Surface Modification in the Bathroom – Man-made surfaces

Look around you and see if you can count the number of different materials surrounding you. A wooden table, glass windows, plastic computers, fabric clothes, the list of different materials in a normal home is almost endless. Each of these materials will have been chemically treated to give it the best and most desirable properties. Surface treatments are designed to improve the properties of the surface they are applied to which means there are as many different surface treatment chemicals as there are surfaces.

Surface treatment in the bathroom

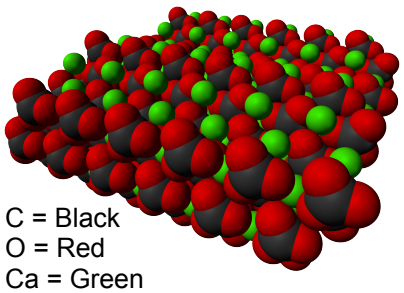
Bathrooms are hostile places for your average material. They are hot and damp and they get cleaned with harsh chemicals and abrasive cleaners. Bathroom surfaces need to maintain their appearance and function as long as possible which means that every surface is going to need some help. Natural surfaces such as wood and cork are generally sealed with varnish to protect them, but you can't varnish a mirror or your towels, so they need different treatments.

Surface treatments often need to be applied regularly to maintain the protection they offer. The easiest way to make sure this happens is to combine the treatment with something else that is normally done on a regular basis – like cleaning. Many cleaners offer protection, the two of interest here are cleaners for shiny surfaces and cleaners for fabrics. These two materials are different in almost every way and so you will be able to see the difference between their respective surface modifying cleaners.

Limescale

Limescale is the common name for deposits of calcium carbonate ($CaCO_3$) and other salts from tap water onto areas where that water has been. Hard water produces far more limescale than soft because it has a higher concentration of dissolved salts such as magnesium carbonate and calcium (Ca) carbonate. It is a particular problem in pipes, kettles and hot water systems where it can cause major damage. This type of limescale is produced by heating water containing Ca carbonates and bicarbonates which causes $CaCO_3$ to precipitate out and coat the kettle or tank.

In the bathroom, limescale is a cosmetic problem. Limescale on mirrors and taps can be unsightly and in some cases unhygienic but as it is a product of water, it is almost unavoidable in hard water areas.



C = Black
O = Red
Ca = Green

Limescale viewed under a scanning electron microscope (left) shows you the crystals of $CaCO_3$ which have formed with plate-like structures building one on top of the other. This shape is the result of the crystal structure of $CaCO_3$ (right) which is plate-shaped on the atomic scale.

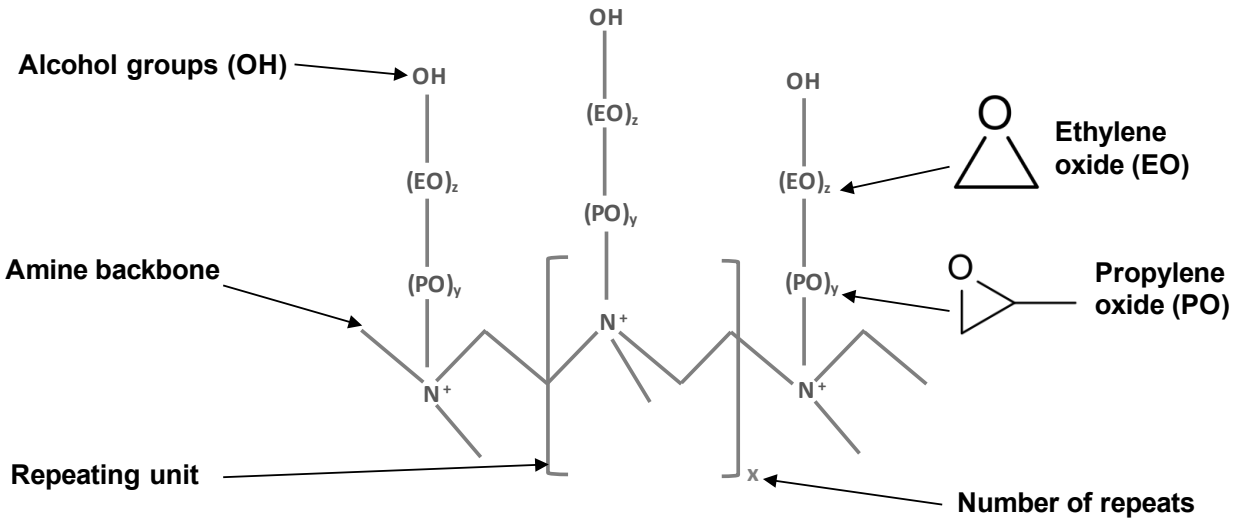
Limescale and mist prevention

It is possible to soften your tap water chemically but this can be expensive and needs to be installed for the whole building to be effective. Instead targeted limescale removal and prevention is a cheaper option.

