming heavier. This kind of steel made from lots of nanoparticles (nanostructured steel) can be used to build bridges which last longer and are more durable.

SURFACE ENLARGEMENT

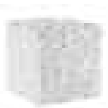
Nanostructured materials have lots of other benefits. For example, carbon can be used to produce what are called ‘carbon nanotubes’, or tiny tubes made of carbon atoms which are 400 times stronger than steel but still as light as a feather. These are extremely well suited to sports equipment such as tennis racquets.
What makes nanoparticles so interesting, therefore, is the fact that they can be used to develop things which did not previously exist.

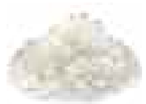
Nice to know

If science can manipulate materials and break substances down into nanoparticles, it makes you wonder whether nanomaterials could be dangerous to either humans or the environment. However, as yet, there has been no indication of any danger based purely on something being or becoming smaller. Of course, something which is dangerous in a large format will still be dangerous when smaller. Five hundred years ago there was a doctor, philosopher and researcher who said that it all depends on the dose: his name was Paracelsus and his theories still apply today.

4th Experiment: the link between Surface enlargement and solubility

Materials





- 1 level teaspoon of granulated sugar (normal white retail sugar)
- 1 sugar cube
- 1 piece of rock sugar (approx. 0.5 cm in diameter)
- 3 glasses
- teaspoon to stir
- Warm tap water
- stopwatch or watch with a second hand
- 1 piece of paper
- 1 pen

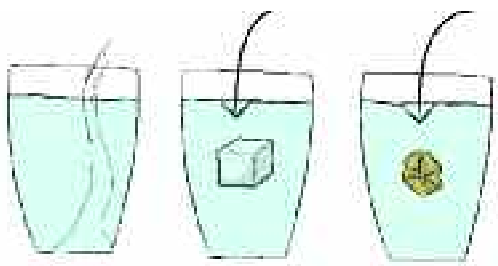
Method

1. Fill three glasses with the same amount of water and place them on a table.

2. Get your watch or stopwatch ready, and start timing when you add the level teaspoon of crystalline sugar into the first glass. Stir 10 times with the teaspoon and then wait until the sugar has fully dissolved. Now stop the watch and write the time down on a sheet of paper.

3. Start timing again when you add the sugar cube into the second glass. Again, stir 10 times and then wait until the sugar has fully dissolved. Then stop the watch again and note the time down on the sheet of paper..

4. Start timing for the third time when you add the rock sugar into the third glass. Once again, stir 10 times and then wait until the rock sugar has fully dissolved. You will have surely noticed by now that it takes much longer. Write the measured time down on the paper.



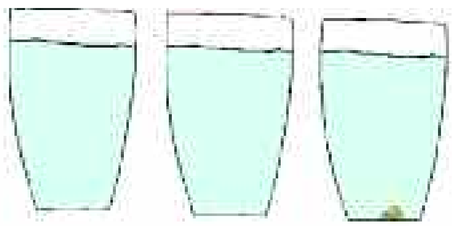
1. 2. 3.

SURFACE ENLARGEMENT AND SOLUBILITY

5. Compare the times you have written down. Which type of sugar dissolved the most quickly?

Observation

The granulated sugar dissolves the quickest, followed by the sugar cube and finally the rock sugar.



Explanation

In the surface enlargement experiment, you learnt that smaller particles have a larger surface area than bigger particles. We discovered that a larger surface area can change how a substance behaves, and saw that larger surface areas offer more opportunities for reaction with other particles.

The granulated sugar particles here are the smallest and have the largest surface area. This means that they react more quickly with the surrounding water and dissolve the quickest compared with the sugar cube and rock sugar. Rock sugar, on the other hand, is made from extra-large crystals. This means that the surface touching the water is much smaller than for granulated sugar, and so the rock sugar takes the longest to dissolve in the water.

Nanoparticles are the smallest particles and, therefore, have the largest surface area. This means that they are extremely reactive. Our example using sugar shows how much reactivity increases as the surface area grows. All three are made of the same material, namely sugar – the only thing which has changed is the shape of the sugar and, therefore, the size of the individual sugar crystals.

Surface enlargement and solubility

Application

By changing the size of substances, we can determine and change their reactivity. This opens up a wide range of potential applications.

