Health and safety

Do not inhale the vapours of the aerosol.

Ensure the room is well ventilated during the anti-fog application.

Keep away from eyes and wear waterproof rubber gloves when applying the spray.

We advise that you prepare the glass outdoors or in a ventilated room before the children are present and at least half an hour before doing this experiment.

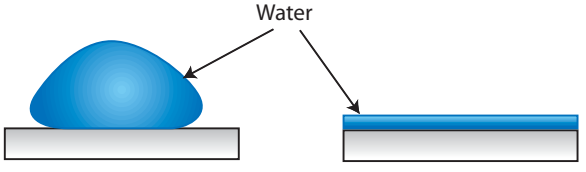
What happens in this experiment?

The anti-fog spray is composed of nano-particles suspended in an alcoholic solution. When the solution dries only the nano-particles stay on the surface while the alcohol evaporates.

Anti-fog agents create a thin film that does not allow the formation of water droplets. This film reduces the **surface tension** of the liquid (the surface tension is the result of the cohesive forces between the molecules that are responsible for the formation of spherical droplets). In the case of water its surface tension is very high. The angle of contact (the angle between the water droplet and the surface it is resting on) is much lower with the surfactant and water sprayed on the surface creates a thin layer instead of forming round droplets.

This is explained by the fact that the nano-particles applied to the surface by the anti-fog spray are **hydrophilic**. This means that they can bond with water molecules through weak chemical bonds called **hydrogen bonds**. The glass itself is slightly hydrophilic and the anti-fog spray increases this property. The water is therefore subjected to two different forces: reduced surface tension that tends to round off the droplets, and bonding to the anti-fog nano-particles that flattens them.

The result is a very thin layer of water on the surface of glass through which it is still possible to see. This type of technology helps prevent goggles used for skiing or swimming steaming up.



Anti-fog flattens the droplets of layer in a thin, transparent layer

Applications

Anti-fog sprays can be defined as a self-cleaning technology since they use the interaction between water and the surface to repel dirt or grease. Water-repellent textiles (see activity 7 on hydrophobic textiles) or water-repellent compounds (also called hydrophobic compounds) are also classified as self-cleaning materials although they work in the opposite way. Anti-fog spray reduces the contact angle between water drops and the glass surface and flattens them out; water-repellent textiles increase this angle and cause round drops that simply roll off the surface.

Why are they self-cleaning? In super-hydrophilic conditions cleaning occurs when the thin layer of water flowing on the surface washes away dust and dirt. Super-hydrophilic surfaces are also oleophobic, which means that they repel oil and grease which makes them in turn easier to clean. Super-hydrophobic coatings cause the formation of spherical droplets that roll off the surface, picking up particulate dirt in their path.

Anti-fog coatings are used to prevent fog forming on optical devices or windows. As they maintain a thin layer of water, hydrophilic coatings can also be used as lubricants and increase the durability and the resistance to abrasion of some materials. Finally, hydrophilic coatings of rubber can be use in sealant products to stop water leaks: the water is attracted to the coating, so less is available to flow through gaps.

If we can be sure that these types of products have no negative environmental impact, this nanotechnology presents a good solution for avoiding the use of large quantities of detergents, plastic and chemical products. Scientists are currently looking for a way to create a permanent anti-fog layer using silica nanoparticles that will last much longer than the anti-fog spray.

Ideas for conducting the activity or discussion

- You could try the anti fog on a mirror.
- You could ask the children in which situations they would have liked to have an anti-fog spray.

Learning objectives or school curriculae

- To understand how nanoparticles can be used to provide a coating that prevents fog formation.
- To have an example of an application of nanotechnology and nanoscience.
- To learn more about the hydrogen bonds that are responsible for some of the unique properties of the water molecule.