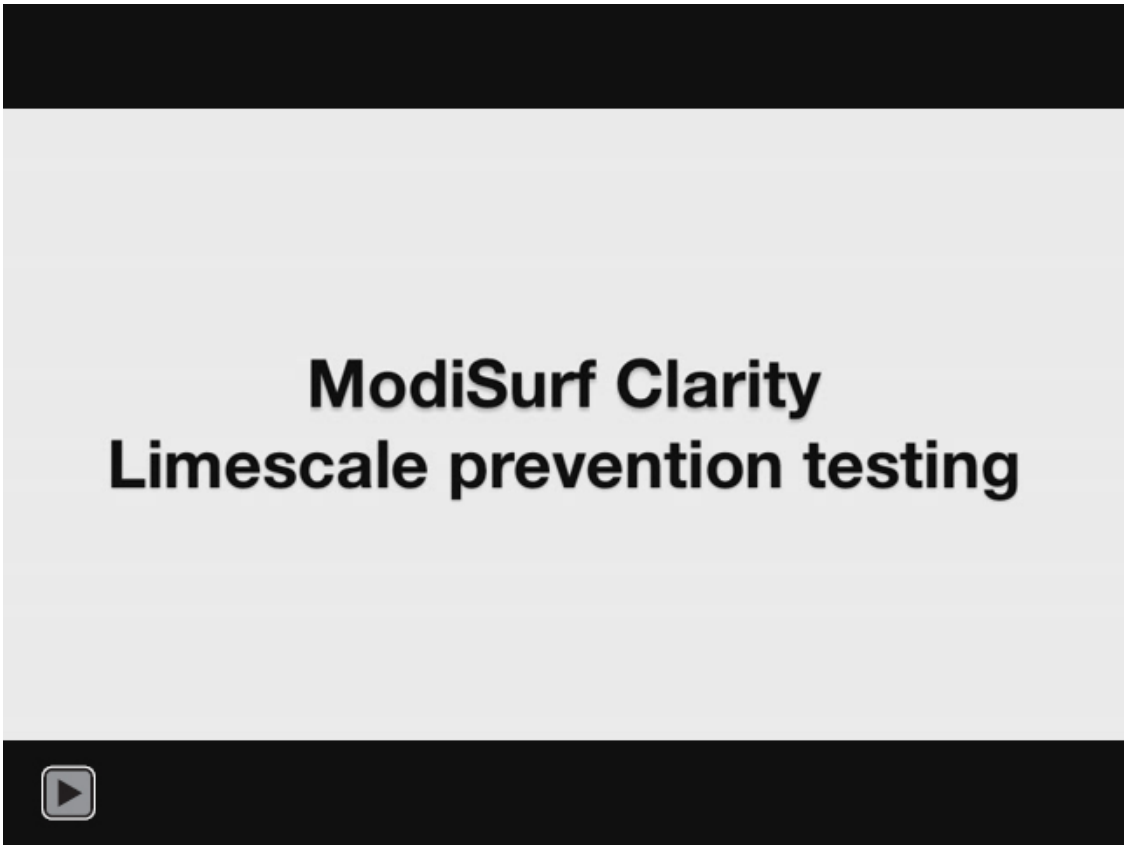
Croda's ModiSurf product is added to surface cleaners and modifies the surface, making it harder for limescale to form. Surfaces such as mirrors and metal taps will stay shiny and limescale-free for longer, meaning less frequent cleaning to maintain their appearance.

ModiSurf is a polymer, which is a molecule made of repeating units (monomers) joined together in a chain. Polymers can be designed to have particular properties and because there are so many monomers available, the possibilities are endless. The ModiSurf polymer structure (below) has a polyamine backbone

with ethylene oxide (EO) and propylene oxide (PO) groups branching off it in a repeating pattern (the parts in the brackets). x is the number of repeats of that monomer there are in one chain, y and z are the number of EO and PO groups in that branch of the polymer.