One extremely exciting discovery was when scientists made nanoparticles out of gold. Suddenly, the gold was no longer gold in colour, but red! As early as the Middle Ages, people used to colour-glass such as church windows with gold to get a red colour, but at the time no one knew that this was because the gold had been broken down into gold nanoparticles.

Nanotechnology has, therefore, been used for centuries without our knowing it. Today, we know how the particles are produced, and we can change the
colour as much as we like by changing the size of the particles.

With the help of nanoparticles, you can even produce new colours. What colour arises depends on the metal particles used: While gold particles produce a ruby red, silver particles can make glass appear bright yellow

On your next trip, go into a church and look for a window with a bright red colour. Then ask the priest where the red colour comes from – you can bet that they won't know!

Surface enlargement and solubility

Nice to know

This effect was probably discovered as a side effect in alchemistic experiments to create gold. The unsuccessful attempts of the alchemists frequently led to the discovery of other quite useful materials: including this gold, which has been used as a nano paint pigment. It was also called "purple of Cassius" – first described in the 17th century.

Looked at closely, the nanoparticles (or nanoclusters) each consist of only a few thousand or even separate isolated atoms. These teeny particles are in fact too small to be seen with normal light. Those who would like to know how the colour effect arises can go on a journey of discovery into the topic of "surface plasmon resonance". SPR yields insights into how particle size, shape and density correlate with the wavelength of light, and how this affects the colour of glass and other materials.

The colourising properties of nanoparticles were used even earlier: Even the Egyptians worked with nanoparticles without knowing it. They used an ink which contained a special type of soot – today we would say that the ink contained carbon nanocomponents.

5TH EXPERIMENT: DETECTING COLLOIDS USING THE TYNDALL EFFECT

In order to explain the Tyndall effect, let us first take a look at our inspiration: Nature. When light rays like those from the sun become visible as streaks through the air, then we speak of the Tyndall effect. This can be well seen in a forest, for example, when sunrays appear through the trees, or in fog at dusk. The sunrays, or perhaps the beams from a car's headlights, scatter off finely dispersed water particles in the forest or in the fog, making the beams visible. The effect was named after its discoverer, Irish physicist John Tyndall (1820 to 1893).

When light rays like those from the sun become visible as streaks through the air, then we speak of the Tyndall effect.

The Tyndall effect always occurs when particles exist whose size is approximately equal to the wavelength of the incident light, so 400 to 800 nm. This condition arises when nanoparticles are suspended in a solution. Systems that exhibit the Tyndall effect are called colloids (from Greek: kolla = glue), where the particles in such a system are called colloidal particles. A colloidal suspension is accordingly a solution that contains particles in the size range from 1 nm to 1000 nm. The nanoscale colloidal particles are so small that they cannot be retained by a paper filter and they cannot even be seen under an optical microscope.

The Tyndall effect thus provides a way to distinguish between suspensions (= heterogeneous mixture of a fluid and finely dispersed solids within it) and true solutions (= homogeneous mixture consisting of two or more chemically pure substances).

The following experiment shall demonstrate this phenomenon.

Tyndall effect

Materials

- 80 ml orangeade, e.g. „Flirt“ (Aldi)
- 80 ml tap water
- A concentrated light source, e.g. laser pointer or small torch
- 2 beakers, 80 ml

Method

1. Fill the first beaker with 80 ml of lemonade and the seond with 80 ml of water.
2. Hold the light beam against the beaker containing the lemonade and shine it through the liquid.
3. Then hold the light beam against the water beaker and shine it through the water.

Observation

When you shine light through lemonade, you can clearly see the red light beam within the yellow liquid.

The visible beam of the laser pointer proves that nano-scale colloidal particles are present in the solution.

Tyndall Effect

When shone through water, only reflections on the glass from the the laser pointer are to be seen. There is no visible beam of light.

The beam of the laser pointer cannot be seen, since the water contains no colloidal particles.

Explanation

The lemonade has beta-carotene (β-carotene) added for colour. Some of the dissolved β-carotene exists as a nanoscale colloid. That is why it reflects the light beam.

There are no colloidal particles present in the water, which is why no Tyndall effect is observed when light is shone through it.

This experiment demonstrates how you can detect nanoscale colloidal particles in solutions using the Tyndall effect.

Nice to know

A simplified light scattering technique is nephelometry, developed by Tyndall, which measures scattered light intensity to determine the concentration of solute colloidal particles or floating aerosol particles. You can use light scattering measurements to measure the sizes of colloidal particles (e.g. for determining the molar mass of solute macromolecular molecules). A perfect, practically scatter-free light is infrared light, which can be shone straight through fog. A number of modern infrared technologies are based on this principle.

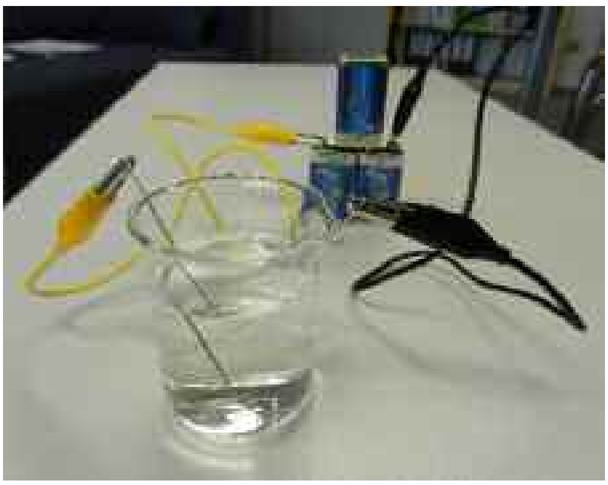
6TH EXPERIMENT:
PRODUCING COLLOIDAL SILVER

Materials

- 2 Stücke segments of fine silver wire (999.9), each about 10 cm long (supply source e.g. www.schmuckclub.de)
- 80 ml distilled water
- 3 block batteries (9 V)
- 2 alligator clips
- 1 beaker

Method

1. Connect the three block batteries together so that they yield 27 V.
2. Fasten an alligator clip to each end of a silver wire.
3. Fill the beaker with distilled water and dip the two ends of the silver wire into it.
3. Now close the circuit by connecting the other ends of the alligator clips respectively to the negative and positive terminal of the batteries.
4. After five minutes, break the circuit. Now shine the laser pointer through the liquid. Take care that the laser pointer does not shine into anyone's eyes.



Experimental setup: Closed circuit with silver wires in water.

Producing colloidal silver

Observation

As soon as the alligator clips are attached to the batteries and a closed circuit exists, tiny bubbles appear at the cathode (negative terminal).

As soon as a closed circuit exists, tiny bubbles appear at the cathode.

If the laser pointer is shone through the solution after five minutes, then the Tyndall effect is observed.

The Tyndall effect is best seen when you darken the area or hold the beaker against a dark background.

The visible beam of the laser pointer proves the existence of nanosilver.

Explanation

When the circuit is closed, electrolysis takes place, meaning the silver starts to dissolve. The product is colloidal silver, consisting of a mixture of silver ions, silver atoms and silver particles (colloids). A gas (hydrogen) forms at the cathode (negative terminal) and silver ions form at the anode (positive terminal).

Producing colloidal silver

Application

Colloidal silver water has a large range of applications. Because silver has an antibacterial effect, colloidal silver solutions can act against bacteria, viruses and fungi. It can kill off many pathogens within very short time.

The therapeutic uses of colloidal silver have been known since the middle of the nineteenth century. At the beginning of the twentieth century, silver was being studied intensively by many scientists and recognised as a proven germ-killing agent. Respected medical journals published articles about the wonderful healing properties of colloidal silver.

At the same time, the pharmaceutical industry was also intensifying its research and development activities. It invented new antibiotics and had them patented.
With that, colloidal silver was almost entirely forgotten by medical practitioners and patients alike. Now, however, interest in it is growing strongly again, since the side effects of antibiotics are being viewed more critically and the number of resistances to antibiotics is constantly rising.

Nice to know

The health-promoting effects of silver were already recognised thousands of years ago. The healing action of silver was known in ancient Greece, Rome, China, India and Persia. In ancient Egypt, wounds would be covered with silver foil. Many famous physicians and healers from the Middle Ages, such as Paracelsus and Hildegard von Bingen, used silver. As prophylactic measures, the noble and wealthy stored their reserves in silver containers and used silver cutlery. American gold diggers preserved their drinking milk by putting silver coins in it. Only many years later was it discovered that silver in colloidal form could be used for much more.