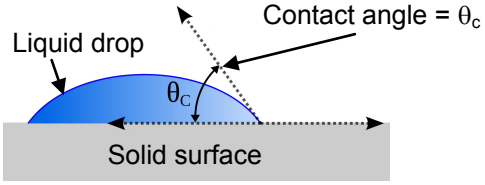


ModiSurf stops limescale from forming by making the surface more hydrophilic (water loving). This means a very thin film of water is left on the surface which keeps the $CaCO_3$ in solution and stops it from crystallising into limescale. The video below shows how ModiSurf reduces the build-up of limescale.



The ModiSurf effect also works on mirrors to keep them from misting up in the steamy atmosphere of the bathroom. When mist forms on mirrors it is as a result of water condensing in tiny droplets on the cold glass surface. ModiSurf makes the droplets form with a different shape which makes them much less visible, reducing the appearance of mist on the mirror.

The method for measuring water droplets on a surface is to measure their contact angle with the surface. This is a function of the wettability of the surface – the more wettable it is, the lower the contact angle, because the surface and the liquid interact with each other more, hence the liquid spreads out more.



Contact angle 36.5° on an untreated glass slide

Contact angle 11° when treated with 0.1% ModiSurf Clarity solution

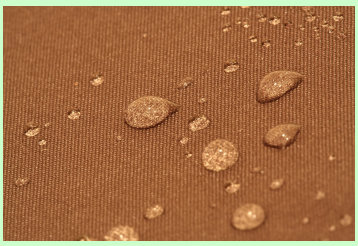
Contact angle 3.8° when treated with 0.5% ModiSurf Clarity solution

As the concentration of ModiSurf is increased, the contact angle of the water droplet on the glass slide decreases. Finally, with 0.5% ModiSurf, the water drop is almost completely flat and won't look like mist on a mirror.

ModiSurf is added to shower cubicle and glass cleaners to both prevent mist and limescale and keep your bathroom looking pristine.

The video below demonstrates how ModiSurf limits the formation of mist on bathroom mirrors.

Wettability

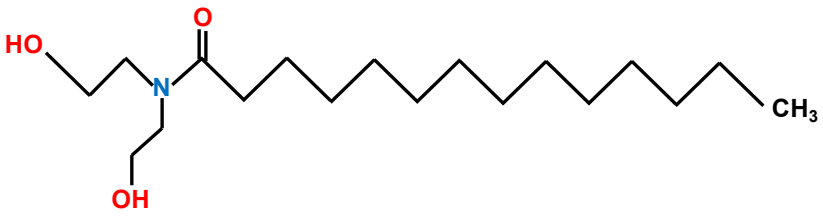


You can see the difference in wettability yourself by looking at the contact angle of drops of water. This fabric is waterproof because it has been treated to make it hydrophobic. It repels the water drops so they can't stick to the fabric and just run off. This also makes them stick up from the fabric because they don't want to touch it. The coating is called polytetrafluoroethylene (PTFE) and is otherwise known as Teflon, the same non-stick coating used in frying pans!

Fabric conditioning

Surfaces aren't just flat places you can put your toothbrush down, there are large surfaces that you can see but there are also microscopic surfaces you can't see with the naked eye. For example, the outside of each fibre that makes up a bath towel is a tiny little surface. By treating all these micro-surfaces, the properties of the towel itself can be changed.

Cirrasol ST Ultra is a fabric conditioning additive for laundry detergent products. It softens the fibres by the addition of free fatty amides into the wash.



Myristic acid diethanolamide

Myristic acid diethanolamide is an example of a fatty amide. The long chain of $-CH_2-$ groups is hydrophobic (water hating) and the amide group at the end, centred on the N atom is hydrophilic. This makes the fabric softener a kind of surfactant capable of interacting with both aqueous and non-aqueous substances at once.

Cirrasol ST Ultra is used in the rinse cycle of the wash. The amides stick to the fibres in the cloth and "fluffs" them up, making the cloth softer and feel more conditioned. If comparing two sets of towels, one washed with Cirrasol ST Ultra and one without, it is possible to see the volume difference the conditioner has made to the towels.