Supplementary experiment: Action of nanosilver

The following experiment serves to demonstrate the antibacterial action of colloidal silver: The effect of nanosilver on the growth of microorganisms. Because the microorganisms need time to grow, and this experiment requires about five days, some of the work steps will have to be divided over several periods.

Materials

- 10 ml nanosilver solution from previous experiment
- 3 Aagar plates with culture medium (e.g. from Klüver & Schulz)
- 10 ml tap water
- 3 disposable pipettes
- 1 spatula
- 1 cotton swab
- 3 test tubes

Method (approx. 5 days)

1. Rub a cotton swab gently on the inside of your cheek and then streak the sample across an agar plate. Now put this plate in a warm place for two days, e.g. near a heater or in an incubator (37 °C).

   Colonies of bacteria will be visible after two days.

Agar plate with mouth flora streak.

2. After two days, apply several drops of tap water onto the plate. Swish it back and forth so that some particles of the mouth flora bacteria dissolve. Take this solution with a pipette and squirt it into a test tube.

Action of nanosilver

3. Into the second tube, add 10 ml of colloidal silver solution (nanosilver solution) from the previous experiment. Into the third test tube, fill 10 ml of tap water.

1st test tube: Solution with mouth flora bacteria

2nd test tube: 10 ml colloidal silver solution

3rd test tube: 10 ml tap water

4. Now add 10 drops of the solution with mouth flora bacteria into the second and third glass each and allow the test tubes with the new mixtures to stand for 30 minutes. Gently shake the test tubes every ten minutes during these 30 minutes.

5. Next, pour each test tube onto a fresh agar plate and distribute the liquid evenly. Now allow the plates to stand at room temperature for three days. In the incubator at 37 °C, they only need one day.

6. Now compare the two agar plates as to how the microorganisms have developed.

Observation

Only a few microorganisms have grown on the plate with the nanosilver solution (right plate). The plate without the nanosilver solution (left plate) is covered with microorganisms.

Linke Platte mit Wasser, rechte mit Nanosilber-Lösung.

Action of nanosilver

Explanation

The action of nanosilver has long been known, but still has not been fully researched. It is believed that nanosilver blocks the replication of genetic material (DNA) and so cells can no longer divide. Additionally, nanosilver inhibits certain enzymes and thus blocks important biochemical reactions in the organism.
This experiment clearly demonstrates the germ-killing action of nanosilver.

Application

Nanosilver soothes irritations and acts against acne and herpes, since it regulates the discharge of sebum and sweat. It is also used to treat neurodermatitis.

Nice to know

It has been alleged that colloidal silver is dangerous because it could cause silver deposits in the body. The skin then turns bluish-grey, a condition also known as argyria. This, however, only happens when silver salts are ingested. Colloidal silver, by contrast, is not a silver salt solution, rather a solution of ultrafine silver particles, which only dissolve as silver ions at low concentrations. Accordingly, when ingesting colloidal silver, it is always recommended to avoid taking it together with drinking water. If one was to do so, then this could produce silver salts due to the minerals present in the water. For the same reason, it should be taken no less than one hour before or after a meal.

NANORA

NANORA is a unique network of public policy institutions, associations, clusters and research and technology centres. Each is active in supporting nanotechnology research and business activities in their respective region and committed to advancing their region by fully exploiting their regional nanotechnology potentials. NANORA – the Nano Regions Alliance – funded by the European Union through the INTERREG IVB NWE Programme, aims at improving framework conditions and support infrastructures for nanotechnology stakeholders.

Its objectives are:

- to develop joint cross-regional business collaborations and supports for companies using nanotechnology expertise to develop more competitive products
- to open new market opportunities for SMEs by taking joint transnational actions for new target markets
- to ensure outreach to policy level and long-term anchoring of the Alliance in the regions

NANORA-Partner

NANORA unites participants from nanotechnology-strong regions from Belgium, France, Germany, Great Britain, Ireland and the Netherlands committed to supporting nanotechnology as a key enabling technology.