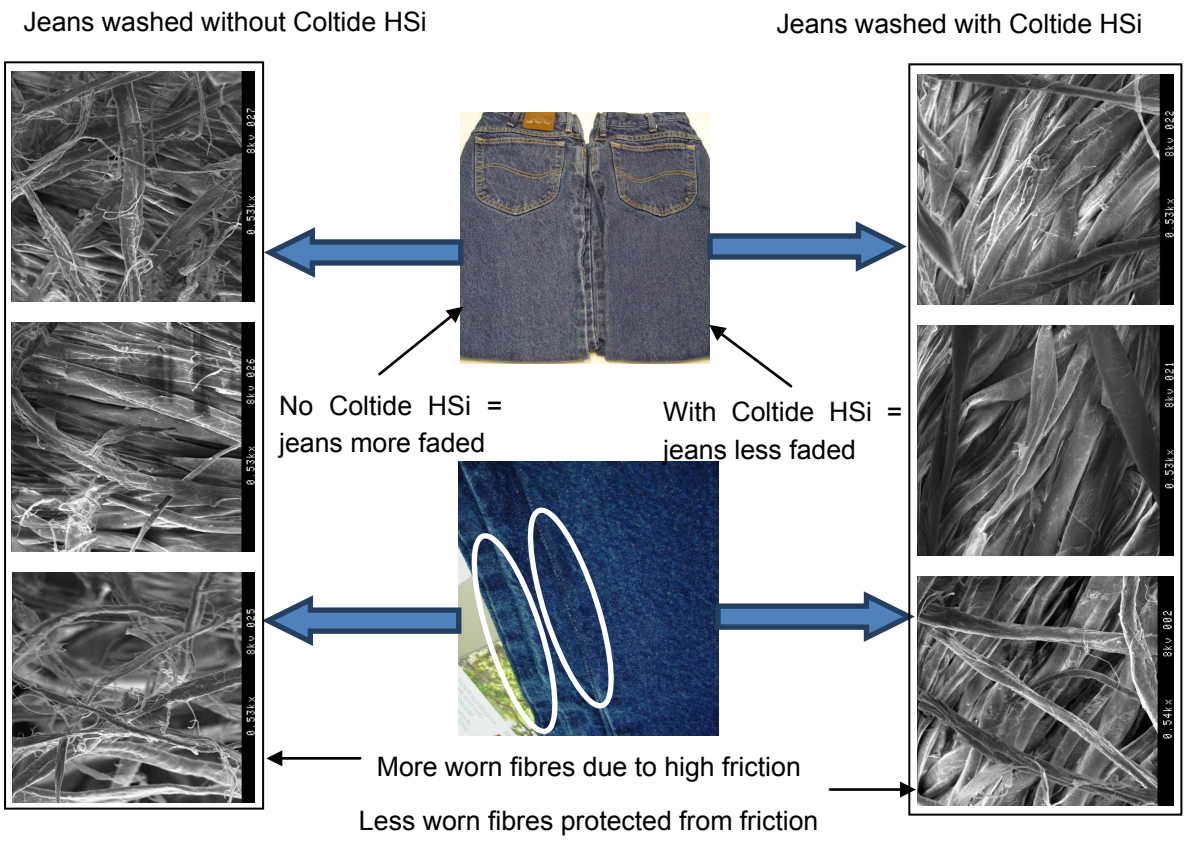
Towels washed with conditioner →

← Towels washed without conditioner

Another type of fabric conditioner is Coltide HSi, which is a polymer made out of wheat and silicon. In this case, the conditioner reduces the friction between fibres in the cloth. This makes the cloth last longer, as it is experiencing less wear and tear, and keeps it looking new.

The type of polymer is called a co-polymer which is a polymer made of two different monomers. In this case, one monomer is derived from wheat protein and the other from silicon.

Coltide HSi coats the fibres of cloth and acts as a lubricant, stopping them from rubbing together as much as they would without conditioning. When two pairs of jeans are washed 20 times, one with another commercial fabric conditioner and the other with conditioner containing Coltide HSi, it is possible to see the difference in the fibre wear clearly using scanning electron microscopy.



Conclusions

Surface modification is required all over the home but nowhere more so than in the bathroom. The hostile conditions are challenging for any surface to maintain its appearance and function without help. Additives in cleaning products like laundry detergents and surface cleaners means that mirrors stay un-misted when you shower, taps don't get fuzzy with limescale and your towels stay fluffy for longer. These additives have been developed individually for the different surfaces they are used on. Advances in home technology and materials just means we will need more surface protectors to keep our new bathrooms and kitchens spotless.

Test your knowledge

Take the short quiz below to test your understanding of surface modification - man-made surfaces.